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Developing a dynamic model of metacognitive influences on anomalous experiences and functional outcome in young people with and without psychosis.

By

Abigail Wright

Thesis submitted for the degree of Doctor of Philosophy

School of Psychology

University of Sussex

November 2018

Statement

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Abigail Wright
16th November 2018

The thesis conforms to an 'article format'.

Chapter 1: Introduction and Chapter 9: General Discussion present a synthetic overview and discussions of the field and the research undertaken.

Chapter 2: Wright, A.C., Fowler, D. & Greenwood, K.E. (2018). Developing a dynamic model of unusual experiences and function in young people with or without psychosis: a cross-sectional and longitudinal study protocol. *BMJ open*, pp.8–10. This chapter is a protocol paper published within BMJ Open. This chapter is referenced separately using AMA referencing, consistent with the publication format.

Chapter 3: Wright, A.C., Fowler, D. & Greenwood, K.E. (submitted). A metacognitive model: The role of metacognitive components on functional outcome and subjective recovery in individuals with and without First Episode Psychosis. This chapter is a cross-sectional study written in the format for Psychological Medicine.

Chapter 4: Wright, A.C., Davies, G., Fowler, D. & Greenwood, K.E. (submitted). Three-year follow-up study exploring metacognition and function in individuals with First Episode Psychosis. This chapter is a follow-up study written in the format for Schizophrenia Research.

Chapter 5: Wright, A.C., Davies, G., Fowler, D. & Greenwood, K.E. (2018). Self-defining Memories Predict Engagement in Structured Activity in First Episode Psychosis, Independent of Neurocognition and Metacognition. *Schizophrenia Bulletin*, pp.1–11. This is a cross-sectional study published within Schizophrenia Bulletin. This chapter is referenced separately using AMA referencing, consistent with the publication format.

Chapter 6: Wright, A.C., Fowler, D. & Greenwood, K.E.. What is the association between metacognition and anomalous experiences and delusional beliefs? A systematic literature review. This chapter is a systematic literature review written in the format for publication in Clinical Psychology Review.

Chapter 7: Wright, A.C., Fowler, D. & Greenwood, K.E. (pilot study). Understanding the association between anomalous experiences, perceptual biases and metacognitive ability within a non-clinical sample: a pilot study. This chapter is a developmental pilot study.

Chapter 8: Wright, A.C., Nelson, B., Fowler, D. & Greenwood, K.E. Perceptual biases, metacognition and their association with anomalous self-experiences in individuals with and without First Episode Psychosis. This chapter is an experimental study written in the format for publication in Abnormal Psychology.

All other chapters are consistent with APA formatting and references for these chapters are included together at the end of the thesis to avoid repetition.

Data from this thesis has been presented at the following conferences:

- Chapter 4 oral and poster presentation at IEPA-11: "Three-year longitudinal study exploring metacognition and function in First Episode Psychosis" (Boston, October 2018)
- Chapter 5 poster presentation at Schizophrenia International Research Society (SIRS) conference: "Self-defining memories predict engagement in structured activity in First Episode Psychosis" (Italy, April 2018)
- Chapter 8 oral presentation at Early Career Hallucination Research (ECHR) Event: "Perceptual biases, metacognition and their association with anomalous self-experiences in First Episode Psychosis" (London, November 2018)

Acknowledgements

First and foremost, I must give my sincere thanks to my supervisors: Professor Kathryn Greenwood and Professor David Fowler. Kathy, throughout the PhD you have always encouraged me to strive for great things and, in the process, have provided a space to give me detailed feedback to help me learn and develop as a researcher. Thank you for your honest and supportive supervision throughout it all. David, thank you for your support and expertise throughout this thesis, and for encouraging me to reflect on the bigger picture of research in clinical practice. I feel honoured to have had this opportunity to work with you both and to be part of a growing and stimulating field of research.

I am grateful to my funders: ESRC and SPFT, for supporting this PhD studentship. I am particularly thankful to have been given the opportunity to conduct research within the NHS and meet incredible people who have experienced psychosis and are so willing to help others. From this, I owe a massive thank you to all the great people who took part in my research studies. The strength and courage it took to share your personal experiences with me has not gone unrecognised.

I was fortunate enough to have been given the opportunity to visit Professor Kim Mueser, Professor Susan McGurk and Professor Paul Lysaker during the summer of 2018. I am very thankful to them for providing many insightful discussions on psychosis. I have been inspired by their work and I am excited to continue working with them.

A huge thank you goes to all members of the SPRiG group (both past and present). To Dr Geoff Davies, thank you for your support both academically and emotionally. From our first conversation about metacognition to working on several great papers, I am grateful for your advice and your patience, and for always been at the end of the phone. Dr Clio Berry, thank you for your support with all things PhD, and particularly your brilliant stats knowhow! Dr Sarah Fielding Smith, thank you for your kindness and support throughout this. I am forever grateful for our friendship. To all the administration staff at Sussex Partnership NHS Foundation Trust and University of Sussex. The difficulty of NHS recruitment was made significantly more bearable with your support.

To my truly wonderful Oxford friends; Charlotte, Owain and Clare for being there from the start and throughout; and particularly at the end, when things were tough. I am so

thankful to have you all. To my fantastic friend, Nikita, for being understanding, kind and thoughtful. I am lucky to have you as a friend. To all my Sussex PhD peers; our collective will has got us through it.

To my Mum and Dad, you are two incredible people with the most beautiful hearts. Your unwavering encouragement and selflessness has allowed me to successfully complete this PhD. Thank you for being part of the journey – through the ups and downs – I couldn't have done it without you both (nor without the writing breaks to the BT). To Lance and Stacey, for always thinking of me, believing in me and cheering me on in all things. You are both so wonderfully thoughtful. To Daniel, for being a great role model and someone who has always inspired me to achieve good and great things. I love you all very much.

In dedication to

All those experiencing psychosis, your inner strength and power is truly inspiring.

"What lies behind us and what lies before us are tiny compared to what lies within us"

– Ralph Waldo Emerson

UNIVERSITY OF SUSSEX

Abigail Wright

Thesis submitted for the degree of Doctor of Philosophy

Developing a dynamic model of metacognitive influences on anomalous experiences and functional outcome in young people with and without psychosis.

Summary

Beck and Rector (2005) proposed a model of functional outcome in schizophrenia, suggesting the path between neurocognition and functioning is mediated by functional capacity and cognitive processes. These cognitive processes include defeatist performance beliefs, self-stigma and, most recently, metacognition, considered 'thinking about thinking'. Metacognition has been proposed to work in a hierarchy between the object- and meta-level, outlined within Nelson and Narens (1990) model, including several metacognitive components: metacognitive ability, experience and efficiency, connected by metacognitive processes. Firstly, this thesis investigated how different metacognitive components may interact dynamically and predict both what people do in their everyday lives (functional outcome) and how people feel about their everyday lives (subjective recovery outcome) in First Episode Psychosis (N=62), compared to healthy controls (N=73). Following this, this thesis examined the role of metacognition in predicting functional outcome across a three-year period, in FEP (N=26). Finally, it was suggested that metacognition may be expanded to include the way one thinks about oneself through important memories, e.g. self-defining memories (SDMs). The role of SDMs as an additional mediator between neurocognition and functioning in psychosis (N=71) was investigated.

Next, using only one of the metacognitive components: metacognitive efficiency, this thesis explored whether this component could be used to explain the presence of anomalous experiences. Anomalous experiences refer to a rich number of various psychic phenomena, including anomalous self-experiences and anomalous perceptual experiences, leading to anomalous delusional beliefs. Initially, this thesis developed and piloted two metacognitive tasks in healthy student sample (N=125). Next, these tasks were used to examine the relationship between anomalous experiences and metacognitive

efficiency within the first two samples (N=135): FEP group (N=62) and healthy control (N=73).

Current findings demonstrated a role for metacognitive ability in predicting both functional outcome and subjective outcome in FEP, cross-sectionally, and in predicting functional outcome across three years. Alongside this, holding specific self-defining memories was shown to predict functional outcome, independent of neurocognition and metacognition, in FEP. However, no significant association was demonstrated between anomalous experiences and metacognitive efficiency, instead anomalous self-experiences were associated with auditory perceptual biases. This thesis highlights the importance of enhancing metacognitive ability, alongside neurocognitive ability and SDMs, in order to improve functioning.

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Abbreviations

ARMS = At Risk Mental State
ATM = Autobiographical Memories
BCIS = Beck Cognitive Insight Scale
CAPS = Cardiff Anomalous Perceptions Scale
CBT-p = Cognitive Behavioural Therapy – Psychosis
CDS = Cambridge Depersonalisation Scale
CDS ABE = Cambridge Depersonalisation Scale Anomalous Bodily Experiences
CDS AFS = Cambridge Depersonalisation Scale Alienation From Surroundings
CDS ASR = Cambridge Depersonalisation Scale Anomalous Subjective Recall
CDS EN = Cambridge Depersonalisation Scale Emotional Numbing
CFA = Confirmatory Factor Analysis
CLI = Comparative Fit Index
CRT = Cognitive Remediation Therapy
DUP = Duration of Untreated Psychosis
EASE = Examination of Anomalous Self-Experience
EFA = Exploratory Factor Analysis
EIS = Early Intervention Service
ESM = Experience Sampling Method
FEP = First Episode Psychosis
FIML = Full Information Maximum Likelihood
GABA = Gamma-Aminobutyric Acid
IPASE = Inventory of Psychotic-Like Anomalous Self-Experiences
IPII = Indiana Psychiatric Illness Interview
LI = Latent Inhibition
MAI = Metacognition Assessment Interview
MAR = Missing At Random
MAS = Metacognitive Assessment Scale
MAS-A = Metacognitive Assessment Scale-Abbreviated
MCAR = Missing Completely At Random
MCQ = Metacognitions Questionnaire
MERIT = Metacognitive Insight and Reflection Therapy
Meta-*d'* = Metacognitive Sensitivity
Meta-*d'*/*d'* = Metacognitive Efficiency
MLE = Maximum Likelihood Estimation
MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire
NMDA = N-Methyl-D-aspartic acid
NEET = Not in Education Employment or Training
PANSS = Positive and Negative Syndrome Scale
PDI = Peter's Delusion Inventory
PTG = Psychosis Theme Group
QPR = Questionnaire of Process of Recovery
RMSEA = Root Mean Square Error of Approximation
SDM = Self-Defining Memories
SDT = Signal Detection Theory
SMS = Self-Memory System
SMI = Severe Mental Illness
SSI = Schizotypal Symptom Inventory
TMT = Trail-Making Task

TUS = Time-Use Survey
UCSD = University of California San Diego
UHR = Ultra-High Risk
UPSA = University of California San Diego Performance-Based Skills Assessment

1. Chapter One: Introduction

1.1 Psychosis

1.1.1 Definition

Psychosis is a serious mental health disorder and referred to a state of being out of touch with reality (Cooke, 2014; The National Institute of Mental Health, n.d.). Psychosis is characterised by positive symptoms (experiences that are in addition to normal experience, e.g. hearing voices), negative symptoms (dampening of normal experiences, e.g. loss of motivation), cognitive deficits and disorganised symptoms and an impairment in functioning.

There are a number of psychological symptoms within psychosis, which fit into 4 broad categories:

1.1.2 Positive symptoms

Positive symptoms can include hallucinations; aberrant sensory experiences which occur in the absence of a stimulus. This can occur in a variety of sensory domains; hearing, vision, smell, touch and taste. Hallucinations most commonly occur in the auditory domain (Shergill, Murray, & McGuire, 1998; Waters, Allen, et al., 2012). Positive symptoms can also include delusional beliefs, referring to strongly held false beliefs, outside of the cultural norm, which persist even when presented with contradictory evidence. There are a number of different types of delusions: Delusions of control, believing that an external being is capable of controlling one's mind; Grandiosity, believing one has special powers or hidden talents which gives one an inflated sense of power; and Persecutory delusions, believing one is being conspired against.

1.1.3 Negative symptoms

Negative symptoms can include blunted affect; reduced expression of emotion through reduced range of facial expressions and flat tone of voice; reduced feeling of pleasure in life; detachment from emotional events or experiences; and reduced speech. Whilst negative symptoms are usually grouped into one category, this factor was recently considered to be split into two factors: negative community symptoms (Emotional

withdrawal, Passive/apathetic social withdrawal, and Active social avoidance) and negative emotional expression symptoms (Flat affect, Poor rapport, Lack of spontaneity, Mannerisms and posturing, Motor retardation, and Avolition) (Liemburg et al., 2013).

1.1.4 Cognitive deficits

Cognitive deficits refer to difficulties in memory, attention, processing speed, executive functioning, and perceptual reasoning. These variables can represent one single neurocognitive factor (see Keefe et al. 2004; Keefe et al. 2006; Nuechterlein et al. 2011; Schmidt et al. 2011) which is impaired in psychosis. It has been suggested psychosis is initially characterised by a general cognitive deficit, which may change over the course of the illness (Hill, Schuepbach, Herbener, Keshavan, & Sweeney, 2004) and is demonstrated across FEP groups (schizophrenia, bipolar, psychotic depression) (Hill et al., 2009). Recently, cognitive factors were considered to be a central part of the experience of psychosis (Hasson-Ohayon, Goldzweig, Lavi-Rotenberg, Luther, & Lysaker, 2018). Meta-analysis demonstrated that cognitive deficits in psychosis have been considered neurodevelopmental (occurring before the onset of psychosis) not neurodegenerative (Bora, 2015; Bora & Murray, 2014; Zipursky, Reilly, & Murray, 2013).

1.1.5 Disorganised symptoms

Disorganised symptoms can include disorganised speech and thoughts (e.g. thought disorder). This category has been shown to have significant overlap with cognitive deficits and negative symptoms (Basso, Nasrallah, Olson, & Bornstein, 1998; O'Leary et al., 2000), and the items referring to negative or disorganised subscales within the Positive And Negative Syndrome Scale (PANSS) (Kay & Fiszbein, 1987) have been disputed (Marder, Davis, & Guy, 1997), highlighting evident overlap between the concepts.

1.1.6 Diagnosis

Psychosis is an umbrella term which is central to the clinical diagnoses in schizophrenia spectrum disorders, outlined in the ICD-11. Additionally, affective psychosis is classified under affective disorders in ICD-11 under Bipolar Type I or Type II (6A60-61). According to DSM-5 "schizophrenia is characterized by delusions, hallucinations,

disorganized speech and behaviour, and other symptoms that cause social or occupational dysfunction. For a diagnosis, symptoms must have been present for six months and include at least one month of active symptoms" (American Psychiatric Association, 2013). The DSM 5 recently increased the threshold to require the individual to exhibit at least two of the specified symptoms.

However, there is controversy surrounding the use of diagnoses in mental health. Psychosis has long been noted as having a very heterogeneous course (Carpenter, William, Kirkpatrick, & Brian, 1988) and, therefore, classifying individuals who have very different experiences within the same category may not always be appropriate nor helpful for the individual. Mental health clinicians focus on both diagnosis and symptom expression; with a move towards focusing on symptom severity using a continuum approach. At the start of the continuum is subtle expressions of psychotic experiences within the general population to extreme psychotic symptoms, as demonstrated within acute psychosis (Cuesta, Basterra, Sanchez-Torres, & Peralta, 2009). By using this continuum approach, this shifts the focus to current difficulties faced by the individual. From this, research has triggered the interest in a "what works for whom" or "personalised medicine" approach.

1.1.7 Prevalence and incidence

In terms of prevalence, psychosis appears in approximately 1% of the population (Frith, 1992; Johns & van Os, 2001; RM Illness, 2012; Singleton, Lee, & Howard Meltzer, 2000) or 3.1 cases per 1000 (Kessler et al., 2007; Morgan et al., 2014). In terms of incidence, there is a 0.2-0.7% lifetime incidence rate for non-affective psychosis (Kendler, Gallagher, Abelson, & Kessler, 1996). Incidence estimates of psychosis are associated with low income; unemployment (Kessler et al., 2005); a marital status of single, divorced, or separated; and urban residence (Kendler et al., 1996), suggesting that psychosis is a complex disorder with multiple psychological, social and biological factors involved.

However, research has recently demonstrated that psychotic experiences/symptoms may be more common than once thought. For example, paranoia, excessive fears about others which are common in psychosis (Freeman et al. 2002; World Health Organization, 1973),

appear to have a prevalence of 18.6% calculated from data taken from the general population (Freeman et al., 2011). Equally, anomalous experiences, common in psychosis (Mitchell et al., 2017), are demonstrated to be common within the general population (Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012), with 48% of a large sample within the general population reporting these experiences (Pechey & Halligan, 2012). This demonstrates psychosis is not a discrete illness entity (Johns & van Os, 2001), but instead psychotic experiences are on a spectrum, meaning low level symptoms may be common in the general population. However, it should be noted that whilst these psychotic experiences may be common within the general population (Vaughan Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012), the frequency and intensity is increased in those with psychosis or those with emerging severe mental health difficulties (Brett, Johns, Peters, & McGuire, 2009; Reininghaus et al., 2016; Yung, Phillips, Yuen, & McGorry, 2004).

1.1.8 Age of onset

Typically, psychosis occurs in late adolescence, with First Episode Psychosis (FEP) demonstrating a mean age of onset at 23.7 years, compared to youth-onset psychosis at 13.6 years and late-onset psychosis at 60.7 years (Kessler et al., 2007; Rajji, Ismail, & Mulsant, 2009). Late adolescence may be a particularly vulnerable period as the brain is undergoing specific changes, including the development of higher cognitive functions (Paus, Keshavan, & Giedd, 2008) and increased white matter volume, enabling a smooth flow of information throughout the brain (Paus, 2005). Psychosis has been associated with impairment in the connection of white matter in the brain (Wu et al., 2015), associated with loss of cognitive control capacity (Schaeffer et al., 2015). Later this has been associated with positive and negative symptoms in psychosis (Asami et al., 2014). Alongside biological changes, there are many environmental changes occurring within late adolescence, such as changing schools or moving to University, changes in friendships and relationships; associated with poor mental health (Currie et al., 2012; Green, McGinnity, Meltzer, & Ford, 2004; Sawyer et al., 2001). As both biological and environmental factor play a role in the development of psychosis (Paus et al., 2008), this gives rise to the bio-psycho-social model of psychosis; including genes, childhood/adult adversity, urban living, migration and other risk factors (Murray, Bhavsar, Tripoli, & Howes, 2017).

1.1.9 Prognosis or outcomes

Although clinical recovery after an experience of psychosis was previously considered poor (May et al., 1981), recent research has demonstrated that around 50% of individuals with schizophrenia have favourable outcomes after long follow-up periods (Harrison, Hopper, Aig, et al., 2001; Harrow, Grossman, Jobe, & Herbener, 2005; Wunderink, Sytema, Nienhuis, & Wiersma, 2009), recently supported within First Episode Psychosis (FEP) samples (Henry et al. 2010; Robinson et al. 2004). For example, a 10-year follow-up study showed 77% of those followed up showed at least one period of recovery, with 46% as symptom free for at least two years (Morgan et al., 2018). However, for Robinson et al. (2004) and Edwards, Maude, McGorry, Harrigan, & Cocks (1998) only 14% and 6.6% (respectively) met the criteria for full recovery, suggesting whilst some may experience recovery, during early stages of illness this recovery may be slow.

Clinical recovery can be deemed as both improvement in symptomatology and social/occupational functioning (Andreasen et al., 2005; Harvey & Bellack, 2009). Liberman and Kopelowicz (2002) created operationally defined criteria for recovery from schizophrenia, including symptom remission, employment, independent living, and social support, sustained for two years.

The service user model of recovery has recently gained interest which aims to focus on aspects of recovery and wellbeing that are important to the individual and their subjective experience. A well-established piece of research from Anthony (1993) suggested that recovery is "a way of living a satisfying, hopeful, and contributing life even with the limitations caused by illness. Recovery involves the development of new meaning and purpose in one's life as one grows beyond the catastrophic effects of mental illness" (p. 15). Recovery is considered to include building a meaningful and satisfying life, as defined by the person themselves (Shepherd, Boardman, & Slade, 2008). Recovery may be a "process of self-discovery and self-management" (Yeomans et al., 2010, p.92). Recovery is not easily separable from "recovering" (Liberman & Kopelwicz, 2005) as the process of recovery entails evolution and change and may never be a fixed state, but instead a personal journey, a multi-dimensional construct for an individual, rather than an objective status (Mancini, Hardiman, & Lawson, 2005). When there is evidence of

resolved symptoms and increased function, there is commonly evidence of subjectively experienced qualities such as hope, empowerment, and independence (Liberman & Kopelwicz, 2005). Therefore, both objective and subjective outcomes are important.

1.1.10 First Episode Psychosis

First episode psychosis refers to the first psychotic episode which may be disturbing and unusual, causing fear or confusion in the individual. As suggested above, FEP occurs usually in late adolescence. Early detection is key for early intervention to prevent deterioration of symptoms and function and increase likelihood of good recovery outcomes (Johannessen et al., 2001). A shorter Duration of Untreated Psychosis (DUP) has been modestly associated with better long-term outcomes (Marshall et al., 2005). Studies assessing DUP in the United Kingdom demonstrate a mean DUP of 74 days (Reichert & Jacobs, 2018), predominately due to the targets enforced on Early Intervention Services (EIS). However, there are a number of barriers to prevent early help-seeking: fear, stigma, confusion, embarrassment, psychotic symptoms themselves. Hence, services have attempted to reduce delays in waiting time or treatment for those who do seek help (Addington, Van Mastrigt, Hutchinson, & Addington, 2002; Lincoln, Harrigan, & McGorry, 1998). For example, service users with FEP should be allocated and engaged with EIS within two weeks of the referral or offered an assessment if considered as having "At Risk Mental State" (ARMS). During the assessment for FEP or ARMS there are certain standards the EIS team must adhere to provide adequate and appropriate care (Early Intervention in Psychosis Network, 2016). Early Intervention Services (EIS) for First Episode Psychosis has a key role in preventing further disability, often during the "critical-period" (Birchwood, Todd, & Jackson, 1998), and is important for the detection of those who are at-risk and provide targeted interventions to prevent further difficulties (Bertolote, Mc, Shiers, & Smith, 2002; Max Marshall & Rathbone, 2011; Mcgorry, Killackey, & Yung, 2008).

1.2 **Functional outcome**

1.2.1 Definition

Functional outcome is a measurable aspect of an individual's specific activities of daily living, and social and occupational functioning. Functional outcome is particularly important in psychosis, as studies have demonstrated that a significant number of young

people with psychosis have poor functioning and fail to return to work (Fowler et al., 2009). Fowler et al. (2010) suggested "If the goal is prevention of long term social disability it may be worth investigating if emphasising more clearly early functional impairment and comorbid emotional and behavioural dysfunction should take priority in selecting cases for intensive intervention in prevention clinics rather than psychotic symptoms alone" (p.66). Even a follow-up study at 2, 5, and 11 years, demonstrated that there were still significant impairments in social and occupational functioning at each point for individuals with psychosis (Carpenter & Strauss, 1991). This highlights the importance of tackling and understanding poor functional outcome in young people with, or at clinical risk of, psychosis to prevent potential long-term disability.

1.2.2 Occupational functioning

Employment is central to the concept of recovery in Severe Mental Illness (SMI) (McGurk, Mueser, Derosa, & Wolfe, 2009), as finding meaningful work or roles can be an important part of recovery for those with severe mental health difficulties (Provencher, Gregg, Mead, & Mueser, 2002; Secker, Grove, Seebohm, 2001; Spaniol, Wewiorski, Gagne, & Anthony, 2002). However, employment is generally low in schizophrenia, First Episode Psychosis (FEP) and those with At-Risk Mental State (ARMS) (Cella, Edwards, & Wykes, 2016; Cotter et al., 2017; Marwaha & Johnson, 2004). For many, employment is considered a long-term goal (Secker, Grove & Seebohm, 2001) and studies have demonstrated that being in paid work is associated with fewer symptoms and better functioning in psychosis (Bell, Paul, & Robert, 1996; Eklund, Hansson, & Ahlqvist, 2004; Marwaha & Johnson, 2004), improved quality of life in schizophrenia and physical functioning (Strassnig et al., 2018; Üçok, Gorwood, & Karadayi, 2012).

Occupational functioning has been measured using a simple categorical variable (within full-time or part-time work or unemployment for a period of time) (McGurk & Meltzer, 2000), although this does not explain much regarding the quality of this work. A study assessing occupational functioning in FEP measured work based on number of jobs, hourly pay, number of hours per week and number of weeks per job. McGurk et al. (2009) later measured occupational functioning in a more detailed manner by tracking paid employment on a weekly basis through combination of interviews with consumers and staff. Employment quality can be measured using scales such as the Work Behavior

Inventory (Bryson, Lysaker & Zito, 1997) which involves observation and rating of the individual's behaviour at work on areas including: social skills, cooperativeness, work habits, work quality and personal presentation. This has been reliably used in a schizophrenia sample (Lysaker, Dimaggio, et al., 2010).

1.2.3 Social functioning

Social functioning refers to several functional areas such as school/work, leisure activity, living skills, forming peer relationships (Bourdeau, Masse, & Lecomte, 2012). Social functioning is considered poor in schizophrenia (Häfner, Nowotny, Löffler, an der Heiden, & Maurer, 1995), First Episode Psychosis (Grant, Addington, Addington, & Konnert, 2001) and ARMS (Chudleigh et al., 2011), suggesting social functioning impairments precede the onset of full-threshold psychosis (Grant et al., 2001). The quantity and quality of reported social networks is significantly reduced (Macdonald, Hayes, & Baglioni, 2000) and social relationships tend to be more negative (Mackrell & Lavender, 2004).

Alike to daily functioning, Bourdeau, Mass and Lecomte (2012) measured social functioning using the Client's Assessment of Strengths, Interests, and Goals (CASIG), including social: friends and leisure, then vocational: money management, food preparation, health management, transportation, personal hygiene and care for personal possessions. However, this measure encompasses a range of functional activities rather than social activities per se. Instead, social functioning has been measured using more detailed measures that better capture social functioning deficits. The Maryland assessment of social competence (MASC) measures an individual's ability to solve common problems in an interpersonal context (Bellack, Sayers, Mueser, & Bennett, 1994). This involves role play scenarios involving social interactions and the individual must maintain focus and achieve the goal of the scenario. Bellack et al. (1994) and Hawkins, Sofronoff and Sheffield (2009) also used the Social problem solving assessment battery (Sayers et al., 1993) which assesses the ability of individuals to discriminate between effective and ineffective social problem-solving behaviour.

In order to increase ecological validity, Patterson, Goldman, McKibbin, Hughs and Jeste (2001) used the social skills performance assessment, specifically for measuring social

skills directly for individuals with diagnosis of schizophrenia. This involves the participant initiating and maintaining a conversation for 3 minutes e.g. greeting a neighbour or calling a landlord to request a repair for a leak. They are then scored on fluency, clarity, focus, negotiation ability, persistence and social appropriateness during the interaction. This enables the individual to demonstrate appropriate real-life skills for social functioning.

1.2.4 Functional capacity

Functional capacity or direct performance on everyday skills task, is shown to be poor in psychosis (Patterson et al., 2001). This can be measured using specific level of functioning measures; assessing variety of aspects such as personal care, interpersonal skills, community activities and work skills (Bowie et al., 2008; Mausbach, Moore, Bowie, Cardenas, & Patterson, 2009). Functional capacity is significantly impaired in schizophrenia and FEP (Bowie, Reichenberg, Patterson, Heaton, & Harvey, 2006; Vesterager et al., 2012) and has been consistently associated with difficulties in community/real-world functioning (Bowie et al., 2006; Green, Kern, Braff, & Mintz, 2000; Mausbach et al., 2010; Vesterager et al., 2012).

Direct Assessment of Functional Status Scale was developed by Loewenstein et al. (1989) for Alzheimer's disease and related disorders; reliably used within schizophrenia (Gladsjo et al., 2004; Patterson et al., 2002). This assesses functioning in several areas, including, time orientation, communication, transportation and grooming. This direct behavioural assessment is considered less likely to be prone to biases, inherent to subjective ratings and therefore provide a superior method for assessment conducted longitudinally (Loewenstein et al., 1989).

UCSD Performance-Based Skills Assessment (UPSA) has been used to measure functional capacity in adults with severe mental health difficulties (Patterson et al., 2001). This measure assesses participants' performance in 5 domains: household chores, communication, finance, transportation, and planning recreational activities. This measure correlated with other functional capacity measures and has been used reliably in various studies (Leifker, Bowie, & Harvey, 2009; Mausbach et al., 2009), including with FEP (Davies, Fowler, & Greenwood, 2017). A brief version has been created which only

assesses communication and finance: UPDA-B (Mausbach, Harvey, Goldman, Jeste, & Patterson, 2007).

The Test of Adaptive Behaviour in Schizophrenia (TABS) (Velligan et al., 2007) assesses functional capacity in assessing the initiation of tasks in the real world and ability to identify problems that occur during the course of functional activities. For example, clothes closet; selecting appropriate clothes for various circumstances, or shopping skills; using a map to get to the store, shop for items with pictures of aisles, and identifying when they had not received the correct change. This incorporates motivation which may be more related to subjective functioning. Whilst performance-based measures appear to have the most evidence for predicting concurrent self-maintenance abilities (Mausbach et al., 2009), a criticism for the role-play type assessment is that they are conducted within an artificial setting and other issues such as medication side-effects, physical disability, and symptoms may play a role.

1.2.5 Community functioning

Community functioning involves identifying the structured activities an individual is currently involved within, rather than the observing whether they have the functional capacity skills to perform the different activities. This can include occupational functioning, social functioning, independent living, and sports/leisure activities, the most varied category of outcomes (Green et al., 2000). Community functioning has been demonstrated as impaired in schizophrenia (Velligan, Bow-Thomas, Mahurin, Miller, & Halgunseth, 2000) and First Episode Psychosis (Malla & Payne, 2005).

Community functioning has been measured using a supermarket shopping task (Hamera & Brown, 2000), which involves an individual selecting appropriate and cost-effective items within a real-world shopping environment. Greenwood, Landau and Wykes (2005) demonstrated that individuals with schizophrenia were significantly impaired on the task compared to healthy controls. This overcomes the criticism of functional capacity tasks which are conducted within artificial settings. Greenwood et al. (2016) recently used a virtual reality version of the shopping task, in which significant correlations were found between virtual reality and real-life function measures of function (accuracy and efficiency). It was suggested that a virtual reality functional shopping measure may

enhance predictions of real life performance over and above existing cognitive test procedures and may be more time-efficient. This supported virtual reality as a viable alternative to direct assessment of real life function.

1.2.6 Global functioning

Other more traditional community functioning measures use interviews or self-report type measures to assess functioning, which can be corroborated by caregivers' or staff reports. Global Assessment of Functioning (GAF) is the most commonly used measure of functioning which is a clinician-rated measure of an individual's overall functioning (Aas, 2010; Jones, Thornicroft, Coffey, & Dunn, 1995). The measure consists of 10 ranges of functioning which describe a person's overall psychological, social and occupational functioning. The Specific Level of Function Scale (Schneider & Streuening, 1983) uses caregiver's report on individual's functioning on physical functioning e.g. vision, hearing, personal care, interpersonal relationships e.g. maintaining contacts, socially acceptability e.g. repetitive behaviours, swearing, participation in community activities, and work skills. The Role Functioning Scale (Goodman, Sewell, Cooley, & Leavitt, 1993; McPheeters, 1984) has been used to assess functioning in different domains: working: productivity; independent living: self-care, managing household, eating, sleeping, hygiene; extended social network relationships: neighbours, church, community.

Community Adjustment Form (CAF) (Test et al., 1991) assesses the individual's living situation, time spent in institutions, employment record, leisure time activities, social relationships, quality of environment, and subjective satisfaction with life. This was initially used for assessing long-term community care through an assertive continuous treatment team. However, this has only been used within individuals considered to have long-term severe mental health difficulties, particularly with the inclusion of an item assessing time spent in institutions, which may not be as informative within a FEP group.

The Time-Use Survey, adapted from the UK 2000 Time Use Survey (Short, 2003, 2006), assesses social and occupational functioning and has been used multiple times within FEP (Fowler et al., 2009; Harrison, Hopper, Craig, et al., 2001). This measures the number of hours in structured activity per week. Previous research demonstrated that healthy control

participants were engaged in 63 hours of structured activity per week, compared to individuals with First Episode Psychosis who were only engaged in 25 hours of structured activity a week (Hodgekins, French, et al., 2015). Whilst individuals who experienced delayed recovery were only engaged in around 20 hours per week. However, improvements in hours spent in structured activity has been associated with recovery from psychosis (Fowler et al., 2009; Hodgekins, Birchwood, et al., 2015), hence this is a clinically significant measure.

1.3 Subjective outcome

1.3.1 Definition

Functional outcome has been considered as more relevant for the "disease" model, focusing on symptom remission and objective level of functional recovery. However, the literature is not consistent in the method of recording recovery which leads to unnecessary variation (Silverstein & Bellack, 2008) and such functional measures can be confounded by symptoms (Hodgekins, French, et al., 2015).

More recently, literature also considered a "recovery"-focused model, focused on service user perspective and subjective outcome on recovery (Silverstein & Bellack, 2008). Literature reviews of personal narratives demonstrate themes within personal recovery/subjective outcome in mental health which include social connectedness, meaning, hope, identity, responsibility (Andresen, Oades, & Caputi, 2003; Leamy, Bird, Le Boutillier, Williams, & Slade, 2011; Roberts & Boardman, 2013; Sheridan, 2017; Warner, 2009) and empowerment (Warner, 2010). The use of the subjective model of recovery has become mental health policy in a number of countries (Department of Health, 2011; Le Boutillier et al., 2015). Subjective recovery models identify recovery as both a process and an outcome (Ramon et al., 2007), which mimics the peaks and troughs in the recovery trajectory that can be demonstrated within First Episode Psychosis (Hodgekins, Birchwood, et al., 2015a), along with the historically recorded heterogeneity of psychosis recovery (Carpenter, William, Kirkpatrick, & Brian, 1988).

Recovery is defined as a deeply personal, unique process of changing one's attitudes, values, feelings, goals, skills and/or roles. It is a way of living a satisfying, hopeful and contributing life even with the limitations caused by illness (Anthony, 1993). "Recovery can imply a return to a former identity or the emergence of a new one" (p. 55) (Topor,

2001), with new meaning and purpose in one's life as one grows beyond the catastrophic effects of mental illness (Anthony, 1993, p.15). It may be that individuals do not aim to return to their former identify, as this could have led to symptoms or functional difficulties which may have been intrinsic and habitual aspects of their existence and identity (Harvey & Bellack, 2009; Henriksen & Parnas, 2014). Instead, creating a new self, which integrates the experiences into their lives, may be more beneficial.

Although research has started to move towards identifying similar definitions and themes in recovery across languages and countries (Oades & Slade, 2008), there is currently no universal definition of recovery and, at times, it can be a contested concept (Bonney & Stickley, 2008). Despite this, Leamy et al. (2011) demonstrated, within a review of the literature, that both ethnic minority and ethnic majority groups have a very similar concept of recovery, with only stigma and spirituality majorly differing. Recovery is defined by the service users as a nuanced, multifaceted concept, with many influences from society, mental health system, peers, family, and individual aspects (Leggatt, 2002). Recovery is an ongoing process which requires a change in attitudes and values (Booney et al., 2008). It can be associated with learning and growth. People's experiences are fluid and are seen as uniquely individual journeys. Roberts and Boardman (2013) suggested that it is important that the individual becomes actively involved and engaged with their recovery process. The service user-led recovery movement has much to say about empowering people through re-balancing the power and authority of professionals (Shepherd et al., 2008).

1.3.2 **Measures**

Subjective outcome (or personal recovery) has been measured predominately using self-report measures and the following research will highlight appropriate measures to determine which measure to use within this thesis. Warwick-Edinburgh Mental Wellbeing Scale (WMWS) covers both feelings and functioning aspects of mental wellbeing (Clarke et al., 2011). This focuses entirely on positive aspects of mental health, considered the foundation for wellbeing and effective functioning for both the individual and the community (WHO). Questionnaire of Process of Recovery (QPR) (Neil et al., 2009) fits a number of the recovery models outlined above very well (Bonney & Stickley, 2008; Leamy et al., 2011). It focuses on identity, empowerment, acceptance, insight,

control, responsibility, and assessing whether there has been an evident change from a previous identity (e.g. during the mental health crisis, for example) as suggested by the recovery model from (Sheridan et al., 2012). This measure is currently being used within the NHS services to assess subjective outcome.

The Choice of outcome in CBT for psychoses (CHOICE) (Greenwood et al., 2010) measure is a service user-led outcome measure of psychological wellbeing, following CBT-p. This focuses on individual's outcome based on their experiences and feelings, and does not require them to acknowledge their illness. However, due to some questions, this is considered most appropriate following CBT-p. The Recovering Quality of Life (ReQol) (Keetharuth et al., 2018) was developed to assess quality of life in individuals with mental health conditions. This is consistent with the themes of recovery, as reported by Roberts and Boardman (2013). However, ReQol is slightly more negatively worded. From the research on the various measures, this thesis will use the Questionnaire of Process of Recovery (QPR) as it appears the most appropriate measure for recovery in psychosis as it covers a range of different aspects of recovery which are outlined in the recovery measures, it is acceptable to a group of service users and is currently being used within NHS services; so this research may be more directly translatable or applicable to current services.

1.3.3 **Association with functional outcome**

Functional outcome is associated with aspects constituting quality of life (Frattali, 1998) and it has also been associated with subjective outcome (self-rated outcome reflecting sense of wellbeing and quality of life) in individuals with severe mental health difficulties (Malla & Payne, 2005; Provencher et al., 2002). Although these concepts do reflect different criteria to judge improvement and are influenced by different factors, e.g. diminished insight, demoralization, or altered life expectations, so the relationship between these can change over time (Goldberg & Harrow, 2005). There is clear interest in the early identification of those at risk of poor outcome (objective and subjective), to target interventions to reduce this disability. Assessing both objective and subjective function will allow a more in-depth understanding of functional recovery and the variables which are associated with it.

As literature has highlighted that poor outcome is associated with failure to return to work and further disability (Fowler et al., 2009), there is a large social and personal cost associated with psychosis (Knapp, Mangalore, & Simon, 2004). Despite significant advances in psychological interventions for psychosis, outcomes remain poor. Therefore, there is clear interest in the identification of factors which influence recovery after FEP.

1.4 **Factors which influence functional outcome**

1.4.1 Neurocognition

Research assessing functional outcome within individuals with psychosis has generally focused on the influence of neurocognitive difficulties (Green, 1996; Green et al., 2000; Green, Kern, & Heaton, 2004; Lepage, Bodnar, & Bowie, 2014). Domains of cognitions have generally been combined into one neurocognitive factor within psychosis (see Keefe et al., 2004; 2006; Nuechterlein et al., 2011; Schmidt et al., 2011). Reviews identifying which specific aspects of cognitions influence outcome in psychosis can be found elsewhere (see Makarewicz, Karakuła-Juchnowicz, & Łobejko, 2017). For example, Vesterager et al., (2012) demonstrated using a 10-month follow-up study that cognitions (working memory and visual learning) predicted functional outcome in FEP. Whilst Torgalsbøen, Mohn, Czajkowski and Rund (2015) demonstrated attention specifically predicting functioning after 2 years of FEP. This suggests the different influences of various cognitive functioning.

Given the multitude of factors at play in individuals deemed as experiencing long-term schizophrenia, assessing a FEP group may be more valuable in terms of identifying changes or developments of deficits. A recent systematic review demonstrated that there is evidence of basic cognition impairments in individuals with ARMS (including memory impairments, executive functioning, processing speed, learning, attention) and there is a progressive cognitive decline from ARMS to the onset of First Episode Psychosis (de Paula, Hallak, Maia-de-Oliveira, Bressan, & Machado-de-Sousa, 2015). Studies have also demonstrated that ARMS individuals who later develop psychosis show greater cognitive deficits (Simon et al., 2012) (see Fusar-Poli et al., 2013 for a review). Although it is not yet clear whether it is possible to predict psychosis based on cognitive functioning alone (Fusar-Poli, 2014, 2017).

The relationship between cognition and functional outcome has been consistently demonstrated with cross-sectional studies (Allott, Liu, Proffitt, & Killackey, 2011; Carrión et al., 2013). Longitudinal studies have been able to demonstrate cognition predicts functional outcome within schizophrenia samples (Delbert G Robinson et al., 2004), First Episode Psychosis samples (Milev, Ho, Arndt, & Andreasen, 2005; Nuechterlein et al., 2011; Stirling et al., 2003), and ultra-high risk of psychosis group (Lin et al., 2011). Whilst a global measure of functioning can be useful, a more detailed understanding may facilitate research efforts to help better target care for individuals with FEP.

1.4.2 Functional capacity

Beck and Rector (2005) and Grant and Beck (2009) proposed a model of functional outcome in schizophrenia, suggesting that neurocognitive deficits influence functional outcome via cognitions and functional capacity. Cross-sectional studies have demonstrated that neurocognitive ability is associated with functional capacity within individuals with schizophrenia (Bowie et al., 2010; Bowie et al., 2008; Green et al., 2004) and First Episode Psychosis, particularly working memory, social cognition and negative symptoms predicts functional capacity (Vesterager et al., 2012). However, studies with participants with schizophrenia, compared to FEP, have suggested a more generalised relationship between domains of cognition and functional capacity (Bowie et al., 2008; Evans et al., 2003).

Importantly here, functional capacity can impact functional outcome in schizophrenia (Bowie et al., 2006), considered the most important predictor of functional outcome within schizophrenia (Green, 1996; Green et al., 2000) and within a sample of older adults with schizophrenia (Leifker et al., 2009). As suggested by Beck and Rector (2005) functional capacity has been demonstrated to act as a mediator between neurocognition and functional outcome in FEP (Davies et al., 2017). This relationship has been confirmed longitudinally within a schizophrenia sample (Bowie et al., 2008).

1.4.3 Negative symptoms

The effects of therapies focused on improving neurocognition to increase functional outcome in psychosis, seem to be blocked by additional factors, e.g. negative symptoms

(Bowie et al. 2010). Studies have highlighted that symptoms, particularly negative symptoms, can predict some of the variance in functional capacity in FEP (Vesterager et al., 2012) and Leifker et al. (2009) suggested symptoms, particularly negative symptoms, may be a stronger predictor of everyday performance skills than cognitive ability in schizophrenia. Negative symptoms have a distinctive and independent effect on functional outcome relative to other symptoms (Rabinowitz et al., 2012). Importantly here, negative symptoms have been associated with poor function in psychosis (Bourdeau et al., 2012; Harvey, Koren, & Bowie, 2006; McGurk & Mueser, 2006; Milev et al., 2005) as well as reduced likelihood of living independently or being employed (Hofer et al., 2005; Rosenheck et al., 2006). Alike to functional capacity, symptoms were also suggested to mediate the relationship between neurocognition and functional outcome in schizophrenia (Hjorthøj, Bak, & Td, 2016; Ventura, Hellemann, Thames, Koellner, & Nuechterlein, 2009). Longitudinal studies support this research by demonstrating that negative symptoms, but not positive symptoms, were significantly related to outcome measures at two-year follow-up of individuals with first episode psychosis (Ho et al., 1998).

However, Milev et al. (2005) demonstrated an overlap in the variance in outcome explained by cognitions and negative symptoms. Negative symptoms and cognitive deficits share many characteristics, e.g. prevalence, course, correlation with function (Harvey et al., 2006), although still remain independent and separable. In addition, Greenwood, Landau and Wykes (2005) demonstrated that it is the interaction between negative symptoms and cognitive deficits which lead to poor function. However, studies have still demonstrated that cognition and functional capacity play a large role in functional outcome, independent of symptoms in FEP (Peña et al., 2012). This highlights the importance of considering negative symptoms, along with cognitive deficits, in understanding poor functional outcome.

1.5 Are neurocognition, functional capacity and negative symptoms also associated with subjective outcome?

Studies assessing quality of life, as a measure of subjective outcome, demonstrated that neurocognitive ability was related to quality of life, arguably a measure of subjective recovery outcome, (Savilla, Kettler, & Galletly, 2008); although when symptoms were controlled, this relationship was no longer significant (Wegener et al., 2005). In relation

to negative symptoms, studies have demonstrated a negative association between quality of life and negative symptoms in schizophrenia (Norman et al., 2000; Savilla et al., 2008), particularly during stabilisation in schizophrenia (Bow-Thomas, Velligan, Miller, & Olsen, 1999). On the other hand, Morrison et al. (2013) recently demonstrated, using the Questionnaire of Process of Recovery (QPR), there was no effect of negative symptoms or neurocognition on subjective self-rated recovery. Instead, QPR was related to psychosocial factors such as self-esteem, locus of control and emotion. This suggests that cognitions and negative symptoms may not be related to an overall measure of subjective outcome, instead there is a more complex relationship with additional factors to be explored.

1.5.1 Additional factors

Research has shown that functional outcome is multiply determined by neuropsychological performance, functional capacity, and symptoms (Bowie et al., 2006). However, even when including these factors, there is still a large amount of unaccounted variance between neurocognition and functional outcome (Schmidt et al., 2011), with only 40-60% of the relationship between neurocognition and functional outcome understood (Green et al., 2004). Beck and Rector (2005) and Grant and Beck (2009) proposed a model of functional outcome in schizophrenia, suggesting cognitive factors mediate the relationship between neurocognition and functional outcome in schizophrenia. This has included motivation and defeatist performance beliefs (Grant & Beck, 2009b); negative thoughts about one's ability to successfully perform goal-directed behaviour (Campellone, Sanchez, & Kring, 2016), and self-stigma (Berry & Greenwood, 2018); awareness and agreement of a stereotype. Both of which can lead to the “why try” effect (Corrigan, Larson, & Rüsch, 2009) and have been shown to impact on functional outcome in young people with and without psychosis (Berry, 2013; Berry & Greenwood, 2017, 2018). Recently, the focus on cognitive processes, which predict outcome, has moved to metacognition (Davies et al., 2017; Koren, Seidman, Goldsmith, & Harvey, 2006).

1.6 **Metacognition**

1.6.1 Definition

Metacognition is defined as "thinking about thinking" (Flavell, 1979; Semerari et al., 2003a) and the way one thinks about one's experience. As humans, we regularly make decisions upon our knowledge of the outside world and the reflection of this knowledge is termed metacognition (Metcalfe, 1996). Nelson and Narens (1990) outlined a metacognitive model suggesting two levels: an object-level, including cognitive processes (such as perception and memory), and a meta-level, an appraisal of the object-level ("metacognition"). These two levels must work in harmony to ensure metacognition can be effectively harnessed to enable cognitive processes to appropriately guide thought and behaviour.

Metacognition ranges from sub-conscious and momentary reflection to more explicit, complex reflection of the self and others. The research literature suggests that metacognition may be fractionated and may appear in many different forms (Nelson & Narens, 1990; Shea et al., 2014). Three levels of metacognition have been proposed and will be discussed here: i) Metacognitive ability/knowledge: capacity to think about one's own cognitions, emotions and behaviour, as well as others', and to use this reflection to respond to challenges (Lysaker, Erickson, et al., 2010; Lysaker et al., 2011), ii) Metacognitive experience: appraisal of one's experience or performance after an activity, and iii) Metacognitive sensitivity/efficiency[1]: "knowing that you know" (Sherman, Barrett, & Kanai, 2015), and this level, in particular, may involve unconscious knowledge to generate a "feeling of knowing" (Nelson, Gerler, & Narens, 1984). This level is assessed using within-task confidence ratings. These metacognitive levels may influence each other, via metacognitive processes. Nelson and Narens (1990) highlighted two metacognitive processes: i) Metacognitive control process, (i.e. metacognitive ability is used to guide, correct and control ongoing action, e.g. by shifting attentional focus; Wells & Purdon, 1999), and ii) Metacognitive monitoring process (i.e. monitoring of ongoing

[1] Metacognitive efficiency refers to the same cognitive process as metacognitive sensitivity. However, metacognitive efficiency is calculated by additionally taking into consideration objective performance on a task (e.g. a visual detection task). Within this thesis, these terms will be used interchangeably as they refer to the same cognitive process, despite slight differences in the calculation.

metacognitive experience to update higher-level metacognitive ability; Efklides, 2006). These are important for ensuring accurate metacognitive functioning.

Whilst neurocognition (e.g. executive functioning) has been related to metacognition, metacognition is suggested to represent a more personal and complex understanding regarding oneself and others (Trauelsen et al., 2016). Metacognition has also been considered dissociable from cognitions (Brüne, Dimaggio, & Lysaker, 2011). This means that an individual can have accurate metacognitions, but may still present with poor cognitive ability. For example, Song et al. (2011) demonstrated that participants were able to accurately acknowledge when their cognitive performance was good and when it was poor, demonstrating metacognition is independent of the specific task and a subject of study in its own right (Fleming, Dolan, & Frith, 2012). Metacognition is also domain-specific as a participant can possess appropriate metacognitive sensitivity in the perceptual domain but poor metacognitive sensitivity in memory domain (Fleming, Ryu, Golfinos, & Blackmon, 2014), independent of objective performance on the tasks.

1.7 **Metacognitive components**

1.7.1 Metacognitive ability

Metacognitive ability, as outlined above, is the capacity to think about one's own cognitions, emotions and behaviour, as well as others', and to use this reflection to respond to challenges (Lysaker et al. 2010; Lysaker, Erickson, et al. 2011).

Lysaker and colleagues proposed metacognitive ability is a "meaning-making process, or the ability to form complex and integrated ideas about the self and others that we use to guide our lives" (Lysaker & Klion, 2017, p.10), which is deficit in schizophrenia. These views are not necessarily new as Bleuler (1911 translated in 1950) previously suggested schizophrenia involves a deficit in 'associations' or the ability to link ideas and events together to make sense of the world and react/interact with the world appropriately. This can be measured by assessing the capacity to think about cognition, the self and others, and use this knowledge to respond to challenges (Lysaker et al., 2011; Lysaker, Dimaggio, et al., 2010; Lysaker & Dimaggio, 2014). This can be captured using Metacognition Assessment Scale (Semerari et al., 2003a) or Metacognition Assessment Interview (MAI) (Lysaker et al., 2005) which aims to assess how people are able to

identify their own and other's recurrent patterns of thinking, feeling and dealing with social problems. It has been suggested those with schizophrenia commonly experience deficits in metacognitive ability which play a role in functioning, cognition, distress and symptoms of psychosis (Lysaker et al., 2013; Lysaker et al., 2014; Lysaker, Dimaggio, et al., 2010; Lysaker et al., 2012) and FEP (Davies et al., 2017; Trauelsen et al., 2016). Lysaker and colleagues view metacognitive ability as critical for persons with Severe Mental Illness (e.g. psychosis) leading to the development of a new metacognitive therapy: Metacognitive Reflection and Insight Therapy (MERIT).

1.7.2 Metacognitive experience

Metacognitive experience is the appraisal of one's experience or performance after an activity. This provides an assessment of "online" awareness, in order to assess current performance and identify the opportunity for additional strategies to be used to alter performance.

Metacognitive experience can be measured by assessing awareness of abilities. For example, the memory awareness rating scale (MARS) (Clare, Wilson, Carter, Roth, & Hodges, 2002), which has been in part constituted by the Rivermead Behavioural Memory Test (RBMT) (Gilleen et al., 2011; Wilson, Cockburn, Baddeley, & Hiorns, 1989). This involves asking an individual to provide two scores of their memory ability: i) a prediction score (before the task) and ii) post-diction score (after the task). The prediction score assessed knowledge of performance. However, this measure is subject to biases and external influences which are difficult to appropriately control, e.g. previous experience on a task. The post-diction measure assesses "online" awareness of performance and experiences; metacognitive experience. The post-diction rating can be compared to the actual performance on a task which provides a postdiction discrepancy score, and overcomes the limitations of mismatch discrepancy between self- and other-ratings (Gilleen, Greenwood & David, 2011). Therefore, it is important to ensure the subjective metacognitive experience rating is compared to actual performance, as performance may have differed within the chosen task which can influence the metacognitive experience rating and score.

1.7.3 **Metacognitive sensitivity/efficiency**

Metacognitive sensitivity is one's ability to discriminate between task-related correct and incorrect decisions, and can be measured by confidence ratings within a task. Metacognitive sensitivity involves unconscious knowledge which generates a "feeling of knowing" or "knowing that you know" (Sherman et al., 2015). This type of metacognition has been shown to be modality-specific (Fleming et al., 2014).

Metacognitive sensitivity can be assessed using a signal detection task, based on Signal Detection Theory: a means of analysing the structure of the observer's decisions in psychophysical tasks and specifies the optimal/ideal detection process in a variety of situations (Green & Swets, 1974). A signal detection task could involve a participant making two forced-choice binary judgments of whether a visual stimulus (white dot) was present or absent (first judgment) within a noisy, moving picture, e.g. "Was the dot present or absent?". Then making a second forced-choice binary judgment of confidence in relation to the first judgment, e.g. "Are you confident or guessing?". This can be used to calculate metacognitive sensitivity *(*meta-*d')*, which describes how well matched confidence ratings are to correct vs incorrect trials.

Metacognitive efficiency (meta-*d'*/*d')* is one's ability to discriminate between one's own correct or incorrect perceptual decision, whilst taking into account objective performance (Fleming & Lau, 2014). In other words, metacognitive efficiency captures the same cognitive process as metacognitive sensitivity, but involves an additional calculation to control for objective performance on the particular task (e.g. the visual detection task described above). The decisions are made quickly to ensure that these decisions are based on lower-level (implicit) feelings of ability or confidence.

With regard to psychosis, metacognitive sensitivity/efficiency has been demonstrated as significantly impaired in First Episode Psychosis (FEP) compared to healthy matched control participants (Bliksted et al., 2017; Davies et al., 2018). Chapter 6 presents a systematic literature on the association between anomalous experiences, anomalous (delusional) beliefs and metacognition, including metacognitive sensitivity.

1.7.4 Metacognitive processes

As suggested within this Nelson and Narnes (1990) model, the meta-level must accurately represent object-level and it does so by using two metacognitive processes: i) Metacognitive monitoring process and ii) Metacognitive control processes, both enable the individual to use their metacognition to guide thought and behaviour.

Metacognitive monitoring process is involved in the using metacognitive experience to update metacognitive ability. This can be assessed using self-reflectivity subscale of Cognitive insight scale (Beck, Baruch, Balter, Steer, & Warman, 2004), appropriate to assess metacognitive monitoring in psychosis (David, Bedford, Wiffen, & Gilleen, 2012; Gilleen, David, & Greenwood, 2016). This measure assesses an individual's capacity and willingness to observe their mental productions and to consider alternative explanations (Bruno, Sachs, Demily, Franck, & Pacherie, 2012). Inappropriate self-reflectivity may mean the individual is unable to synthesise and comprehend ideas about themselves and may later attribute experiences or thoughts to external forces (Chan, 2016).

Metacognitive controlling process is involved in using metacognitive knowledge/ability to change current thinking. This can be assessed using the Trail-Making Task (Reitan, 1958), specifically part B:A which assesses flexibility and set-shifting (Gilleen et al., 2016). This measure assesses set-shifting which is an important skill for controlling as it concerns the flexibility to change current thinking from one set of thinking to another set.

1.8 **Metacognition and functional outcome**

In terms of relevance to psychosis, metacognitive ability is poorer in psychosis (Lysaker, Pattison, Leonhardt, Phelps, & Vohs, 2018; Lysaker et al., 2005), and is shown to have an impact on functional, social and work outcomes in psychosis (Arnon-Ribenfeld, Hasson-Ohayon, Lavidor, Atzil-Slonim, & Lysaker, 2017; Brüne, Dimaggio, & Lysaker, 2011; Davies & Greenwood, 2018; Luedtke et al., 2012; Lysaker et al., 2010), independent of cognition and symptoms (Lysaker et al., 2011, 2014). Metacognitive ability is shown to mediate the relationships between neurocognition, functional capacity and functional outcome in FEP (Davies et al. 2017). Negative symptoms have been associated with metacognition and may also predict functioning (Hamm et al., 2012;

James et al., 2016; McLeod, Gumley, MacBeth, Schwannauer, & Lysaker, 2014). Limited research has assessed the role of metacognitive ability on functional outcome in FEP, independent of negative symptoms.

Secondly, metacognitive experience (appraisal of experience) has also been associated with social functioning (Stratta, Daneluzzo, Riccardi, Bustini, & Rossi, 2009), real-world functioning and work outcomes (Gould et al., 2015; Verdoux, Monello, Goumilloux, Cougnard, & Prouteau, 2010). However, Gilleen, Greenwood and David (2014) demonstrated that metacognitive experience ("online" awareness within the moment) is, on average, intact within schizophrenia. This presents a potential dissociation between metacognitive ability and metacognitive experience which may be the result of impaired metacognitive processes (self-reflection and set-shifting) (Gilleen et al., 2016).

Metacognitive monitoring processes (measured using the self-reflection sub-scale of the Beck Cognitive Insight Scale), have been shown to be poorer in psychosis than controls (Engh et al., 2007; Warman, Lysaker, & Martin, 2007) and this process has been related to global functioning in schizophrenia (Davies et al., 2017; Giusti, Mazza, Pollice, Casacchia, & Roncone, 2013). Metacognitive control process (set-shifting using Trail-Making Task) has been demonstrated as poor in psychosis (Riley et al., 2000), and has been linked to real-world outcomes (Strassnig et al., 2018). Gilleen et al. (2016) demonstrated that intact metacognitive experience in schizophrenia required both good metacognitive monitoring (BCIS self-reflectiveness subscale) and good metacognitive control (set-shifting on Trail Making Task) processes. Research within FEP sample could identify key early deficits in the model, which may be driving other metacognitive deficits, later leading to poorer functioning. Thirdly, metacognitive efficiency is poorer in psychosis (Bliksted et al., 2017; Davies et al., 2018) and it has not been associated with explicit real-world outcomes.

It is currently unclear which metacognitive processes may be driving these metacognitive difficulties. Equally, limited studies have assessed metacognitive processing in individuals with FEP, which may provide information regarding the early deficits predicting these later difficulties. From this, an aim of the thesis is to assess which metacognitive components may impact on what individuals are doing day to day: their functional outcome.

In terms of metacognition predicting functioning across time in psychosis, there is limited evidence. Studies have suggested that those with an at-risk mental state, whose functioning declined and later transitioned into psychosis, displayed more maladaptive metacognitive beliefs (Barbato et al., 2014). Intervention studies focusing on metacognition have demonstrated an improvement in functioning (Briki et al., 2014; Dubreucq, Delorme, & Roure, 2016; Moritz et al., 2014; Rocha & Queirós, 2013). However, no study has yet assessed the role of metacognitive ability on functioning across a long follow-up period, particularly within FEP; where recovery is more likely.

1.9 Self-defining memories

Metacognitive ability has previously been negatively associated with difficulties in recalling autobiographical memories and personal narratives (Lysaker et al., 2013; Lysaker & Bob, 2013). In particular, self-defining memories are relevant to narrative identity (Conway, Singer, & Tagini, 2004) and metacognitive ability has been associated with forming complex ideas of one's life as a narrative across a lifetime (Lysaker et al. 2010; Lysaker et al. 2013; Lysaker et al. 2013). It may be that SDMs overlap with metacognitive ability in terms of being a reflective process on the self. However, it is a distinct reflective process as it focuses on one memory, which, when compromised, may impact on functioning. Self-defining memories also incorporate an affective information component (salient past memory with emotions associated with this). Therefore, it may be suggested that self-defining memory is associated with metacognition or represent a similar concept, which when compromised may impact functioning in psychosis. Based on the Beck and Rector (2005) functional outcome model, it may be suggested that cognitive processes could extend beyond metacognition to self-defining memories. Hence self-defining memories may play an independent role in functioning, alongside metacognition.

Alongside functioning, metacognitive components have also been related to hallucinatory experiences and delusional beliefs/ideation in both clinical and non-clinical groups (Eisenacher et al., 2015; Moritz, Woodward, Whitman, & Cuttler, 2005; Warman, 2008). However, the literature is less clear on which particular metacognitive components may play a role. Studies have focused on metacognitive ability, monitoring,

and sensitivity. A full review of this literature is presented in chapter 6. This association may then later have a role in the relationship between metacognition, functional or subjective outcome in psychosis. By understanding this association with anomalous experiences, this may help us better understand influences on outcome in psychosis.

1.10 Anomalous experiences

An anomalous experience is an unusual event, deviating from expectancy or normality. Anomalous experiences can be divided into a number of categories including: i) anomalous self-experiences; involving distortions of the unified 'self' or being (Henriksen & Parnas, 2014), ii) anomalous perceptual experiences; involving distortions of sensory experiences, and iii) anomalous (delusional) beliefs; including most commonly experiences of paranoia. It has been suggested that anomalous self-experiences precede anomalous perceptual experiences (Nelson, Parnas, & Sass, 2014), and then if anomalous perceptual experiences are appraised as negative or threatening this can lead to anomalous (delusional) beliefs (Corlett et al., 2009; Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001). Therefore, there is suggested to be a hierarchical relationship between these different experiences (Fletcher & Frith, 2009).

Anomalous events (experiences/beliefs) are experienced by a large number of people within the general population (Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012). However, the frequency and intensity of anomalous experiences is increased for individuals with First Episode Psychosis (FEP), and particularly those with an "at risk" mental state (Brett, Johns, Peters, & McGuire, 2009; Reininghaus et al., 2016). Several other studies have highlighted early reports of self-experience disturbance predicted development of psychosis (Hartmann et al., 1984; Parnas, 2005; Parnas, Handest, Jansson, & Sæbye, 2005). It was considered that after anxiety and depression, anomalous self-experiences (e.g. depersonalisation) were the most frequent symptoms seen in psychiatry (Stewart, 1963); and particularly within psychosis (Sass, Pienkos, Nelson, & Medford, 2013).

With this in mind, it has been suggested that anomalous experiences could be linked to the progression of positive symptoms in psychosis. Recent studies also suggest anomalous self-experiences are associated with positive symptom expression (Brent,

Seidman, Thermenos, Holt, & Keshavan, 2014; Nelson & Raballo, 2015; Preti, Cella, Raballo, & Vellante, 2012). Such sub-threshold psychotic experiences can predict psychotic symptoms at a later stage (Yung et al., 2003; Yung, Phillips, Yuen, & McGorry, 2004). This body of literature highlights that disturbance of the self may be a key marker of development of psychosis and early identification.

1.10.1 **Anomalous self-experiences**

Anomalous self-experiences concerns an internal distortion of the unified 'self' or being (Henriksen & Parnas, 2014). In order to understand anomalous self-experiences, it is important to understand the concept of the 'self' or being. The self is a conscious, subjective experience of being. Henriksen & Parnas (2014) described that the experience of 'being' signifies that we exist as a "self-present, single, temporally persistent, bodily and bounded subject of experience" (p. 543). The self can be related to the term 'ipseity' which refers to the experiential sense of being a self-coinciding subject of experience of the world. Theories have suggested that the self is not one large overarching unit but, instead, is a multifaceted hierarchical arrangement of self-positions that continually realign with dominant self-positions complementing each other, rather than competing (Dimaggio et al., 2009; Hamm & Lysaker, 2016; Henriksen & Parnas, 2014; Lysaker & Lysaker, 2002). Our internal dialogue makes us aware of these different selves to enable us to interpret and understand the world. Being aware of multiple forms of feeling, thinking and acting provides information which is necessary to form an integrated point of view. This allows one to maintain a sense of wholeness or sameness (Dimaggio et al., 2009).

Three levels of self have been proposed. Firstly, the prereflective self which refers to implicit first-person quality experiences, e.g. my experience or sense of 'my-ness'. This is a foundation level of selfhood and other levels of selfhood are built on this (Parnas, Sass, & Zahavi, 2013). Secondly, the reflective self which refers to self as an object of reflection e.g. my sense of self as the same across time. In order to have a sense of temporal unity of self, the individual must have the knowledge that moment-to-moment experience is their own in the first place (Nelson, Sass, & Škodlar, 2009). Thirdly, the narrative self which is language-based and includes abstract cognitive representations

referring to social identity, personality, habits and history, and may include complex ideas of self and others which relies on metacognitive ability (Lysaker et al. 2011).

Research has suggested that within psychosis or schizophrenia there is a disruption to the prereflective self, which leads to a new ontological existence (Henriksen & Parnas, 2014; Nelson & Raballo, 2015). Once there is a disruption in the prereflective self, on which the other selves are built, this can lead to anomalous self-experiences, explained by the ipseity-disturbance model (IDM) (Sass & Parnas, 2003). This was recently re-considered the bio-pheno-social model (Sass, Borda, Madeira, Pienkos, & Nelson, 2018). This suggests that the disturbance of the prereflective self involves three aspects: i) hyperreflexivity; heightened awareness of aspects of experience that are normally implicit, ii) diminished self-affection; weakened sense of existing as a subject of awareness, and iii) disturbed "grip"; loss of salience or stability of objects in perceptual or cognitive awareness. This focus on aspects of the self which have been tacitly experienced (e.g. breathing or thoughts) is likely to alienate the self and lead to a variety of dissociative experiences, e.g. depersonalisation, disturbances in stream of consciousness, distorted bodily experiences, and existential reorientation (Nelson et al., 2009; Sass & Parnas, 2003; Sass et al., 2018).

Anomalous self-experiences can be measured using Examination of Anomalous Self-Experience (EASE; Parnas et al., 2005; Sass et al., 2013). This is a symptom checklist using a semi-structured exploration of experiential anomalies of self-awareness. Cicero et al. (2016) recently developed IPASE, a survey version of the EASE. Researchers have also developed the Cambridge Depersonalisation Scale (Sierra & Berrios, 2000), a self-rating scale used to assess anomalous self-experiences (specifically, dissociation, an analogous form of self disturbance; Sass et al. 2013). Importantly, anomalous self-experiences have been associated with positive symptoms in psychosis (Nelson, Sass and Skodlar, 2009; Nelson, Parnas & Sass, 2014; Parnas, 2005; Sass, 1998; Sass et al., 2013) and, therefore, anomalous perceptual experiences.

1.10.2 **Anomalous perceptual experiences**

Anomalous perceptual experiences involve distortions of sensory experiences, which can occur in a variety of modalities, e.g. visual: falsely perceiving flashing lights or figures of objects, or auditory: falsely hearing your name being called out in a crowd or thinking of a song and hearing it with clarity. Anomalous perceptual experiences have been suggested to develop from cognitive disruptions, or bouts of aberrant salience, suggesting a crucial role of perceptual/cognitive abnormalities in our understanding of phenomena in psychosis (Hemsley, 1993; Hemsley & Hemsley, 2015).

These experiences can be measured using Cardiff Anomalous Perceptions Scale (CAPS: Bell, Halligan, & Ellis, 2006), which has been reliably used in both clinical and non-clinical participants (Bell et al., 2006). This measure assesses whether the participant has experienced such phenomena before and, if so, how frequently do they occur, how distressing and distracting are these experiences. As suggested above, anomalous experiences may be a prerequisite to full-blown psychotic symptoms, e.g. hallucinations. Evidence has demonstrated that hallucinations within psychosis commonly occur in the auditory domain (Shergill et al., 1998; Waters, Allen, et al., 2012). Recent research has suggested, although visual hallucinations occur less frequently than auditory hallucinations, there is still an increased presence of this phenomena in individuals with schizophrenia (27% of individuals) (Manford & Andermann, 1998; Waters et al., 2014). Visual hallucinations tend to represent a more severe psychopathological profile, associated with stress or trauma (Read, Agar, Argyle, & Aderhold, 2003; Waters et al., 2014). From this, it has been suggested that clinicians typically ask about auditory hallucinatory experiences, neglecting visual experiences (Bracha, Wolkowitz, Lohr, Karson, & Bigelow, 1989; Waters et al., 2014) or patients do not voice these visual experiences as they may be less noticeable e.g. brighter lights or outlines of objects, rather than fully formed objects. Following this research, there is clear interest in assessing the separate modalities of anomalous experiences, to further understand their cognitive underpinnings.

Until recently, no scale has divided anomalous perceptual experiences into separate sensory modalities. For example, Schizotypy personality questionnaire categorised the scale into subscales such as cognitive-perceptual, disorganized and interpersonal factors

(SPQ, Raine, 1991). A new scale assessing these unusual anomalous experiences has been devised: Multimodal Unusual Sensory Experiences Questionnaire (MUSEQ; Mitchell et al., 2017), which includes 6 subscales dividing the scale in terms of sensory modalities: auditory, visual, olfactory, gustatory, bodily sensations, and sensed presence. This scale can enable assessment of different anomalous perceptual experiences. Regardless of modality of anomalous perceptual experience, these experiences are suggested to be cognitively appraised by the individual, resulting in the development of anomalous (delusional) beliefs (Garety et al., 2001).

1.10.3 Anomalous (delusional) beliefs

Anomalous (delusional) beliefs are considered fixed false beliefs (Garety, 1999), outside of the cultural norm. The most commonly experienced delusional belief is paranoia or persecutory delusions (Garety & Hemsley, 1987). Paranoia can be common in the general population (Freeman, Pugh, & Garety, 2008). Anomalous perceptual experiences may occur and later lead to anomalous (delusional) beliefs. Maher (1974, 1988; 2005) previously suggested that anomalous perceptual experiences may occur prior to a paranoid ideation, as these experiences demand explanation so a theory is developed to explain these experiences. This hierarchical framework between anomalous perceptual experiences and anomalous (delusional) beliefs is supported by many cognitive theories (Corlett et al., 2009; Fletcher & Frith, 2009; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002; Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; McKay & Dennett, 2009). Aligned with this, McKay and Dennett (2009) considered there are two types of misbelief, i) misbelief through a breakdown in normal functioning of the belief formation system (e.g., delusions) and ii) those arising in the normal course of that system's operations (e.g., based on incomplete/inaccurate information). The former has been considered anomalous beliefs which are used as protective mechanisms. To understand this framework, it is important to consider the theories associated with the development and maintenance of these different anomalies, and the role of metacognition here.

1.11 Predictors of anomalous experience and anomalous (delusional) beliefs

1.11.1 Information processing deficit

Anomalous experiences and beliefs in schizophrenia were previously suggested to be the result of a 'general cognitive deficit' in associative processes, which connect ideas and organisation relevant thoughts (Bleuler, 1911, translated in 1950). Whilst this early work was a foundation to future theories, researchers have stated that the pattern of behaviour in psychosis is not interpretable in terms of the well-established 'generalised deficit' in psychosis (Hemsley, 1998). Instead, Hemsley (1993) proposed a theory of information processing deficit in psychosis which suggested that cognitive deficits are caused by the issue (or a "weakening") of integrating top-down (prior knowledge in memory) and bottom-up (current stimulus input) influences. It has been debated whether this process is conscious or unconscious (John & Hemsley, 1992).

Alongside Hemsley (1993), Gray and colleagues (Gray, 1995; Gray, Feldon, Hemsley, & Smith, 1991) aimed to understand psychotic experiences using a comparator models. Gray (1995) suggested that the contents of one's consciousness consists of the outputs of a moment-by-moment comparator system. In this area, predicted states of the world, from memory stores, are compared to actual states of the world to assess whether there is a mismatch. Following a mismatch, information is sent to other areas to trigger exploratory behaviour to understand the mismatch and update the internal model. In psychosis, it is suggested that bottom-up processes are dominant, such that stimuli in the environment appear unusually salient. This reduction in top-down influences on current perception, results in ambiguous, unstructured sensory processing. This represents the anomalous experience which appears in psychosis, particularly FEP (Reininghaus et al., 2016).

An example of this information processing deficit is latent inhibition. Latent inhibition (LI) is a learning phenomenon involving the idea that learning performance is poorer if the task involves pre-exposed non-reinforced stimulus (Weiner, 2003) as prior experience has an interfering effect. Therefore, latent inhibition is a measure of ability to filter out irrelevant stimuli. However, latent inhibition has been shown to be poorer in psychosis (Lubow, 2005) and psychosis prone individuals (Lubow, 1992). Hemsley (1993)

suggested that LI is not simply habituation, but individuals must assess contextual cues which may be relevant to the associations. Therefore, individuals with psychosis can learn new associations with previously associated concepts better than controls as they do not overuse their prior information. This disrupted LI in psychosis can be used to explain the presence of hallucinations or perceptual disturbances as there is difficulty in filtering out irrelevant stimuli in the environment (Baruch, Hemsley, & Gray, 1988; Hemsley, 1993) and then attempts to understand the disturbance which may manifest as a delusion-like idea (Corlett, Frith, & Fletcher, 2009; Maher, 1984, 1988).

However, there appears to be inconsistencies within the literature. Weiner (2003) demonstrated that administrating NMDA blockade drugs (using ketamine to mimic positive and negative symptoms of psychosis, Stone et al., 2008), resulted in persistent latent inhibition, so individuals were overusing prior information. To understand this, a review from Weiner (2003) suggested a two-headed latent inhibition model of psychosis. This suggested that latent inhibition disruption is more likely associated with early stage psychosis. For example, recent research demonstrated that a group of ARMS participants demonstrated disrupted in LI, suggesting these individuals are impaired in their allocation of attentional resources based on past predictive value of repeated stimuli (Kraus et al., 2016; Kraus, Keefe, & Krishnan, 2009). Then later there is suggested to be a reinstatement of LI in chronic psychosis, due to medication (Hemsley, 1993; Williams et al., 1998); highlighting the role of dopamine in information processing deficit. This model can explain the two extremes of cognitive switching: excessive switching of associations which is caused by disrupted LI and inflexible switching in persistent LI. Failure to ignore irrelevant stimuli for the former and attentional perseveration for the latter.

Therefore, this research suggests that difficulties in using prior knowledge or experience is evident in psychosis. Difficulty with using prior knowledge to filter out irrelevant stimuli in the environment can mean the environment becomes overly salient and confusing leading to anomalous perceptual experiences, which may later manifest as a delusion-like idea.

1.11.1 Self-monitoring theory

Frith (1987) suggested individuals with psychosis may have an inability to appropriately self-monitor due to a fault in the internal monitoring, comparator system, and corollary discharge. For example, when we perform an action (arm raise) we make a motor command, e.g. "I want to move my arm upwards". A signal is sent to the motor, and then sensory system, and another signal (corollary discharge) generates the predicted sensory feedback. Both the signals are compared (Blakemore & Sirigu, 2003; Frith, Blakemore, & Wolpert, 2000; Frith, Frith, Blakemore, & Wolpert, 2015) and, if matched, the individual experiences the movement as predicted and can assign agency to the movement, e.g. "I moved my arm upwards". However, for individuals with psychosis, there is a fault in the corollary discharge (prediction of movement) which may induce a feeling of strangeness, or lack of agency, that the movement was externally caused, rather than self-produced.

As an example, Blakemore and colleagues suggested that, typically, individuals cannot tickle themselves as they are unable to use their self-monitoring system to predict both their own movements and the sensation produced from these movements (Blakemore et al. 2000). However, for individuals with psychosis who may have difficulty with monitoring or predicting their own movements, Blakemore and colleagues suggested that individuals with psychosis may experience self-produced tickling as a more intense experience. Blakemore, Smith, Steel, Johnstone and Frith (2000) demonstrated that individuals with psychosis, who had auditory hallucinations or passivity experiences, experienced tactile sensation produced by themselves or the experimenter as equally intense/tickly. An increase in intensity of a tickle was also demonstrated within healthy controls when a time delay was introduced between when they expected to experience the tickle compared to when they actually experienced the tickle (Blakemore, Frith, & Wolpert, 1999). In particular, it was suggested that less weight was being given to internal predictions and individuals with psychosis tend to focus on external cues (Frith, 2012; Synofzik et al. 2010; Synofzik et al. 2013), as a result of saliency. Therefore, difficulty with internal models of prediction may cause an environment to appear surprising and salient to the individual, which warrants explanation.

1.11.2 Prediction errors and Bayesian models

Following from the self-monitoring deficit in psychosis (Frith, 1987), theories of the self, including understanding agency, free will and intentions, propose that the self is constructed via simulated Bayesian computational models (Apps & Tsakiris, 2014; Clark, 2013). Frith and Friston (2013) outlines the basic Bayesian model, which suggests that when we perform an action we predict the outcome based on prior knowledge/experience (Corlett, Honey & Fletcher, 2016). If the outcome is not as we predicted, then we experience a prediction error/'Bayesian surprise' (Schwartenbeck, FitzGerald, Dolan, & Friston, 2013). From this, we modify our knowledge on which our expectation was based to prevent the prediction error in the future (Schwartenbeck, FitzGerald, Mathys, Dolan, & Friston, 2015).

Bayesian computational models have suggested that, within psychosis, there is a disruption in this predictive coding in such that there is a weakening of use of prior beliefs and overreliance on sensory occurrences. This loss of top-down predictions leads extra weight to be given to external influences which means everything becomes salient and surprising to the individual (Adams et al., 2013). This hypothesis was recently used to explain anomalous experiences, particularly within psychosis or those with a propensity to anomalous experiences (Adams et al., 2013; Corlett et al., 2007; Davies, Teufel, & Fletcher, 2017; Fletcher & Frith, 2009; Frith & Friston, 2013; Rudolph et al., 2015; Sterzer et al., 2018; Teufel et al., 2010a).

However, recent studies have demonstrated that those with FEP or those with psychosis proneness had a shift in bias towards prior knowledge and beliefs, over sensory evidence (Davies, Teufel, & Fletcher, 2017; Teufel et al., 2015). Davies et al. (2017) recently suggested that the predictive coding can be used to explain both anomalous perceptual experiences and anomalous (delusional) beliefs. The authors suggest that prior beliefs work at different levels of the anomalous experiences/delusional beliefs hierarchy. For example, hallucination-proneness relied on both prior knowledge about details of the environment and knowledge of 'gist' of the environment, but delusion-proneness was less associated with prior knowledge about details and instead was influenced by prior beliefs about the overall 'gist'. Anomalous (delusional) beliefs are suggested to be the result of

higher-level, metacognitive strategies used to account for salient, anomalous experience (Corlett et al., 2007; Hemsley & Garety, 1986).

1.11.3 Neurotransmitters

Dopamine theory has been a prominent and well-established theory in psychosis (Carlsson, Hansson, Waters, & Carlsson, 1997; Kapur, 2003; Laruelle & Abi-Dargham, 1999), demonstrating an increased presynaptic dopaminergic function in psychosis (Howes et al., 2012). In particular, pre-synaptic dopamine synthesis and synaptic dopamine availability is increased in psychosis (Howes, Dm, & Mccutcheon, 2017) and those with ARMS, who later transitioned to psychosis (Howes, Montgomery, Asselin, Murray, & Paul, 2013). In this psychotic transition group, there was a direct relationship between magnitude of dopaminergic dysfunction and severity of prodromal symptoms.

Pharmacological models have been developed which highlight the role of dopamine, glutamate and serotonin in psychosis (Aghajanian & Marek, 2000; Carlsson et al., 1997; Coyle, 2006; Kapur & Remington, 1996) and, more recently, 'GABAergic involvement' in schizophrenia (Harrison, 2015). From this research, it appears there are various mechanisms involved; NMDA receptor hypofunction, GABAergic deficits and serotonin-2A overactivity, may lead to dysregulation of subcortical dopamine (Cohen & Halassa, 2015; Kegeles et al., 2000), leading to these psychotic experiences. With this evidence in mind, dopamine has been described as the wind of the psychotic fire (Laruelle & Abi-Dargham, 1999), that dopaminergic abnormality in psychosis is like a state abnormality associated with dimensions of psychosis instead of the fundamental abnormality in psychosis (Kapur, 2003).

1.11.4 Aberrant salience

Psychosis itself has been defined as a "state of aberrant salience" (Kapur, 2003), linked to a disruption in dopamine and glutamate activation (Corlett et al., 2007). Within psychosis, Kapur (2003) suggested that the dysregulated dopamine transmission leads to stimulus-independent release of dopamine, leading to aberrant salience of external objects and internal representation, e.g. in psychosis dopamine creates salience, instead of mediating between contextually relevant saliences. Hallucinations are suggested to be a direct result of the aberrant salience which develops as a cognitive effort to make sense

of these experiences, later leading to delusional beliefs (Fletcher & Frith, 2009; Freeman et al., 2002; Garety et al., 2001). Therefore, Kapur (2003) suggested that it is antipsychotics which "dampen the salience" and prevent these anomalous experiences or delusional beliefs.

Reininghaus et al. (2016) demonstrated, using experience sample methodology, for individuals with FEP, ARMS and healthy controls, that aberrant salience and elevated stress sensitivity was associated with increased psychotic experiences. Within the FEP group, increased sensitivity to minor stressful events or threat anticipation led to more intense psychotic experiences, and in the ARMS group, aberrant salient experiences and sensitivity to outsider status were associated with more psychotic experiences. This highlighted that aberrant salience, stress sensitivity and threat anticipation are important for psychotic experiences in daily life. More recently, momentary aberrant salience has been associated with psychotic experiences (Reininghaus et al., 2018). However, cognitive biases; a lower threshold for accepting a stimulus as present (Moritz, Woodward, Jelinek, & Klinge, 2008; Moritz et al., 2017; Veckenstedt et al., 2011), was importantly involved in this relationship (Reininghaus et al., 2018).

1.11.5 Signal detection theory

Signal detection theory (SDT) suggests that information recognition involves discerning signal within an uncertain environment (Waters, Woodward, Allen, Aleman, & Sommer, 2012). SDT methods allow us to capture two aspects of perception: i) perceptual sensitivity (*d'*): the ability to discriminate between two perceptual decisions and ii) perceptual bias (*B*): the tendency to report one decision over the other.

Signal detection theory (SDT) studies have demonstrated that anomalous experiences are associated with perceptual signal detection biases towards noticing stimulus (e.g. a voice) when it was in fact absent (Bentall & Slade, 1985; Kok, Kouider, Lange, & Supe, 2015; Barkus et al., 2010; Mussgay & Hertwig, 1990); or those with psychosis have a lower threshold for accepting a stimulus as present (Moritz et al., 2009; Moritz, Woodward, Jelinek, & Klinge, 2008; Moritz et al., 2017; Veckenstedt et al., 2011). For example, in the classically reported Bentall and Slade (1985) study individuals with a predisposition to hallucinations, or those with psychosis and hallucinations, falsely perceived a noise

when it was absent, but could accurately report it when it was present. The role of perceptual biases was later supported by studies within psychosis/psychosis-proneness samples (Mussgay & Hertwig, 1990; Teufel et al., 2015; Teufel, Kingdon, Ingram, Wolpert, & Fletcher, 2010; Varese, Barkus, & Bentall, 2011). Given the hierarchical model of anomalous experiences – from anomalous self-experiences to anomalous perceptual experiences to anomalous (delusional) beliefs – it is important for studies to assess whether perceptual biases could also be related to anomalous self-experiences. Limited research has assessed this hypotheses. Varese et al. (2012) demonstrated, within a small group of patients with schizophrenia, no significant association between anomalous self-experience (dissociation) and auditory perceptual bias. The lack of association may be due to statistical power, which the authors note as a limitation.

Research has demonstrated that perceptual biases may be present in both visual and auditory domain (Mussgay & Hertwig, 1990); despite many research studies in this area focusing on auditory perceptual biases (Bentall & Slade, 1985; Varese et al., 2011). Likewise, anomalous experiences can appear in several different domains: auditory, visual, olfactory (Mitchell et al., 2017); although most commonly in the auditory domain (McCarthy-Jones et al., 2017; Shergill et al., 1998; Waters, Allen, et al., 2012). From our knowledge, no study has yet assessed the modality-specific association between perceptual biases and anomalous experiences. Therefore, it is currently unclear whether there is also a modality-specific association between visual perceptual biases and visual anomalous-perceptual experiences or whether auditory perceptual biases may also predict visual anomalous experiences.

A literature review was conducted to assess the cognitive models of hallucinatory experiences, including source-monitoring, self-monitoring and signal detection theory (Brookwell, Bentall, & Varese, 2013). This literature review demonstrated significant effects for source-monitoring and signal detection studies, e.g. perceptual biases, for explaining hallucinatory experiences in both clinical and non-clinical participants. Furthermore, Kok, Kouider, Lange and Supe (2015) demonstrated that healthy controls, with proneness to hallucinations, demonstrate a bias in prestimulus activity in the visual cortex towards an expected stimuli. These studies support the notion that both visual and auditory hallucinations may be due to an imprecise/biased information processing system, which biases prior knowledge.

This perceptual bias, towards noticing salient aspects within the environment, may later lead to false perceptions. As Dodgson and Gordon (2009) suggested that the false positives may be a by-product of a perceptual system that has evolved to reduce false negatives in conditions of threat leading to hallucination. Studies from Reininghaus and colleagues have demonstrated, using Experience Sampling Method (ESM) aberrant salience is linked to liberal acceptance bias; associated with perceptual biases, and threat anticipation, have both been separately linked to with increased psychotic experiences in FEP (Reininghaus et al. 2016; 2018). Therefore, it appears there is an appraisal of salient aspects in the environment (as a result of the bias information processing) which can lead to anomalous perceptual experiences.

1.11.6 Cognitive appraisals

Garety et al. (2001) model suggests anomalous perceptual experiences may occur via two routes: i) cognitive (perceptual bias) and affective disturbance, and ii) affective disturbance alone. The cognitive disturbance is then (metacognitively) appraised by the individual, in order to understand this experience (Maher, 1984, 1988). However, they may be appraised as negative or distressing, which can lead to anomalous (delusional) beliefs. Therefore, both the perceptual bias and the metacognitive appraisal of the anomalous experiences may be key to understanding both anomalous experiences and anomalous (delusional) beliefs.

Whilst many theories have been proposed to understand anomalous experiences, it is clear that there is substantial support for anomalous experiences arising from deficit in the Bayesian predictive processing (Fletcher & Frith, 2009; Schwartenbeck et al., 2013; Seth, 2013; Seth, Suzuki, & Critchley, 2012). The Bayesian predictive processing theory suggested that deficit in this processing can cause environmental stimuli to appear more salient leading to these anomalous perceptual experiences. These anomalous perceptual experiences are then cognitive appraised, resulting in the development of delusional/anomalous beliefs (Garety et al., 2001). This supports the hierarchical framework proposed by Fletcher and Frith (2009).

Therefore, it may be suggested that the way in which individuals think about and interpret their own experiences may play a role in the presence and maintenance of anomalous experiences/beliefs. To support this, metacognitive sensitivity, measured using confidence ratings within a certain task, has been demonstrated as poor in those with First Episode Psychosis (Bliksted et al., 2017; Davies et al., 2018), those with a propensity to psychotic symptoms (Bhatt et al. 2010), those with a history of hallucinations (Gaweda, Woodward, Moritz, & Kokoszka, 2013) and those at high risk (Gawęda et al., 2018). This supports that metacognition may contribute to the maintenance of anomalous perceptual experiences and, later, the development of anomalous (delusional) beliefs. However, it is currently unclear which aspects of metacognition may, or may not, be related to anomalous events. From this, chapter 6 includes a literature review with an aim to further understand various anomalous events: anomalous experiences and anomalous delusional beliefs, which may have a relationship with metacognition.

1.12 Summary of thesis chapters

Research within this introduction highlights the complex relationships between neurocognition, metacognition, functional capacity, functional outcome and subjective outcome in psychosis. This thesis will specifically focus on the role of metacognition on outcomes in young people with and without psychosis. However, as suggested above, metacognition is measured in a variety of different ways. This thesis will explore how metacognitive components are related and which metacognitive components are relevant in poor outcomes, in both FEP and those without psychosis. There is clear interest in the early identification of those at risk of poor outcome (objective and subjective), to target interventions to reduce this disability. However, no study has yet assessed the role of metacognitive ability on functioning across a long follow-up period, particularly within FEP; where recovery is more likely. This thesis aims to explore the role of metacognitive ability across time on functional outcome within FEP; where recovery is more likely.

Metacognition has also been shown to be involved in appraising experiences, particularly anomalous experiences or delusional beliefs which may be related via a hierarchical framework. Research in this area has suggested the role of perceptual biases or cognitive deficits may predict anomalous experiences, but metacognition may maintain these anomalous experiences and anomalous (delusional) beliefs in young people with and

without psychosis. Anomalous self-experience, perceptual experiences and delusional beliefs are suggested to be associated within a hierarchical framework. However, limited evidence has assessed the role of perceptual biases on anomalous self-experiences and the role of metacognition on each of these levels. However, research in this area is within its infancy and requires more detailed and rigorous assessment of these relationships. Finally, this thesis will investigate the relationship between anomalous self-, perceptual experiences and (delusional) beliefs with perceptual biases and metacognition in young people with and without psychosis (see figure 1 for full proposed model).

1.13 Aims of thesis

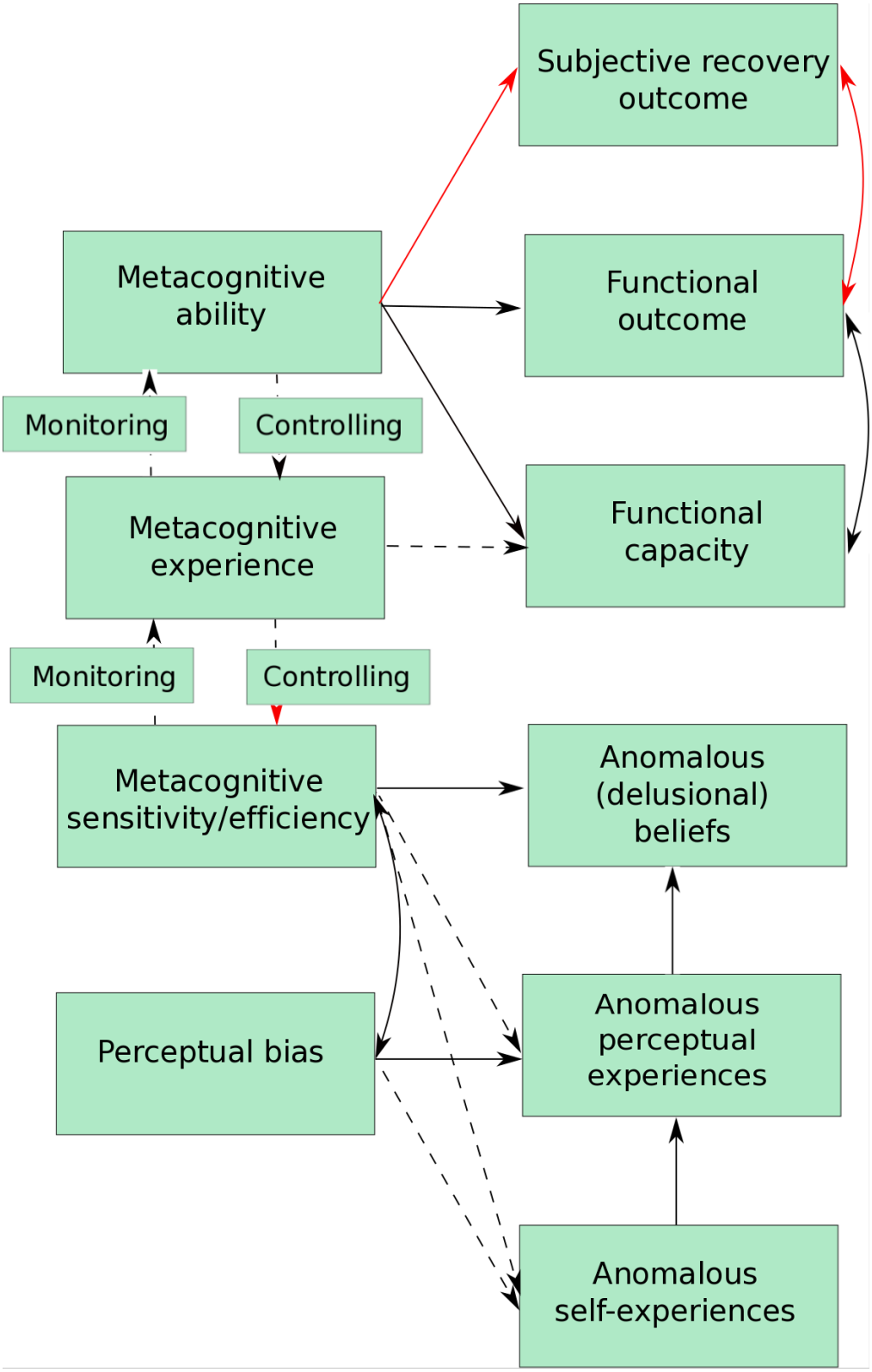
The first aim of the thesis is to assess the connection between metacognitive variables and which metacognitive components are important for anomalous experiences and difficulties in functioning in psychosis (Chapter 2 & 3).

The second aim of the thesis is to assess variables associated with both objective and subjective function, to enable an in-depth understanding of functional recovery. However, limited research has assessed whether other metacognitive components are relevant in poor functional outcome in FEP (Chapter 3, 4 and 5).

Given the limited longitudinal research, **the third aim of the thesis** is to assess whether metacognitive ability can predict functional outcome across a longer follow-up period, particularly within FEP; where recovery is more likely (Chapter 4).

The fourth aim of the thesis is to assess the role of cognitive and metacognitive processes on anomalous experiences and delusional beliefs (Chapter 6, 7 and 8).

Figure 1: Proposed model for metacognitive influences on anomalous experiences and functional outcome in young people with and without psychosis. Note: Solid line signifies associations already present within the literature. Solid red lines are present in schizophrenia.



2. Developing a dynamic model of anomalous experiences and functional outcome in young people with or without psychosis: a cross-sectional and longitudinal study protocol.

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Chapter 2 is published in BMJ Open:

Wright, A.C., Fowler, D. & Greenwood, K.E. (2018). Developing a dynamic model of unusual experiences and function in young people with or without psychosis: a cross-sectional and longitudinal study protocol. *BMJ open*, pp.8–10.

2.1 Abstract

2.1.1 Introduction

Anomalous experiences are common within the general population, but the frequency and intensity is increased in young people with psychosis. Studies have demonstrated that perceptual biases towards noticing these phenomena plays a role, but the way one thinks about one's experience (metacognition) may also be relevant. Whilst poor metacognitive function has been theoretically associated with anomalous experiences, this relationship is currently unclear. However, metacognition may work along a continuum with various metacognitive levels, many of which have been demonstrated as impaired in psychosis. These metacognitive components may interact via processes that maintain poor metacognition across levels, and that potentially impact both what people do in their everyday lives (functional outcome) and how people feel about their everyday lives (subjective recovery outcome) in people with psychosis compared to healthy participants.

2.1.2 Methods and analysis

This study will investigate the association and contribution of metacognition to anomalous experiences and outcome measures cross-sectionally, and longitudinally in a 36-month follow-up. Firstly, young people with psychosis will be compared with healthy control participants on selected measures of anomalous experience, metacognition, and function, using ANCOVA to identify group differences. Next, the relationship between metacognitive components and processes will be explored, including processes connecting the different components, using regression analyses. Finally, mediation analyses will be used to assess the predictive value of metacognitive measures on outcome measures, both cross-sectionally and longitudinally at 36-months, whilst controlling for symptoms and cognition.

2.1.3 Ethics and dissemination

Ethical and Health Research Authority approval has been obtained through Camberwell St. Giles Research Ethics Committee (reference number: 17/LO/0055). This research project will be reported within a PhD thesis and submitted for journal publication. Once key predictive components of poor outcome in psychosis are identified, this study will develop a series of dynamic models to understand influences on outcome for young people with psychosis.

2.2 Introduction

Anomalous experiences refer to a rich number of various psychic phenomena. These experiences can be divided into three main categories: anomalous self-experiences, the sense that you are not "real" (distortions in experience of self and being); anomalous perceptual experiences, hearing sounds which cannot be accounted for by the environment (distortions of sensory events in various domains; auditory, visual; touch; taste); and anomalous delusional beliefs, experiencing unusual thoughts or beliefs. These experiences may be common within the general population[1,2] but the frequency and intensity of these anomalous experiences is increased in those with psychosis or those with emerging severe mental health difficulties[3,4] and may predict psychotic symptoms at a later stage[5,6]. Research has suggested that anomalous self-experiences are suggested to precede and generate "surface-level" anomalous perceptual experiences (hallucinations)[7] and anomalous delusional beliefs may be developed from anomalous experiences[8,9,10], suggesting a hierarchical framework between the anomalous delusional beliefs, experiences and self-experiences.

Many theories have been proposed to understand anomalous experiences, including source-monitoring deficits[11] and aberrant salience hypothesis[12]. Signal detection theory (SDT) has been the foundation to this research and studies using SDT have demonstrated that anomalous perceptual experiences are associated with perceptual signal detection biases[13,14]; bias towards stating that a stimulus was present when it was in-fact absent. Such signal detection biases have been consistently shown within psychosis/psychosis-proneness literature[15,16,17] and suggest that top-down processes on (false) perception can lead to hallucinations or delusions[8,18,19].

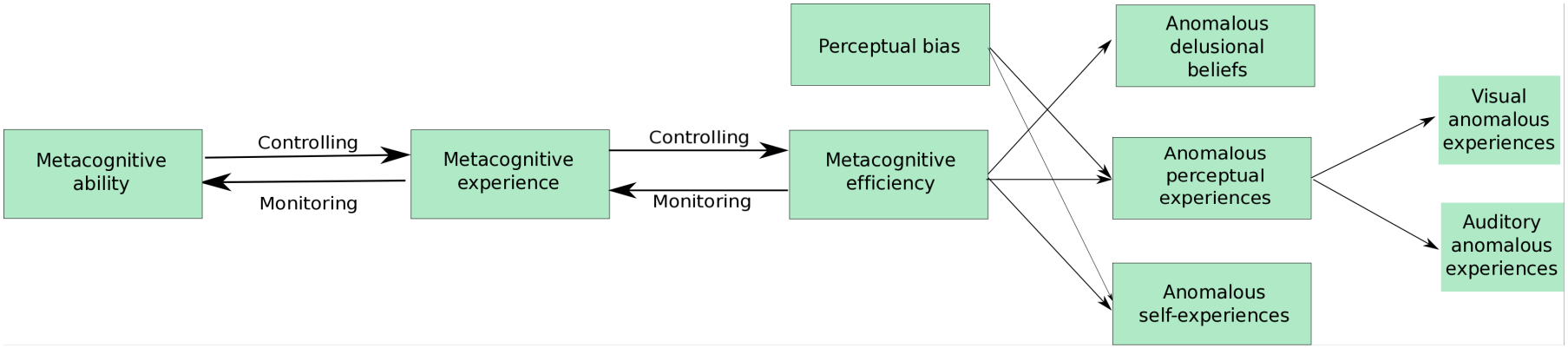
Recent evidence suggests these signal detection biases are associated with metacognition in healthy students[20], and metacognition may therefore play a role in anomalous experiences. Metacognition is defined as "thinking about thinking"[21,22], an abstract view of the object-level[23]. Literature has demonstrated that hallucinatory experiences and delusional beliefs/ideation have been associated with metacognition (overconfidence, specifically) in both clinical and non-clinical groups[24,25,26]. In particular, those with psychosis demonstrate more incorrect self-monitoring responses with higher confidence[27,

[28], also present in those with a history of hallucinations[29], and those within at-risk mental state groups[30].

This research has not been consistent (see Gawęda et al., 2013[28]) as some studies did not control for objective performance, crucial for metacognitive efficiency scores[31, 32]. A recent controlled study demonstrated that individuals with FEP and those at-risk were more likely to misattribute an imagined action for a performed action, compared to healthy controls[30], but found no difference in misattribution of verbal or non-verbal actions. This suggests the deficit in metacognition may be across several modalities. However, metacognitive efficiency/sensitivity (measured using meta-*d'*) is known to be modality-specific[33, 34] and anomalous perceptual experiences (e.g. hallucinations) can vary in modalities[35]. It has also been acknowledged that auditory anomalous experiences are most common in psychosis[36, 37], all of which may suggest a modality-specific association with auditory or visual anomalous experiences and perception/metacognition. This present study will assess the modality-specific association between perceptual bias (signal detection bias) and metacognitions with anomalous perceptual experiences in visual and auditory modalities, whilst controlling for objective performance (see figure 2).

Limited research has assessed the association between anomalous self-experiences and metacognition, but it may be suggested metacognitive efficiency may also be associated with anomalous self-experiences, previously alluded to by Dokic and Martin[38]. This study will empirically test the association between anomalous self-experiences and perceptual biases and metacognition. Anomalous self-experiences and anomalous delusional beliefs have not been considered to be modality-specific, therefore these measures are hypothesised to be related to both visual and auditory perceptual signal detection biases and metacognitive ability.

Figure 2: Proposed model including associations between perceptual signal detection bias and metacognitive efficiency with various anomalous events: anomalous experiences and beliefs, and the associations between metacognitive aspects.



Metacognition has been considered fractionated and can appear in many different forms, associated within a dynamic model[23, 39]. Three levels of metacognition have been proposed: i) Metacognitive efficiency: "knowing that you know"[40], and this level in particular may involve unconscious knowledge to generate a "feeling of knowing"[41] and has been shown to be modality-specific[33], which can be assessed by within-task confidence ratings, ii) Metacognitive experience: online appraisal of one's experience or performance after an activity, and iii) Metacognitive ability is the capacity to think about one's own cognitions, emotions and behaviour, as well as others', and to use this reflection to respond to challenges and link to other relevant narrative events. These metacognitive levels may influence each other via metacognitive processes. Nelson and Narens[23] highlighted two processes: i) Metacognitive controlling processes, (i.e. such that knowledge is used to control, guide and correct ongoing action)[42], and ii) Metacognitive monitoring processes (i.e. monitoring of ongoing experience in order to recognise anomalies and update higher level beliefs)[43], which are important for accurate metacognitive functioning.

As metacognition works in a hierarchical fashion, it may be expected the poor metacognitive efficiency in psychosis, demonstrated above, can impact the next component on the continuum: metacognitive experience, appraisal of one's experience or performance after an activity, via metacognitive processes. However, Gilleen, Greenwood and David[44] demonstrated that metacognitive experience (awareness of level of cognitive ability) is on average intact within a group of individuals with schizophrenia, whilst metacognitive ability is deficit. The dissociation between the different levels of metacognition may be the result of impaired metacognitive processes (self-reflectiveness and set-shifting)[45], akin to various other studies[46, 47, 48]. Due to limited studies, it is currently unclear which metacognitive processes may be driving these metacognitive difficulties. This study aims to further understand the difficulties in metacognitive processes in young people with psychosis and matched healthy controls within two models (see figure 3 and 4).

Figure 3: Part of figure 2 model. Proposed associations between metacognitive efficiency and metacognitive experience with monitoring and controlling processes.

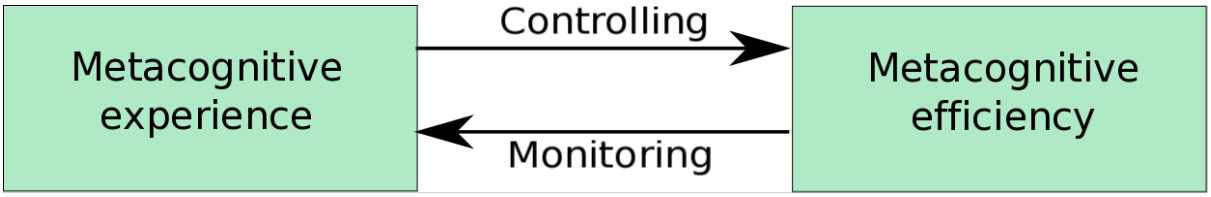
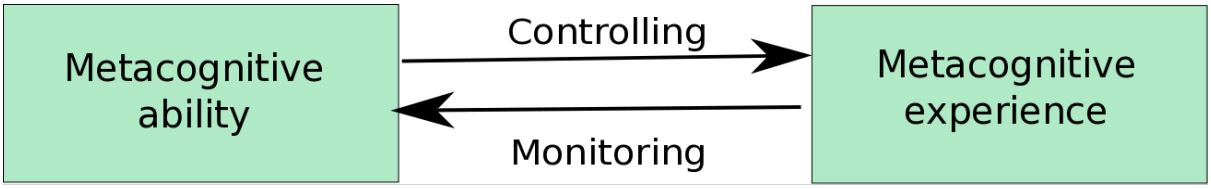


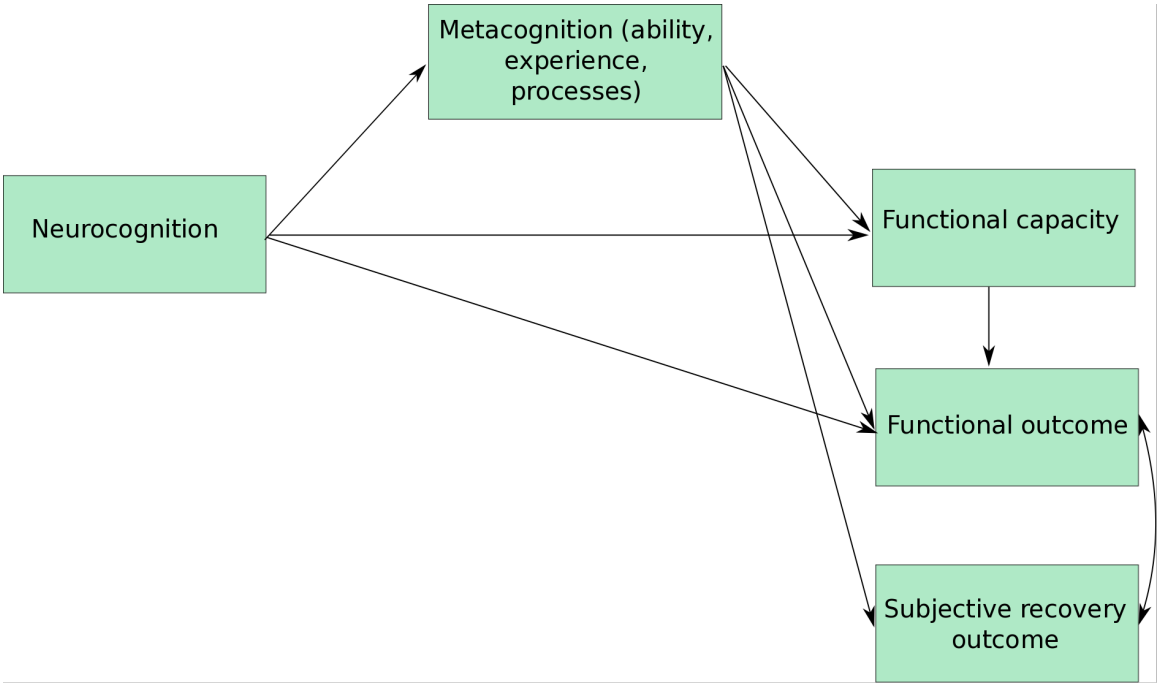
Figure 4: Part of figure 2 model. Proposed associations between metacognitive experience and metacognitive ability with monitoring and controlling processes.



From this, we will assess which metacognitive components may impact on functional outcome: a measurable aspect of an individual's specific activities of daily living. Research suggests functional outcome is predicted by neurocognition[49, 50], functional capacity (measured using real-life performance skills task)[51-53], negative symptoms[54], which has been demonstrated to show a synergistic interaction with cognition to impact functioning[55], and, importantly here, metacognition. Metacognitive ability, measured using the Metacognition Assessment Interview (MAI) or MAS[22, 56], appears to play a crucial role on functional outcome, independent of cognition and symptoms[57-59]. In a recent study, Davies, Fowler & Greenwood[60] demonstrated that metacognition partially mediates the relationship between cognition and functional capacity, and fully mediates the relationship between functional capacity and functional outcome. Limited research has assessed whether metacognitive processes are also relevant in maintaining poor functional outcome over time, independent of cognition. With this in mind, the role of

metacognition will be examined to explore the impact on functional outcome and capacity (see figure 5) and a longitudinal model will also explore the relationships over time.

Figure 5: Proposed model for cross-sectional and longitudinal analyses including indirect effects from symptoms and neurocognition to metacognition and functional capacity to functional and subjective outcome.



Functional outcome has also been associated with subjective recovery outcome (self-rated outcome reflecting sense of wellbeing and quality of life)[61, 62]. Metacognitive capabilities were related to components of recovery beyond the effects of psychiatric symptoms, including aspects of quality of life[63-65]. There is a complex relationship between metacognitive ability, functional outcome and subjective outcome in psychosis. This study will assess these relationships to enable in-depth understanding of functional recovery.

This study aims to develop and test a series of dynamic models to understand (i) the nature of metacognitive deficits compared to healthy controls (chapter 3) (ii) the relationship between metacognitive components (chapter 3) (iii) and the influences of metacognition on objective/subjective functional outcome for young people with psychosis (chapter 3 and 4) and anomalous experiences (chapter 8). If these proposed models can be

demonstrated empirically, this can help to understand and remediate poor outcome within psychosis.

2.3 Hypotheses[1]

Hypothesis 1: A two-way relationship will be present in such that metacognitive control processes will significantly predict metacognitive ability and metacognitive monitoring processes will significantly predict metacognitive experience. In addition, metacognitive control processes will significantly predict metacognitive experience and metacognitive monitoring processes will significantly predict metacognitive efficiency.

Hypothesis 2: Metacognitive variables (metacognitive ability, metacognitive processes and metacognitive experience) will significantly predict outcome measures (functional capacity, functional outcome and subjective recovery outcome) in young people with and without psychosis, even after controlling for symptoms, anomalous experiences and IQ.

Hypothesis 3: Metacognitive variables (metacognitive ability, metacognitive processes and metacognitive experience) will significantly predict outcome measures (functional capacity and functional outcome) at 36-month longitudinal follow-up of participants in young people with psychosis, even after controlling for symptoms and IQ.

Hypothesis 4: Anomalous experiences will be associated with increased signal detection biases and poor metacognitive efficiency, and this relationship will be domain-specific.

2.4 Methods

2.4.1 Design

This is a cross-sectional and longitudinal study. This cross-sectional aspect will explore (i) deficits in metacognition between young people with psychosis and healthy controls; (ii) interrelations between different metacognitive components and processes across the whole sample; and (iii) the contribution of specific novel metacognitive variables to anomalous experiences and outcomes. The longitudinal aspect will identify whether

[1] The order of these hypotheses have been changed to be consistent with the overall structure of this thesis.

metacognition predicts experiences and outcomes at 36-month follow-up period (psychosis sample only).

2.4.2 Participants

Seventy-three young people with psychosis will be recruited. This sample will be made up of a convenience sample from first episode services and the remaining individuals will be those re-recruited from a previous first episode psychosis (FEP) sample (previous N=80), to take part in the main cross-sectional study and longitudinal follow-up aspect. Participants from the previous FEP study have baseline data on metacognition, functional capacity, functional outcome, symptoms and cognition[60]. These data will form the baseline data for the longitudinal analysis. All participants with psychosis will be 18 – 40 years of age, able to read and communicate in English and receiving treatment for psychosis with a UK Early Intervention in Psychosis service at first assessment. Participants with organic causes for psychosis or those with a diagnosis of substance use disorder will be excluded.

Seventy-three healthy control participants will be recruited as a comparison group. These participants will be 18-40 years of age, able to read and communicate in English and matched on age, gender and education with the psychosis sample. Participants will be recruited through advertisement within the local community, e.g. in libraries, cafes and on social media. Participants with current mental health problems or history of psychosis will be excluded following screening questions: i) Are you currently experiencing any mental health difficulties? ii) Are you on any psychotropic medication/substances? iii) Have you been in contact with psychological or psychiatric services for psychological problems? iv) Has anyone in your immediate family experienced an episode of psychosis? E.g. parents, siblings. If healthy control answered yes to any of the questions, these participants were deemed ineligible to take part in the study.

Participants with hearing or sight problems (which cannot be corrected) will be excluded. Data collection will be undertaken within an NHS building or community setting between 10th March 2017 and 4th May 2018. The end date of the study is 18th September 2018.

2.4.3 Patient and public involvement

Patient and Public Involvement is primarily via the Psychosis Interest Group run by the Service User and Carer Involvement Coordinator at the Sussex Partnership NHS Foundation Trust Research and Development department, and service users within the Psychosis Theme Group (PTG). The first author met with the PTG to consult on the development of this project, including the design, methods, and procedure of the project. The lived experience group have viewed all the measures, including the two main computer tasks (visual and auditory tasks), and provided extensive feedback which has been incorporated into this project. Study participants who consent to receiving the study results will receive these by post/email. The first author and the Psychosis Theme Group will continue to meet to consult on recruitment procedures, and on the plans for dissemination to service user groups following data analysis.

2.4.4 Cross-sectional measures

Anomalous experience measures

Anomalous perceptual experiences: Multimodal Unusual Sensory Experiences Questionnaire[35]. This measures anomalous perceptual/sensory experiences with 6 subscales. Both the full scale and subscales have been demonstrated as possessing good reliability (auditory r=0.72, visual r=0.72), good validity between clinical and non-clinical group (Cohen's d = 0.96) and significance with all other anomalous experience scale, and internal consistency (auditory α=0.82, visual α=0.88). The auditory and visual subscales will be used for this study which each provide a combined score for presence and frequency of anomalous experiences.

Anomalous self-experiences: Cambridge depersonalisation scale (trait and state versions)[66]. The trait version includes 29 items measuring frequency (Never to All the time) and duration (Few seconds to More than a week) of anomalous self-experiences over the last 6 months. It demonstrates high internal consistency (>0.6), good validity with other scales (r=0.8) and good reliability (α= 0.89)[66], and is useful for assessing depersonalisation in a schizophrenia group[67]. The state version includes 22 items measuring anomalous self-experiences within-the-moment on a scale of intensity from 0-100. Subscales of the CDS are 'alienation from surroundings', 'anomalous subjective recall', 'emotional numbing' and 'anomalous body experience'.

Anomalous delusional beliefs: Schizotypal Symptom Inventory[68]. This measure assesses residual psychotic symptoms, providing a total score with separate subscales for paranoia, anomalous experience and social anxiety[69]. This present study will use the paranoia subscale as a measure of anomalous delusional beliefs and the anomalous experience subscale as a measure of anomalous perceptual experiences, to confirm MUSEQ data assessing anomalous perceptual experiences. This scale demonstrates high internal consistency (non-clinical sample α=0.87 and clinical sample α=0.92), good validity with other scales (PANSS with total r = 0.59 and paranoia r=0.6) and good test-retest reliability (0.85 for total and 0.6-0.84 for subscales).

Metacognition

Metacognitive efficiency

This encompasses separate computer –based visual and auditory detection task. The critical task in both paradigms is to make two forced-choice binary judgments of whether a visual or auditory stimulus (dot or tone) was present or absent (first judgment) within a noisy picture or presentation of white noise, and whether this was associated with high confidence or low confidence in the first judgment (second judgment).

The first judgment can be used to calculate a score for signal detection perceptual sensitivity and perceptual signal detection bias. *Perceptual sensitivity* (*d'*): the ability to correct report whether the stimulus (dot/tone) was either present or absent. Signal detection theory (SDT) posits that detection making involves depicting whether certain waveforms called signals may or may not be embedded within background 'noise', using internal responses[70]. *Perceptual bias* (*B*) is the tendency to report one decision over the other, e.g. stating the stimuli was present when it was in-fact absent. The internal responses from perceptual sensitivity score is then compared to a decision criterion (c) so all evidence above criteria elicits a response of 'present' compared to below the criteria elicits the response of 'absent'[71]. The perceptual sensitivity score and the decision criterion can be fitted to an empirical Receiver Operating Characteristic (ROC) curve, enabling us to assess perceptual biases in responses, e.g. whether someone was more or less likely to report stimuli as being present based on a lower/higher decision criterion.

The second judgment can be used to calculate a score for metacognitive sensitivity and metacognitive efficiency. *Metacognitive sensitivity* (meta-*d'*) is the ability to discriminate

between correct and incorrect judgments. Alike to the SDT above, metacognitive sensitivity is based on assessment of sensitivity (how well confidence ratings discriminate correct from incorrect trials) and response bias (overall propensity for reporting high confidence). However, this score from the second judgment must take into account first judgment performance[72]. Meta-*d'* indicates the *d'* that would have been predicted to result in the confidence rating assuming the signal detection theory. Optimal metacognitive sensitivity is when perceptual sensitivity score is matched. Meta-*d'* greater or less than *d'* indicates metacognition is better or worse than *d'* [34]. *Metacognitive efficiency* is one's ability to discriminate between one's own correct or incorrect perceptual decision, whilst taking into account objective performance[32]. This is calculated as meta-*d'*/*d'*. Metacognitive efficiency (meta-*d'*/*d'*) was chosen as a more robust form of perceptual metacognition, over metacognitive sensitivity (meta-*d'*) which was previously used by researchers[73].

Performance on the first judgment will be held constant throughout the task and across participants (using a 1-up-2-down staircase procedure) to ensure that metacognitive ability is measured independent of task performance and produces valid scores.

Studies including signal detection tasks typically involve a large number of trials (~400), to avoid statistical bias and large variance in scores[74]. However, following a pilot study, we reduced the trials to 200, whilst maintaining reliable data. To ensure the feasibility of conducting this study within a clinical population, who may present difficulty with attention and concentration[75], the two computer tasks have been developed from a pilot study within a healthy student population[76].

Alongside this, participants will be asked to prospectively and retrospectively rate their performance on the detection tasks. These ratings will be used to assess metacognitive ability and metacognitive experience.

Metacognitive experience: The retrospective rating ("How well do you think you performed overall on the task? For instance, if you think you were right every time, select 100 (all correct). If you think you were correct none of the time, select 0 (none correct). You can select any value in between zero and 100 to indicate what percentage you think you correctly identified") will assess task-related metacognitive experience.

Metacognitive ability: This will be assessed using the Metacognitive Assessment Interview[56]. This measure assesses the ability to understand "the self" and "the other"; termed as one multidimensional construct as 'metacognition'. This measure has demonstrated good inter-rater reliability and internal consistency (α=0.90 for total metacognition), factorial validity, and reliability (r=0.62 to 0.90)[56].

Metacognitive processes (monitoring and control): Monitoring processes will be assessed using self-reflectivity subscale of Cognitive insight scale[77]. This measure possesses good internal consistency (α=0.68), convergent validity (with SUMD-A delusions, r= -0.67)[77] and test-retest reliability (r=0.90)[78]. Studies have demonstrated this measure is appropriate to assess metacognitive monitoring[45, 79]. Control processes will be assessed via set-shifting using trail-making task[80] part B-A. This measure possesses good internal consistency (TMT-A α=0.39, TMT-B α=0.71), convergent validity (with Task Switching Paradigm r=0.32)[81], and good reliability of other forms of TMT (r=0.78)[82]. This measure is appropriate to assess metacognitive control processes[45].

Functional outcome

Functional outcome: Time Use Survey (adapted from Short[83]) provides a retrospectively rated objective measure for hours spent engaging in structured activity per week[84]. This measure has been used within a First Episode Psychosis sample to assess functioning[85, 86]. This measure has good reliability (inter-rater reliability at 0.99)[85], coder reliability (89% accuracy)[87], good validity as differences in Time-Use have been demonstrated between different stages of psychosis, representing social recovery in psychosis[85], validity as TUS is comparable to studies using functioning measures[69].

Functional capacity: The UCSD Performance-Based Skills Assessment[53] provides a total score for real-life performance skills based on simulated tasks. It was adapted to be applicable for UK participants. This measure demonstrates high internal consistency (α=0.88), good validity with other scales (DAFS r=0.86) and good test-retest reliability (r=0.91)[88].

Subjective recovery outcome: The Questionnaire of Process of Recovery[89] provides a score for an individual's subjective functioning (psychosis participants only). This scale has

two subscales: intrapersonal items related to hope, empowerment, confidence, and interpersonal related to connectedness with others, others help/care, reliance. This possesses good internal consistency (intrapersonal subscale, α=.94, interpersonal subscale, α=.77), construct validity (GHQ total score: intra, r=-.83 inter, r=.52) and reliability (intra, r=.87, inter, r.77)[89].

Covariates

Symptom severity: This assesses symptoms of psychosis using Positive and Negative Syndrome Scale[90] (clinical participants only), which is the mostly widely used standardised instrument for assessing symptom severity in schizophrenia[91]. This measure has demonstrated good reliability and validity, and appropriate inverse correlations between positive and negative subscales[92]. This measure has good internal consistency (agreement for PANSS items r=0.69 – 0.94), construct validity (between PANSS and Andreasen rating system, r=0.77) and reliability (interrater correlations for PANSS scales ranged from 0.83 to 0.87)[92].

Cognitive ability: This includes verbal IQ: Vocabulary task[93] is a measure of an individual's verbal knowledge and fund of information. This measure as good internal consistency (correlation with other cognitive measures range r=0.54 to 0.79), construct validity (with WASI-III, r=0.88) and reliability (0.90 to 0.89) and test-retest (0.88)[93]; and performance IQ: Matrix reasoning task[93] is a measure of individual's ability to mentally manipulate abstract symbols and perceive the relationship among them. This measure as good internal consistency (correlation with other cognitive measures range r=0.59 to 0.63), construct validity (with WASI-III, r=0.66) and reliability (0.88 to 0.96) and test-retest (0.76)[93].

2.4.5 Longitudinal measures

For participants who have baseline data, this comprises of the following measures outlined above: metacognitive ability and metacognitive monitoring processes; functional outcome and functional capacity; and all covariates.

2.5 **Analysis**

2.5.1 Sample size

Two sample size estimates have been combined to ensure the analyses have sufficient power to detect effects.

Firstly, sample size to detect differences between individuals with psychosis and healthy control participants on metacognitive efficiency. Using G power with .8 power, .57 effect size based on a previous metacognitive efficiency task in psychosis[94] and 0.05 alpha, the proposed total sample size is 28 (14 per group). Secondly, a regression analysis to assess the predictive value of metacognitive ability, processes and experience on outcome measures (controlling for symptoms and IQ) will be conducted. G power estimation was used for a power calculation based on a power of .80, effect size of .313[60] and alpha of .05. This suggested for 6 predictors a total of 55 participants are required.

In terms of the mediation analysis, power estimation was calculated using the monte carlo method to estimate power for complex mediation models (see Thoemmes, MacKinnon & Resier[95]). Using fixed parameters from Davies, Fowler and Greenwood[60] and power at .8, this suggested a total sample size of 146 participants to detect mediation effects, outlined in the above model.

In terms of the longitudinal analysis, as many of the original sample (n=80) as possible will be followed up to maximise statistical power.

2.5.2 Planned data analysis

Data will be double entered and checked for accuracy, and checked for outliers.

Missing data will be considered as 'Missing at random' (MAR), which means the missing variables are related to additional observed variables within the data, but values of missing data itself. Missing data will be treated according to best practice[96]. Principled missing data methods will be used which combine available information from the observed data to estimate the population parameters and/or the missing data mechanism[97].

Full information maximum likelihood (FIML) involves using all the observed data and creating values for missing data using maximum likelihood estimations. This works well provided that the model for the complete data is realistic[98]. FIML will be used within this study which is considered most appropriate for MAR data and for mediation analyses[99]. Quantitative data (including demographic information) will be reported using descriptive statistics, e.g. means and standard deviations.

Data will be analysed using SPSS and Mplus software. Group differences of all metacognitive measures and perceptual signal detection biases between young people with psychosis and healthy controls will be assessed, controlling for age and IQ. Linear regression analyses will be used to assess how metacognition (and perceptual signal detection biases) predicts anomalous experiences. Cross-sectional and longitudinal predictive analyses will be conducted, including regression analyses which will assess whether metacognitive components; ability, experience, efficiency are predicted by metacognitive processes. A mediation analysis will be used to assess whether functional capacity, functional outcome and subjective recovery outcome are predicted by metacognition and metacognitive processes, whilst controlling for anomalous experiences, symptoms and cognition. These analyses will include bootstrapped bias-corrected confidence intervals.

Results of the planned analyses are presented in chapters 3, 4 and 8.

2.6 Discussion

Our assumption is that metacognitive variables predict, and maintain, anomalous events, poor objective and subjective recovery outcome in young people with and without psychosis. Particularly in young people with psychosis, metacognitive deficits may predict long-term functional outcome.

The study results will be an important addition to the literature and for clinicians for four main reasons: i) this study tests a proposed model from previous literature which may help understand poor functional outcome in psychosis, ii) from this, novel intervention studies can be developed to tackle the potential metacognitive deficits in psychosis which predict this poor functional outcome, iii) this is one of the first studies to assess

metacognition as a longitudinal predictor of functional outcome in young people with psychosis sample, and finally iv) our studies use up-to-date paradigms within the field of metacognition to avoid biases.

2.6.1 Limitations

A foreseeable limitation is that the First Episode Psychosis sample will be comprised of both a previous FEP sample and new participants who are currently engaged in EIS in Sussex. Therefore, individuals will be at various stages of their recovery and support from the Early Intervention Services which adds variation in terms of symptoms and recovery. With this in mind, symptoms will be controlled in the main analysis. However, this will enable exploration of factors which predict this variation. Due to length of follow-up period, another limitation may be the difficulty in re-recruiting these participants into the study. If re-contacting is difficult, the model may not have full power. If so, the individual paths of the model in the longitudinal analyses will be explored.

2.7 **Ethics and dissemination**

This study has been reviewed and approved by Camberwell St. Giles Research Ethics Committee (reference number: 17/LO/0055). The data will be stored securely in accordance with usual NHS procedures and data will be governed by the sponsor: University of Sussex. This research project will be reported within a PhD thesis, and will be written up for publication in scientific journals.

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3. A metacognitive model: The role of metacognitive components on functional outcome and subjective recovery in individuals with and without First Episode Psychosis.

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Chapter 3 has been submitted to Psychological Medicine.

3.1 Abstract

3.1.1 Introduction

Beck and Rector (2005) proposed a model of functional outcome in schizophrenia, suggesting that the path between neurocognition and functioning is mediated by functional capacity and cognitive processes. These cognitive processes can include metacognition, considered 'thinking about thinking'. Metacognition has been proposed to include several components: metacognitive ability, experience and efficiency, connected by metacognitive monitoring and control processes. It is unclear how these metacognitive components interact and which are important for outcomes in First Episode Psychosis (FEP).

3.1.2 Methods

This was a cross-sectional study involving 62 individuals with FEP and 73 matched healthy controls who completed measures of metacognition, functional capacity, functional outcome, and subjective recovery; with covariates: IQ, anomalous experiences and symptoms.

3.1.3 Results

A series of factor analyses demonstrated that metacognitive ability, experience, efficiency and monitoring were separate aspects of metacognition. Metacognitive ability predicted functional capacity, and objective functional outcome, independent of IQ, and subjective recovery independent of mood and anxiety. Metacognitive experience also predicted functional capacity.

3.1.4 Discussion

This is the first study to assess key metacognitive components within a large model and their independent role on outcomes, and to consider the distinct contributions to both objective and subjective recovery. This highlighted the important role of metacognitive ability as an early marker for later poor functioning and as a target for interventions in FEP.

3.2 Introduction

Recent studies exploring recovery in psychosis have demonstrated favourable outcomes after long follow-up periods within schizophrenia and First Episode Psychosis (FEP) (Harrison, Hopper, Aig, et al., 2001; Harrow et al., 2005; Henry et al., 2010; Robinson, Woerner, McMeniman, Mendelowitz, & Bilder, 2004; Wunderink et al., 2009). Recovery can be considered an improvement in symptomatology and functioning (Andreasen et al., 2005; Harvey & Bellack, 2009), and the latter may be objectively assessed in terms of the number of hours in structured activity, e.g. Time-Use Survey (Fowler et al., 2009; Short, 2006). Alongside this, research in psychosis has now begun to consider the subjective perspective of recovery, including quality of life, finding hope, stability, re-establishment of identity, and empowerment (Andresen, Oades, & Caputi, 2003; Leamy, Bird, Le Boutillier, Williams, & Slade, 2011; Sheridan et al., 2012). These subjective recovery models identify recovery as both a process and an outcome (Ramon, Shera, Healy, Lachman, & Renouf, 2009) which mimics the peaks and troughs in the recovery trajectory shown in FEP (Hodgekins, Birchwood, et al., 2015).

These two streams of recovery (e.g. subjective and objective outcomes) have been associated (Provencher et al., 2002) and may have considerable overlap (Malla & Payne, 2005). Research has now started to consider both objective and subjective outcomes in order to understand the 'breadth of success' across recovery (Harvey & Bellack, 2009). There is clear interest in the identification of those with FEP who are at-risk of poor recovery, to target interventions to reduce these poor outcomes.

Functional outcome in schizophrenia has been shown to be predicted by neurocognition (Green et al. 2000), including IQ (Leeson, Barnes, Hutton, Ron, & Joyce, 2009), functional capacity (measured using real-life performance skills task) (Bowie, Reichenberg, Patterson, Heaton, & Harvey, 2006; Bowie et al., 2008), and negative symptoms (Milev et al., 2005; Greenwood et al., 2005). Beck and Rector (2005) proposed that this path between neurocognition and functional outcome is mediated by other cognitive processes: including defeatist performance beliefs, self-stigma (Berry & Greenwood, 2018) and, importantly here, metacognition (Davies, Fowler, & Greenwood, 2017).

Metacognition is considered "thinking about thinking" (Flavell, 1979) or the way one thinks about one's experience. Metacognition has been considered fractionated and can appear in many different forms and representations of the self (Lysaker et al., 2014; Shea et al., 2014). Three levels of metacognition have been proposed. The highest level is metacognitive ability: capacity to think about one's own cognitions, as well as others', and to use this to respond to challenges (Lysaker & Dimaggio, 2014). Metacognitive ability may impact the second level, metacognitive experience: "online" appraisal of one's experience. Metacognitive experience may then impact the lowest level, metacognitive efficiency: unconscious knowledge used to generate a feeling of "knowing that you know" (Sherman et al., 2015). Theoretically, these components have been suggested to be associated within a dynamic model (Nelson & Narens, 1990) via: i) metacognitive controlling processes, (i.e. used to guide and correct ongoing action, Wells & Purdon, 1999), and ii) metacognitive monitoring processes (i.e. monitoring of experience in order to update beliefs, Efklides, 2006). These processes must work in harmony to ensure metacognition is effectively harnessed to enable cognitions to guide thought and behaviour. No study has yet empirically assessed these metacognitive components within a model nor assessed their role on outcomes.

Firstly, metacognitive ability is poorer in psychosis (Lysaker, Pattison, Leonhardt, Phelps, & Vohs, 2018; Lysaker et al., 2005), and is shown to have an impact on functional, social and work outcomes in psychosis (Arnon-Ribenfeld, Hasson-Ohayon, Lavidor, Atzil-Slonim, & Lysaker, 2017; Brüne, Dimaggio, & Lysaker, 2011; Davies & Greenwood, 2018; Luedtke et al., 2012; Lysaker et al., 2010), independent of cognition and symptoms (Lysaker et al., 2011, 2014). Metacognitive ability is shown to mediate the relationships between neurocognition, functional capacity and functional outcome in FEP (Davies et al. 2017; Wright, Davies, Fowler & Greenwood, 2018). Negative symptoms have been associated with metacognition and also functioning (Hamm et al., 2012; James et al., 2016; McLeod et al., 2014). Limited research has assessed the role of metacognitive ability on functional outcome in FEP, independent of negative symptoms.

Metacognitive ability has also been associated with components of subjective recovery outcome in schizophrenia (Kukla, Lysaker, & Salyers, 2013; Phalen, Viswanadhan, Lysaker, & Warman, 2015) and social quality of life (arguably a measure of subjective recovery outcome) (Lysaker et al., 2013; Hasson-Ohayon et al., 2015). Morrison et al.

(2013) recently demonstrated that there was no impact of neurocognition or negative symptoms on subjective recovery, instead negative emotion (including anxiety and depression) and internal locus of control have been shown to have a direct influence on subjective recovery. Individuals within these studies had long-term schizophrenia and no study has yet assessed the association between metacognition and subjective recovery in FEP, independent of negative emotion.

Secondly, metacognitive experience (online appraisal) has also been associated with social, real-world and work functioning (Gould et al., 2015; Stratta et al., 2009; Verdoux et al., 2010). However, Gilleen, Greenwood and David (2014) demonstrated that metacognitive experience ("online" awareness within the moment) is, on average, intact within schizophrenia. This presents a potential dissociation between metacognitive ability and metacognitive experience, which may be the result of impaired metacognitive processes.

Metacognitive monitoring processes (measured using self-reflectiveness scale of the Beck Cognitive Insight Scale) have been shown to be poorer in psychosis than controls (Engh et al., 2007; Warman, Lysaker, & Martin, 2007) and related to global functioning in schizophrenia (Giusti et al. 2013; Davies et al. 2017). Metacognitive control processes (set-shifting using Trail-Making Task) has been demonstrated as poor in psychosis (Riley et al., 2000) and linked to real-world outcomes (Strassnig et al., 2018). Intact metacognitive experience in schizophrenia requires both appropriate metacognitive monitoring and control processes (Gilleen et al., 2016). Research within FEP could identify key early deficits, which may be driving other metacognitive difficulties and could later predict difficulties in functioning.

Thirdly, metacognitive efficiency is poorer in psychosis (Bliksted et al., 2017; Davies et al., 2018). Due to the lack of research linking metacognitive efficiency with real-world outcomes, it is not expected that this metacognitive component will be associated with functioning.

Following Nelson and Naren's proposed model of metacognition, it is hypothesized that there is a hierarchical relationship between the distinct metacognitive components. It is hypothesized that metacognitive ability, experience, monitoring and control processes

will predict functional capacity and functional outcome in young people with and without psychosis, independent of neurocognition (IQ) (and negative symptoms for the psychosis group). In the clinical group only, metacognitive ability will also be related to subjective recovery outcome in FEP, independent of negative emotion.

3.3 Methods

3.3.2 Participants

Individuals with psychosis were recruited through a convenience sample from Early Intervention in Psychosis services in Sussex Partnership NHS Foundation Trust, and a minority were re-recruited from a previous first episode psychosis (FEP) sample (Davies, Fowler & Greenwood, 2017). All had been given a formal diagnosis of First Episode Psychosis (F29) by a psychiatrist, and were aged 18-40 at entry into the study. Participants with primary diagnosis of substance misuse disorder or organic neurological impairment were excluded.

Healthy control participants were recruited as a comparison group, matched with the clinical group on age, gender and educational status. Participants with current mental health problems or family history of psychosis were excluded following screening questions.

3.3.3 Design

This is a cross-sectional study exploring the different components of metacognition and the contribution of these metacognitive measures to functional and subjective outcome measures, independent of IQ and symptoms, with individuals with First Episode Psychosis and matched healthy control participants. Full details of the study design and ethical approval is in the protocol in Chapter 2 (Wright, Fowler & Greenwood, 2018). Data collection was undertaken between March 2017 to May 2018.

3.3.4 Measures

Metacognition

Metacognitive ability: The Metacognitive Assessment Interview (Semerari et al., 2012) required the participant to reflect on a recent difficult interpersonal experience and answer a series of questions to assess i) monitoring, ii) differentiation, iii) integration, and iv)

decentralization. These four subscales are each scored between 0-5, depending on spontaneity, use of aids/prompts and the sophistication of the answer. The scores for the sub-domains are averaged to provide one multidimensional construct as 'metacognitive ability'. Psychometric properties and further details of this measure (and others below) can found in the protocol paper (Wright, Fowler, & Greenwood, 2018).

Metacognitive experience (appraisal): Participants were asked to prospectively and retrospectively rate their performance on the detection tasks above. The retrospective rating was used: "How well do you think you performed overall on the task? For instance, if you think you were right every time, select 100 (all correct). If you think you were correct none of the time, select 0 (none correct)". This scale was adapted from previous metacognitive research (see Rouault, Seow, Gillan, & Fleming, 2018). The participant's accuracy score on the task (S) is subtracted from their subjective retrospective rating (R) to provide a metacognitive experience accuracy score for the individual's ratings (ME) [R – S = ME]. This score ranged from -100 to 100. A score of 0 is perfect accuracy. An appraisal scored below 0 is considered under-confidence and above 0 is over-confidence. This measure provides two separate visual and auditory metacognitive experience scores, one for each task.

Metacognitive efficiency: This encompasses separate computer–based visual and auditory detection tasks. The critical task in each paradigm is to make two forced-choice binary judgments of (i) whether a visual or auditory stimulus (dot or tone) was present or absent (first judgment) within a noisy picture or presentation of white noise, and (ii) whether confidence in this decision was high or low (second judgment). The second judgment captures *metacognitive sensitivity* (meta-*d'*): the ability to discriminate between correct and incorrect judgments. Meta-*d'* greater or less than *d'* indicates metacognition is better or worse than *d'* (Morales, Lau, & Fleming, 2017). *Metacognitive efficiency* involves taking into account objective performance (Fleming & Lau, 2014; Maniscalco & Lau, 2012), and is calculated as meta-*d'*/*d'* (metacognitive sensitivity divided by perceptual sensitivity) (Rounis, Maniscalco, Rothwell, Passingham, & Lau, 2010). The two tasks provide separate visual and auditory metacognitive efficiency scores.

Metacognitive processes (monitoring and control): Monitoring processes will be assessed using the self-reflectivity subscale of the Cognitive insight scale (Beck et al., 2004).

Studies have demonstrated this measure is appropriate to assess metacognitive monitoring (David, Bedford, Wiffen, & Gilleen, 2012; Gilleen et al., 2016). Control processes will be assessed via set-shifting using the trail-making task (Reitan, 1958) time taken in seconds to complete part B-part A. This measure is appropriate to assess metacognitive control processes (Gilleen et al., 2011; Gilleen et al., 2016) and executive control processes (Tombaugh, 2004).

Function

Functional outcome: Time Use Survey (adapted from Short, 2006) provides a retrospectively rated objective measure for hours spent engaged in structured activity per week (Fowler et al., 2009), including work, education, voluntary work, childcare, sports, leisure and housework activities.

Functional capacity: The UCSD Performance-Based Skills Assessment (Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001) is a role play test which assesses the capacity to perform behaviors on simulated tasks. This measure is divided into five sections: i) finance, ii) communication, iii) comprehension/planning, iv) transport, and v) household. During each role-play the individual is given 0 or 1 point(s) by the researcher from the manual guidelines. These raw scores are totalled for each domain and converted into 0-10 scale to be comparable across domains. This score is then multiplied by 2 and summed to provide a total out of 100.

Subjective recovery outcome: The Questionnaire of Process of Recovery (Neil et al., 2009) is a 22-item self-report questionnaire which provides a score for an individual's subjective recovery outcomes; hope, empowerment, confidence, connectedness with others, and reliance (psychosis participants only). The participant rates declarative statements from 0 (strongly disagree) to 4 (strongly agree), with a higher score indicating recovery. Studies have reported scores in the range of 50-60 for schizophrenia samples (Morrison et al., 2013; Neil et al., 2009)

Covariates

IQ: Verbal IQ was measured through the Vocabulary task (Wechsler, 1999), a measure of an individual's verbal knowledge. Performance IQ was measured with the Matrix

reasoning task (Wechsler, 1999), a measure of an individual's ability to mentally manipulate abstract symbols and perceive the relationship among them.

Symptoms: Positive and Negative Syndrome Scale (Kay & Fiszbein, 1987) is the most widely used standardized instrument for assessing symptom severity in schizophrenia (Hermes, Sokoloff, Stroup, & Rosenheck, 2012). This measures provide three separate scores for positive, negative and general psychopathology symptoms. This study also used individual item scores for depression and anxiety. Anomalous experiences were also included as a covariate, using anomalous experience subscale of Schizotypal Symptom Inventory (Hodgekins et al., 2012).

3.4 Planned analysis

Firstly, ANOVAs were conducted to assess the differences in metacognitive scores between the clinical and non-clinical group. Next, an Exploratory Factor Analysis (EFA) was conducted using items from metacognitive components to confirm the loading onto separate metacognitive factors. Next, associations between the metacognitive variables in the full group were explored using a correlational matrix. Next, to assess hierarchical framework for metacognitive components, a mediation analysis was conducted to assess the direct and indirect relationships between metacognitive ability, experience, and efficiency, via control and monitoring processes. Following this, metacognitive ability, experience, monitoring and control processes were used as predictors within a multiple regression analysis to assess the role on functional capacity and functional outcome, independent of IQ (and negative symptoms for FEP group). Next, the role of metacognitive ability on subjective recovery outcome in FEP was assessed, independent of anxiety and depression.

3.4.2 Data and assumption checking

Missing data was kept to a minimum and was shown to be Missing Completely At Random (MCAR) as it was unrelated to key variables within the data. Descriptive statistics for the data were checked for skewness, kurtosis and outliers, and normality of the data was assessed visually and using Kolmogorov-Smirnov test of normality. Trail-Making Task (B-A), PANSS positive and PANSS negative were all negatively skewed, and variables were transformed using Log10 transformation.

3.5 **Results**

3.5.2 Sample characteristics

A total of hundred and thirty-five participants took part. This includes sixty-two participants with First Episode Psychosis and seventy-three healthy control participants (see table 1). Table demonstrates sample characteristics and ANOVAs for comparing metacognitive components between FEP and control group.

Table 1: Sample characteristics and descriptive statistics with difference tests between the two groups.

	FEP sample (N=62)	**Healthy control sample (N=73)**	**Differences test**
Age, yrs. (SD)	26.24 (5.66) range 18-43[1]	26.3 (S.D 6.6) range 18-40	$t(132.99) = -.004, p=.99$
Gender			$\chi^2 (1, 135) = .31, p = .58$
Male	46 (74%)	51 (73%)	
Female	16	22	
Educational level[2]			**χ^2 (3, 134) = 17.88, $p<.001$*** **
No qualifications or	20 (32%)	6 (8%)	
GCSE	22 (36%)	49 (67%)	
A-levels	18 (30%)	18 (25%)	
Degree or Higher Degree			

[1] As this study involved re-contacting individuals from an early cohort study, one participant was above the 18-40 range.

[2] Due to the way educational level, martial status, ethnicity, work status and accommodation status were measured and the assumptions of chi-square tests, we had to collapse the groups. Participants who preferred not to state their answer were removed from these chi-squared analyses.

Work status			**χ^2 (2, 135) = .7.89, *p*=.02***
Full-time or part-time	30 (49%)	36 (50%)	
Not in employment	14 (23%)	5 (7%)	
Other: Student, Looking after home, or Long-term sickness	17 (27%)	31 (42%)	
Accommodation status			χ^2 (2, 134) = 5.19, *p*=.08
Parent's house	25 (40%)	17 (23%)	
Other: Family carer home, support living, or NHS accommodation	7 (9%)	11 (15%)	
Lives independently	29 (47%)	45 (62%)	
	Mean (SD)	**Mean (SD)**	**Difference tests**
Matrix reasoning (t-score)	52.39 (8.53) (range 26-66)	52.04 (7.6) (range 30-68)	*t*(131) -.25, p=.8
Vocabulary (t-score)	51.25 (13.1) (range 20-70)	54.76 (8.65) (range 33-70)	*t*(98.79) -1.78, *p*=.08
2-part IQ	104.54 (14.99) (range 61-131)	106.13 (10.78) (range 75-131)	*t*(102.8) -.68, *p*=.5
MAI total (0-5)	3.15 (.87) (range 1.19-4.56)	3.64 (.65) (range 2.38-4.69)	***t*(111.36) 3.68, *p*<.001*****
Visual metacognitive experience (-100-100)	-20.2 (19.96) (range -53.7-17.3)	-29.08 (18.27) (range -66.7-14.7)	***t*(121) -2.57, *p*=.01****
Auditory metacognitive experience (-100-100)	-20.47 (19.72) (range -69.7-26.7)	-26.5 (21.06) (range -65.0-16.3)	*t*(124) -1.64, *p*=.1

Visual metacognitive efficiency (meta-*d'*-*d'*)	-.45 (.43) (range -1.87-.96)	-.49 (.55) (range -2.29-.72)	*t*(122) -.34, *p*=.74
Auditory metacognitive efficiency (meta-*d'*-*d'*)	-.41 (.53) (range -2.1-.98)	-.43 (.43) (range -1.65-.23)	*t*(125) -.25, *p*=.8
BCIS self-reflectiveness subscale (0-27)	15.3 (4.44) (range 6-25)	12.68 (3.48) (range 5-21)	***t*(132) -2.35, *p*=.02***
BCIS self-reflectiveness subscale (4 items)[1] (0-12)	7.1 (2.7) (range 2-12)	4.85 (2.19) (range 0-9)	***t*(114.98) 5.26, *p*<.001*****
TMT-BA (seconds)	39.63 (39.7) (range -7.7-261.2)	27.0 (16.9) (range 5.2-89.86)	***t*(131) -2.12, *p*=.04***
Time-Use Survey (hours in activity per week)	38.45 (24.14) (range 5-109.69)	55.46 (19.99) (range 8.27-110.9)	***t*(132) -4.46, *p*<.001*****
UPSA total (0-100)	80.9 (9.58) (range 54.87-96.9)	84.38 (9.29) (range 56.6-98.18)	***t*(130) -2.12, *p*=.04***
QPR total (0-88)	61.29 (13.4) (range 31-88)		
PANSS Positive (7-49)	12.44 (4.66) (range 7-26)		
PANSS Negative (7-49)	11.53 (4.04) (range 7-26)		
PANSS General (16-112)	26.86 (5.84) (range 17-39)		

Note: MAI = Metacognitive Assessment Interview; Visual/Auditory metacognitive experience = Postdiction accuracy of visual/auditory performance; BCIS = Beck Cognitive Insight Scale; TMT-BA = Trail Making Task (B-A); UPSA = UCSD Performance-Based Skills Assessment; QPR = Questionnaire of Process of Recovery; PANSS = Positive And Negative Syndrome Scale.

[1] BCIS self-reflectiveness 4 items was derived from the factor analyses below.

3.5.3 Hypothesis testing

Prior to the main Exploratory Factor Analyses (EFA). Two CFAs were conducted to assess i) the factor loadings for the four variables onto one latent variable: metacognitive ability (Metacognitive Assessment Interview), and ii) the factor loadings for 9 variables onto one latent variable: metacognitive monitoring (self-reflectiveness subscale of Beck Cognitive Insight Scale). The metacognitive variables were converted into Z scores, using mean and S.D within this current data. Next, the main EFA was conducted using items for the metacognitive measures to confirm the loading onto four separate metacognitive factors: metacognitive ability, experience, monitoring and efficiency. Metacognitive control processes were not included as this measure includes only one variable (TMT-BA) and is conceptually indefensible.

Confirmatory Factor Analysis (CFA): Metacognitive ability (MAI)

A CFA was conducted which included all individual metacognitive ability variables to assess loading onto one latent variable. Scree plot and model fit suggested one factor (supplementary material) which had excellent fit indices, [$\chi^2(2) = .04$, p=.98, CFI = 1.00, TLI = 1.02, RMSEA = .00].

CFA: Metacognitive monitoring [BCIS-Self-reflectiveness (SR)]

A CFA was conducted which included all individual metacognitive monitoring to assess loading onto one latent variable. BCIS-SR as one factor had poor fit indices, [$\chi^2(27) = 76.19$, p<.001, CFI = .69, TLI = .59, RMSEA = .12] (supplementary material). BCIS-SR 6-8 were excluded ("Even though I feel strongly that I am right, I could be wrong"; "If somebody points out that my beliefs are wrong, I am willing to consider it"; "There is often more than one possible explanation for why people act the way they do"). The CFA was conducted again with 6 items which had improved but still poor fit indices, [$\chi^2(9) = 36.44$, p<.001, CFI = .8, TLI = .67, RMSEA = .15] (supplementary material). All variables significantly loaded onto one factor.

Full Exploratory Factor Analysis (EFA)

An EFA was conducted which included all individual metacognitive factors to identify loadings onto four separate factors. Metacognitive efficiency and metacognitive experience had two factor loadings and, following the theoretical model, two factor

loadings were deemed appropriate for these two factors. The scree plot and model fit suggested five factors. A five factor solution had excellent fit indices, [$\chi^2(31) = 15.1$, p=.99, CFI = 1.00, TLI = 1.02, RMSEA = .00]. Two BCIS-SR were not loading appropriately and were removed from this analysis ("Other people can understand the cause of my unusual experiences better than I can"; "I have jumped to conclusions too fast"). The new scree plot (supplementary material) suggests five factors. However, the model fit supported a four factor solution with good fit indices, [$\chi^2(24) = 13.79$, p=.95, CFI = .97, TLI = .96, RMSEA = .00]. Table 2 presents the factor loadings.

Table 2: Exploratory factor loadings for metacognition.

Item	MAI	Metacognitive efficiency	Metacognitive experience	BCIS-SR
MAI: Monitoring	**.76**			
MAI: Differentiation	**.79**			
MAI: Integration	**.81**			
MAI: Decentralization	**.76**			
BCIS 1: At times, I have misunderstood other people's attitudes towards me				**-.42**
BCIS 4: Some of my experiences that have seemed very real may have been due to my imagination				**-.75**
BCIS 5: Some of the ideas I was certain were true turned out to be false				**-.8**
BCIS 9: My unusual experiences may be due to my being extremely upset or stressed				**-.39**
Visual metacognitive experience			**-.5**	
Auditory metacognitive experience			**-1.04**	
Visual metacognitive efficiency		**.41**		
Auditory metacognitive efficiency		**.85**		

With the acknowledgement of separate and independent factors of metacognition, a correlational matrix was conducted with the metacognitive variables (factor scores)[1], outcome variables and covariates (table 3).

[1] Note: Following the outcome of factor analysis in which BCIS-SR factor had 4 factor loadings, this factor score was used in the following analysis.

Table 3: Correlational matrix with metacognitive variables, outcome variables and covariates.

N=135	TMT (BA)	BCIS (SR-4)	Metacog experience	Metacog efficiency	UPSA	Time-Use	QPR	IQ	PANSS Negative	PANSS Anxiety	PANSS Depression	SSI AE
MAI	***r*= -.2*** ***p*=.02**	*r*= .01 *p*=.99	***r*= -.22**** ***p*=.01**	*r*= .05 *p*=.61	***r*= .48***** ***p*<.001**	***r*= .32***** ***p*<.001**	*r*= .23 *p*=.08	***r*= .55***** ***p*<.001**	***r*=-.56***** ***p*<.001**	*r*= .11 *p*=.42	*r*= .18 *p*=.16	*r*=-.11 *p*=.23
TMT (BA)	1	*r*= .08 *p*=.34	*r*= .15 *p*=.09	*r*= .01 *p*=.95	***r*= -.33***** ***p*<.001**	*r*= -.15 *p*=.08	*r*= .2 *p*=.13	***r*=-.32***** ***p*<.001**	*r*= .12 *p*=.37	*r*= -.07 *p*=.58	*r*= -.12 *p*=.37	*r*= .08 *p*=.38
BCIS (SR-4)		1	*r*= .13 *p*=.17	*r*= .15 *p*=.09	*r*= -.01 *p*=.96	*r*= -.04 *p*=.68	*r*= .08 *p*=.56	*r*= .17 *p*=.05	*r*= .09 *p*=.49	*r*= .16 *p*=.23	*r*= .01 *p*=.98	***r*= .22**** ***p*=.01**
Metacog experience			1	*r*= -.12 *p*=.21	***r*= -.32***** ***p*<.001**	***r*= -.18*** ***p*=.04**	*r*= .02 *p*=.91	*r*= -.13 *p*=.15	*r*= .05 *p*=.69	*r*= .04 *p*=.74	*r*= -.02 *p*=.86	*r*= .15 *p*=.08
Metacog efficiency				1	*r*= .08 *p*=.41	*r*= .01 *p*=.99	*r*= .11 *p*=.48	*r*= -.02 *p*=.87	*r*= -.04 *p*=.79	*r*= .14 *p*=.33	*r*= -.02 *p*=.9	*r*= -.06 *p*=.49
UPSA					1	***r*= -.24**** ***p*=.01**	*r*= .11 *p*=.41	***r*= .52***** ***p*<.001**	***r*= -.5***** ***p*<.001**	*r*= -.01 *p*=.92	*r*= .08 *p*=.55	*r*= -.15 *p*=.09
Time-Use						1	***r*= .44**** ***p*<.001**	*r*= .11 *p*=.21	***r*= -.38**** ***p*=.01**	***r*= -.26*** ***p*=.04**	*r*= -.16 *p*=.23	***r*= -.21*** ***p*=.02**
QPR[1]							1	*r*= .11 *p*=.43	***r*= -.35**** ***p*=.01**	***r*= -.5***** **p<.001**	***r*= -.49***** ***p*<.001**	***r*= -.44**** ***p*=.01**

[1] N=58 (Data collected on FEP group only)

IQ	1	*r*= -.23	*r*= -.06	*r*= -.06	*r*= -.13
		p=.09	*p*=.67	*p*=.65	*p*=.13
PANSS		1	*r*= .09	*r*= .16	***r*= .33***
Negative[1]			*p*=.5	*p*=.22	***p*=.01**
PANSS			1	***r*= .66***	***r*= .42****
Anxiety				***p*<.001**	***p*=.01**
PANSS				1	***r*= .31**
Depression					***p*=.02**

MAI = Metacognitive Assessment Interview; TMT = Trail Making Task (B-A); BCIS = Beck Cognitive Insight Scale; SR-6 = Self-reflectiveness scale 6 items; Metacog exp = Metacognitive experience; UPSA = UCSD Performance Based Skill Assessment; QPR = Questionnaire of Process of Recovery; PANSS = Positive And Negative Syndrone Scale; SSI AE = Schizotpyal Symptom Inventory Anomalous Experiences.

[1] N=59 (Data collected on FEP group only)

Due to the lack of correlation between metacognitive variables (efficiency, experience, ability, control and monitoring), the mediation analysis could not be conducted.

Functional capacity

Stepwise multiple regression analyses were used to assess the role of metacognitive components on functional capacity, independent of IQ and, in the FEP group only, also negative symptoms. Metacognitive ability (MAI) was a significant predictor of functional capacity, R^2=.23, $F(1, 131) = 38.98$, p<.001, and remained so after controlling for IQ, R^2=.33, $F(2, 128) = 30.72$, p<.001. Metacognitive ability predicted 5.6% of this variance (ΔR^2= .06, $F(1, 126) = 10.43$, p=.01).

Metacognitive monitoring (BCIS-SR-4) was not a significant predictor of functional capacity (p>.05).

Metacognitive control (TMT-BA) was a significant predictor of functional capacity, R^2=.11, $F(1, 130) = 16.16$, p<.001, and remained so after controlling for IQ, R^2=.29, $F(2, 127) = 25.29$, p<.001. Metacognitive control predicted 2.4% of this variance (ΔR^2= .02, $F(1, 125) = 4.25$, p=.04).

Metacognitive experience was a significant predictor of functional capacity, R^2=.101, $F(1, 131) = 14.6$, p<.001, and remained so after controlling for IQ, R^2=.34, $F(2, 128) = 31.8$, p<.001. Metacognitive experience predicted 6.3% of this variance (ΔR^2= .06, $F(1, 126) = 12.01$, p=.01).

All significant predictors: metacognitive ability, metacognitive experience and metacognitive control were included within a multiple regression (see table 4). Even when controlling for IQ, metacognitive experience, control process and ability predicted an additional 10.4% of the variance and improved the model (ΔR^2= .104, $F(1, 111) = 18.42$, p<.001). Including anomalous experience as a covariate did not change this result.

Table 4: A stepwise regression model for predictive value of metacognitive components on functional capacity in full sample.

		B	SE B	β	p value	CI
Model 2						
	Constant	48.8				
	IQ	.26	.07	.37	<.001***	.13, .39
	Metacognitive ability (MAI)	2.55	1.09	.211	.02**	.39, 4.72
	Metacognitive control process	-3.37	2.25	-.12	.14	-7.82, 1.08
	Metacognitive experience	-.07	.03	-.21	.01**	-.13, -.02

*<.05, **<.01, ***<.001

In the FEP group only, MAI was not a significant predictor of functional capacity when controlling for IQ and negative symptoms (p=.71) but this result may have been impacted by the smaller sample size. Metacognitive control and experience were not significant predictors of functional capacity when controlling for IQ and negative symptoms (p=.14, p=.09).

Functional outcome

Stepwise multiple regression analyses were used to assess the role of metacognitive components on functional outcome, independent of IQ and, in the FEP group only, also negative symptoms.

Metacognitive ability (MAI) was a significant predictor of functional outcome, R^2=.104, $F(1, 133) = 15.39$, p<.001, and remained so after controlling for IQ, R^2=.12, $F(2, 129) = 8.77$, p<.001. Metacognitive ability predicted 10.9% of this variance (ΔR^2= .11, $F(1, 127) = 15.74$, p<.001). Including anomalous experience as a covariate did not change this result.

Metacognitive experience was a significant predictor of functional outcome, R^2=.03, F(1, 132) = 4.15, p=.04. Whilst controlling for IQ, metacognitive experience was not a significant predictor of functional outcome (p=.097). Metacognitive monitoring and metacognitive control (TMT-BA) were not significant predictors of functional outcome, even when controlling for IQ and/or negative symptoms (p>.05).

Whilst controlling for negative symptoms, neither MAI nor metacognitive experience were significant predictors of functional outcome (p=.2), but may have been impacted by the smaller sample size.

Subjective recovery outcome

Functional outcome significantly predicted subjective recovery outcome in FEP, independent of depression and anxiety, R^2=.41, F(3, 57) = 12.32, p=.01.

Next, this study hypothesized that only metacognitive ability would be associated with subjective recovery outcome in the FEP group. Whilst controlling for depression and anxiety, metacognitive ability was a significant predictor of subjective recovery outcome, R^2=.39, F(3, 57) = 11.55, p<.001. Metacognitive ability predicted 9.7% of this variance and improved the model (ΔR^2= .1, F(1, 54) = 8.57, p=.01). No other metacognitive variable was associated with subjective recovery outcome (p>.05).

3.6 Discussion

This was the first study to assess the independence of different metacognitive components within a large sample of individuals with FEP and non-clinical controls. Metacognitive components were demonstrated to be separate and independent, contrary to our proposed model. This suggests that each metacognitive component is focused on a specific type of reflection or self-assessment, which is important and useful to identify components to target for those with functional difficulties.

Those with FEP demonstrated poorer metacognitive ability and metacognitive control processes than the healthy control group. However, contrary to our hypothesis, the FEP group demonstrated more accurate metacognitive experience (appraisal of experience after a task) and were higher on metacognitive monitoring process than controls. Higher

metacognitive monitoring (self-reflectiveness) and higher metacognitive experience (awareness of cognitive ability) was previously demonstrated in other psychosis samples (Gilleen et al., 2014; Kimhy et al., 2014; Mass, Wolf, & Lincoln, 2012). This current sample had fewer symptoms and better functioning than other FEP studies (Hodgekins, French, et al., 2015; Leucht et al., 2005), which may suggest that this group may have been further along in their recovery and can now more accurately reflect on their experiences, compared to a period of time when they were unwell. To support this, studies have demonstrated self-reflectiveness improves overtime in FEP (Bora et al., 2007; O'Connor et al., 2017), but poor metacognitive ability may continue to persist. Importantly, metacognitive ability was not associated with metacognitive monitoring, which is inconsistent with previous research in FEP (Davies et al. 2017), but may be due to the removal of some items which did not load onto the metacognitive monitoring factor, causing the factors to become differentiated.

Metacognitive experience and metacognitive ability predicted functional capacity, independent of IQ. However, less accurate metacognitive experience predicted higher functional capacity score, even when controlling for negative symptoms. This is in the opposite direction than hypothesized and this may suggest that those with awareness of their difficulties on specific tasks may be less likely to want to engage in functional tasks, to protect themselves from feeling low about potentially performing poorly and this lack of practice may actually corrode their skills (see Greenwood et al. 2005). Conversely, individuals who practice their functional skills daily may be less aware of their specific abilities and more focused on their overall experience.

Metacognitive ability was the only predictor of functional outcome in the full group, whilst controlling for IQ. This supports research in schizophrenia (Arnon-Ribenfeld et al., 2017) and FEP (Davies, Fowler & Greenwood, 2017). When negative symptoms were included, metacognitive ability was not a significant predictor. But this was only within those with psychosis and may have been impacted by power. Alternatively, metacognitive ability may be impacted by negative symptoms, e.g. poverty of speech or motivation. However, Wright, Davies, Fowler & Greenwood (submitted) (chapter 4) demonstrated that metacognitive ability at baseline predicted functional outcome at a three-year follow-up period in FEP, independent of negative symptoms. This suggests that metacognitive

ability has a distinct role on functioning from negative symptoms. Future studies should aim to assess the overlap in these concepts within a larger sample.

Functional outcome was associated with subjective recovery outcome in this FEP sample, and FEP sample scored slightly higher than previous studies within schizophrenia samples (Morrison et al., 2013; Neil et al., 2009). This was the first study to demonstrate the predictive role of metacognitive ability on subjective recovery outcomes in FEP, where recovery may be more variable. This finding suggests that subjective recovery is predicted by an individual's ability to think about their own mind and different states of mind throughout the process of recovery.

There is clear importance of tackling metacognitive ability within the early stages of psychosis to improve both functional and subjective outcomes. Metacognitive Insight and Reflection Therapy (MERIT) enables an individual to integrate their current experiences, increase their sense of agency and improve their ability to manage their experiences (Lysaker et al., 2015, p. 305). MERIT has been shown to improve metacognitive ability, which, in turn, has been shown to improve job satisfaction and social functioning (de Jong et al., 2016; Dubreucq et al., 2016). It is important to note the role of both cognitive and metacognitive factors and the use of cognitive/metacognitive remediation, which has demonstrated evidence of improvement in functioning in schizophrenia and FEP (Breitborde et al., 2015; Reeder et al., 2017). This research may also be important for providing insight for groups of individuals Not in Education, Employment or Training (NEET). As prolonged economic inactivity is shown to affect mental health (Benjet et al., 2012), these current outcomes may be helpful for improving functioning within the general community.

3.6.2 Limitations

There are limitations to the study. Firstly, in terms of the metacognitive model, the sample size was typically small for a factor analysis. Following MacCallum et al. (2001), which suggested that studies with high communalities should use a ratio of 5 participants: 1 variable, this sample size may have been appropriate as this study had communalities at a reasonable level. Future studies should replicate this model within a larger sample. From a theoretical standpoint, it was important to load visual and auditory metacognitive

experience onto one factor and visual and auditory metacognitive efficiency onto another factor. Future studies should aim to assess whether these factors can be combined, as Rouault et al. (2018) demonstrated these two measures displayed similar patterns. Secondly, individuals who typically engage in research studies tend to be higher-functioning, e.g. this sample were on average scoring higher on functioning and lower on symptoms than the average psychosis sample (Hodgekins, French, et al., 2015; Leucht et al., 2005). Caution should be taken when applying these results to a lower functioning group.

3.7 Conclusion

This study demonstrated that metacognitive components described within the psychosis literature are independent and distinct, focusing on particular aspects of reflection. Metacognitive ability and control processes were poor in FEP, compared to metacognitive monitoring and experience which were higher in FEP, compared to a healthy control group. This study demonstrated the role of metacognitive ability and experience in predicting functional capacity, and the role of metacognitive ability and control processes in predicting functional outcome in people with and without psychosis. This study was the first study to provide evidence for the role of metacognitive ability on subjective recovery outcome in FEP, independent of negative emotion, as well as demonstrating the association between the two modes of recovery. In terms of clinical importance, metacognitive ability in particular is a clear and viable targets for improving functional and subjective recovery in FEP.

NOTE: References at the end of the thesis.

4. Three-year follow-up study exploring metacognition and function in individuals with First Episode Psychosis.

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Chapter 4 has been submitted to Schizophrenia Research.

Contributions: Abigail Wright, Professor Kathryn Greenwood and Professor David Fowler developed the hypotheses for the study. Dr Geoff Davies collected the baseline data and Abigail Wright collected the follow-up data. Abigail Wright produced the manuscript with reviewing and editing from all authors.

4.1 Abstract

4.1.1 Introduction

Research has demonstrated that functional outcome in psychosis is predicted by factors such as neurocognition, functional capacity, symptoms and, more recently, metacognition. Metacognitive ability has been demonstrated to mediate between neurocognition and functional outcome in First Episode Psychosis (FEP). Whether metacognition also predicts longer-term recovery in first episode is unknown. This study assessed whether neurocognition, functional capacity and metacognitive ability in FEP predicted functional outcome three years later.

4.1.2 Methods

Eighty individuals with First Episode Psychosis were re-contacted after an average three years (range: 26-45 month follow-up) from baseline. Twenty-six participants (33%) completed neurocognitive measures, metacognition, functional capacity, functional outcome (hours spent in structured activity per week) and psychopathology at baseline and at follow-up.

4.1.3 Results

Individual regression analyses demonstrated neurocognition, functional capacity and metacognitive ability at baseline significantly predicted functional outcome at three years. However, when baseline functional outcome was controlled, only metacognition was a significant predictor of change in functional outcome from baseline to follow-up, $p<.001$. This model explained 72% (adjusted $r^2 = .69$) of the variance in functional outcome at follow-up. Negative symptoms did not change the model.

4.1.4 Discussion

This study demonstrated that better metacognitive ability significantly predicted improvement in functioning in FEP across a 3-year period. This highlights the potential value of clinical interventions that focus on improving metacognitive ability at first point of illness to maximize recovery.

4.2 Introduction

Although clinical recovery after an experience of psychosis was previously considered poor (May et al., 1981), recent research has demonstrated that around 50% of individuals with psychosis had favourable outcomes after long follow-up periods (Harrison, Hopper, Aig, et al., 2001; Harrow et al., 2005; Wunderink et al., 2009) and this has also been demonstrated with First Episode Psychosis (FEP) (Henry et al. 2010; Robinson et al. 2004) . A 10-year follow-up study showed 77% of participants showed at least one period of recovery, with 46% symptom free for at least two years (Morgan et al., 2018). However, for Edwards et al. (1998) and Robinson et al. (2004) only 6.6% and 14% (respectively) met the criteria for full recovery after 1 and 5 year(s) (respectively), suggesting recovery during early stages of illness may be slow. There is clear interest in understanding factors that influence recovery in psychosis, particularly FEP where recovery may be more likely (Harrison, Hopper, Aig, et al., 2001; Morgan et al., 2014). Birchwood et al. (1998) named this the critical-period, highlighting the importance of early and targeted interventions to prevent further decline (Bertolote et al. 2002; McGorry et al. 2008; Marshall & Rathbone 2011).

Clinical recovery can be considered improvement in symptomatology and social/occupational functioning (Andreasen et al., 2005; Harvey & Bellack, 2009). Hodgekins et al. (2015b) suggested assessing functioning, or recovery, using time spent in structured activity per week (Fowler et al., 2009; Harrison, Hopper, Aig, et al., 2001), including employment, education, sports, and leisure. Research has demonstrated that time spent in structured activity is on average 63.5 hours in the healthy population, 25.2 hours in FEP sample (Hodgekins, Birchwood, et al., 2015), and 19.7 hours in a psychosis sample with delayed recovery (Hodgekins, French, et al., 2015). However, engaging in more hours of activity, e.g. paid work, has been associated with reduced symptoms and improved functioning in interventions studies (Bell et al., 1996; Eklund et al., 2004). There is value in the identification of those with psychosis who are at risk of poor functioning across time, to target interventions to reduce this disability. There are four selected lines of evidence which will be discussed here to suggest factors which predict poor functioning: i) neurocognition, ii) functional capacity, iii) symptoms and iv) metacognition.

Research assessing functional outcome within individuals with psychosis has focused on the influence of neurocognitive difficulties (Green, 1996; Green, Kern, Braff, & Mintz, 2000; Green, Kern, & Heaton, 2004; Lepage, Bodnar, & Bowie, 2014). The relationship between neurocognition and functional outcome has been demonstrated cross-sectionally (Allott et al., 2011; Carrión et al., 2013) and longitudinally in schizophrenia, FEP and Ultra-High Risk groups (Robinson et al., 2004; Leeson et al. 2011; Milev et al. 2005; Nuechterlein et al. 2011; Stirling et al. 2003; Torgalsbøen et al. 2015; Lin et al., 2011). However, studies have demonstrated that predicting those who would have poor outcome with neurocognitive variables is substantially more straight-forward than predicting those who would recover (Faber et al., 2011; Gonzalez-Blanch et al., 2010). This suggests a more complex relationship with additional factors to be explored.

Functional capacity has also been shown to predict real-world functional outcome within schizophrenia (Green, 1996; Green et al., 2000; Leifker, Bowie, & Harvey, 2009b) and FEP (Davies, Fowler, & Greenwood, 2017). Functional capacity has been shown to mediate between neurocognition and functional outcome in schizophrenia (Bowie, Reichenberg, Patterson, Heaton 2006) and FEP (Davies et al., 2017). A longitudinal study demonstrated functional capacity predicted real-world functioning in psychosis for those with positive, but not for those with negative symptoms (Best, Gupta, Bowie, & Harvey, 2014). The authors suggested that negative symptoms are distinct and impact functioning, above functional capacity. This demonstrates clear evidence for the relationship between neurocognition, functional capacity and functional outcome in psychosis, although the role of negative symptoms needs consideration.

Following this, models have highlighted that negative symptoms predict functional outcome in psychosis (Rector, Beck, & Stolar, 2005; Ventura, Hellemann, Thames, Koellner, & Nuechterlein, 2009). Negative symptoms have been shown to interact with neurocognition to predict functioning in schizophrenia (Greenwood et al., 2005). Longitudinal studies support this research, demonstrating that low negative symptoms at baseline predict improved psychosocial recovery at 10-year follow-up (Austin et al., 2013). However, Alvarez-Jimenez et al. (2012) demonstrated that whilst symptom remission predicted functional recovery, negative symptoms had little predictive value for long-term functioning. Studies have noted an overlap in the variance in outcome

explained by cognition and negative symptoms (Milev et al., 2005; Villalta-Gil et al., 2006) and, when taking into consideration the role of cognition, symptoms are shown not to predict functioning cross-sectionally (Velligan et al., 2000) and later longitudinally (Peña et al., 2012). These studies highlight that functional outcome is the product of a complex array of abilities and symptoms.

Following this consistent research, models in psychosis suggest that neurocognition, functional capacity and negative symptoms influence functional outcome (Bowie et al., 2008; Grant & Beck, 2009; Rector, Stolar, & Grant, 2011). The path between neurocognition and functioning has been shown to be mediated by functional capacity and cognitive processes (Bowie et al., 2006; Couture, Blanchard, & Bennett, 2011; Grant & Beck, 2009; Rector et al., 2011), including defeatist performance beliefs and self-stigma (Berry & Greenwood, 2018) and, most recently, metacognition (Davies et al., 2017).

Metacognition is considered 'thinking about thinking'(Semerari et al., 2003b) or the way one thinks about one's experience (Dimaggio, Vanheule, Lysaker, Carcione, & Nicolò, 2009b). Metacognitive ability, measured using Metacognitive Assessment Scale (Lysaker et al., 2005) or Metacognitive Assessment Interview (Semerari et al., 2012), is shown to predict real-life functioning in schizophrenia (Arnon-Ribenfeld, Hasson-Ohayon, Lavidor, Atzil-Slonim, & Lysaker, 2017; Davies & Greenwood, 2018; Lysaker et al., 2013). In particular, metacognitive ability is a mediator between neurocognition and functioning schizophrenia (Lysaker et al. 2010) and FEP (Davies et al., 2017; Wright, Davies, Fowler & Greenwood, 2018). Metacognitive ability is shown to have a key role in functioning in psychosis, although this relationship is also influenced by neurocognition and functional skills.

Whether the relationship between metacognition and functional outcome persists across time is unknown. Intervention studies focusing on metacognition have demonstrated an improvement in real-world functioning (Briki et al., 2014; Dubreucq et al., 2016; Moritz et al., 2014; Rocha & Queirós, 2013). However, no study has yet assessed the role of metacognitive ability on functioning over a longer follow-up period; particularly within FEP, where recovery is more likely. In addition, metacognitive ability may enable the use of appropriate skills and abilities to perform a task or challenge. Successful outcome,

following the utilization of metacognitive ability, may predict engagement in more activities. Lysaker et al. (2010a) demonstrated that those with schizophrenia and high metacognitive ability display better work performance across 6-months, as those with high metacognitive ability were able to see their conclusions as fallible and were able to learn and adapt to the changing demands of work. Therefore, metacognitive ability may predict a change in functional outcome across time.

From this, it is hypothesized that functional outcome in FEP at 3-year follow-up will be predicted by metacognitive ability at baseline, independent of neurocognition, negative symptoms and functional capacity. It is also hypothesized that a change in functional outcome will be predicted by metacognitive ability at baseline, independent of neurocognition, negative symptoms and functional capacity.

4.3 **Methods**

4.3.1 Procedure

Ethical approval was obtained from London-Camden and Islington NHS Research and Ethics Committee (Ref: 11/LO/1877). All participants provided informed consent at first entry to the study and participants who gave consent to be re-contacted were contacted after the three-year period.

4.3.2 Participants

Participants with First Episode Psychosis were recruited, via a convenience sample, from outpatient Early Intervention in Psychosis services in Sussex Partnership NHS Foundation Trust. All had been given a formal diagnosis of First Episode Psychosis by a psychiatrist. Participants with a primary diagnosis of substance misuse disorder or organic neurological impairment were excluded.

4.3.3 Design

This is a longitudinal follow-up study exploring the contribution of metacognitive ability to functional outcome at three-year follow-up with individuals with First Episode Psychosis. Full details of the study design and ethical approval is provided in the protocol (Wright et al., 2018). Details of the baseline study are provided in an earlier publication (Davies et al., 2017).

4.3.4 Measures

Measures below were collected at baseline and follow-up time-points.

Metacognitive ability: This was assessed using the Metacognitive Assessment Interview (Semerari et al., 2012), which requires the participant to reflect on a recent difficult interpersonal experience and to answer a series of questions. The measure assesses the individual's ability for i) monitoring, identification of feelings and thoughts, ii) differentiation, distinguishing between dreams, beliefs or assumptions, iii) integration, reflection on different mental states and rules governing them, and iv) decentralization, describing the mental state of the other which is independent of their own view. These four subscales are scored between 0-5, depending on spontaneity, use of aids/prompts and the sophistication of the answer. The scores for the sub-domains are averaged to provide one multidimensional score. This measure has demonstrated good inter-rater reliability and internal consistency (α=0.91 for total metacognition), and construct reliability showing correlations amongst the MAI scales (r=0.62-0.9) (Semerari et al., 2012).

Function

Functional outcome: Time Use Survey (adapted from Short, 2006) captures, via self-report, number of hours spent engaging in structured activity per week for the preceding month (Fowler et al., 2009); including work, education, voluntary work, childcare, sports, leisure and housework activities. This measure has been validated within a FEP sample (Cella et al., 2016; Hodgekins, Birchwood, et al., 2015a), has good reliability (inter-rater reliability at 0.99 Hodgekins et al. 2015b), and is able to reliably capture differences in functioning across different clinical and non-clinical groups (Hodgekins, 2012; Hodgekins, Birchwood, et al., 2015a).

Functional capacity: The UCSD Performance-Based Skills Assessment (Patterson et al., 2001) provides a total score for real-life performance skills based on role-play tasks. This measure is divided into five sections: i) finance, e.g. counting money, ii) communication, e.g. re-arranging a medical appointment, iii) comprehension/planning, e.g. planning a visit to a theme park, iv) transport, e.g. reading a bus timetable, and v) household, e.g. creating a shopping list from a recipe. During each role-play the individual is given points by the researcher from the manual guidelines. These raw scores are totaled for each

domain, converted into 0-20 scale then multiplied by 2 and summed to provide a total out of 100. This measure demonstrates high internal consistency (α=0.88), good validity with other scales (Direct Assessment of Functional Status scale, r=0.86) and good test-retest reliability (r=0.91) (Harvey, Velligan, & Bellack, 2007; Mausbach et al., 2011; Mausbach, Moore, Bowie, & Cardenas, 2009).

Neurocognitive ability: Participants completed a battery of neurocognitive measures, including Verbal and working memory (Logical Memory and Letter-Number Sequencing subscales from the Wechsler Memory Scale (WMS-III)), executive function (Trail-Making Task and Verbal Fluency), Verbal and Performance IQ (Vocabulary and Matrix reasoning tasks). All scores were converted into Z scores using age-scaled population means and standard deviations (Tombaugh, 2004; Tombaugh, Kozak, & Rees, 1999; Wechsler, 1987, 1999). IQ was assessed at follow-up using Vocabulary task and Matrix reasoning task (Wechsler, 1999).

Symptoms: Positive and Negative Syndrome Scale (Kay & Fiszbein 1987) is the most widely used standardized instrument for assessing symptom severity in schizophrenia (Hermes et al., 2012). This measures provide three separate scores for positive, negative and general psychopathology symptoms.

4.4 Planned analysis

Hypothesis testing

Descriptive statistics for neurocognitive ability, metacognitive ability, functional capacity, functional outcome and symptoms were compared between baseline and follow-up. In light of the small sample size, and in order to reduce the number of predictors in the model, a series of single regression analyses were used to assess the predictive value of each variable at baseline on functional outcome at three-year follow-up. After this, a stepwise regression was conducted using only the significant predictors as covariates and metacognitive ability was added to the model in block 2, to assess the independent contribution of metacognitive ability. Next, the predictive value of variables on change in functional outcome from baseline to follow-up was assessed, using baseline functional outcome as a covariate. Then, significant predictors were used as covariates and metacognitive ability added to the model in block 3. Due to the sample size and to

minimise the number of predictors within a single model, the independent role of negative symptoms was used as a covariate within a parallel analyses.

4.5 Results

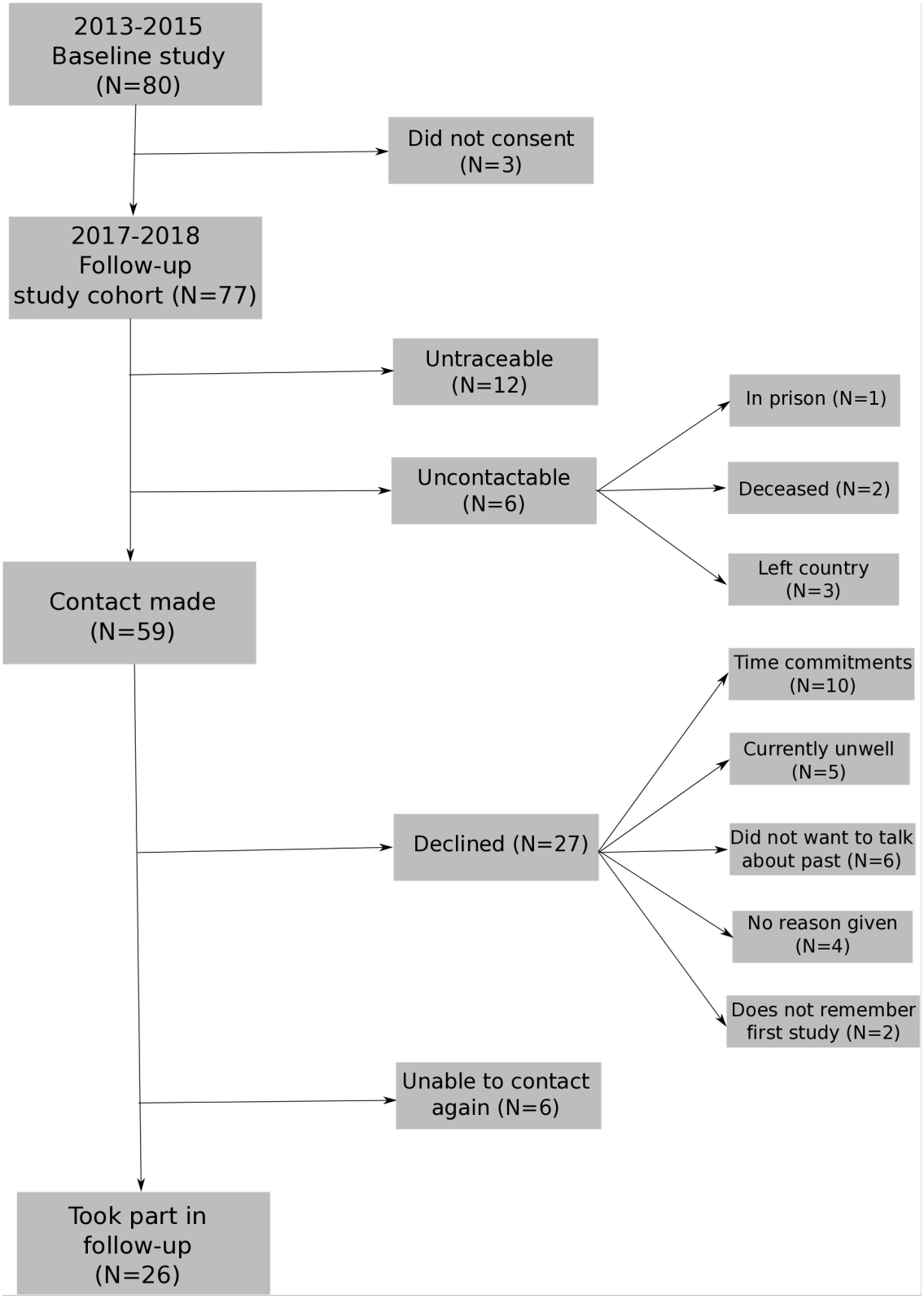
Data and assumption checking

Missing data was considered as 'Missing Completely At Random' (MAR), as missing data was not associated with data within the study. All predictor and outcome data were checked for skewness, kurtosis and outliers. MAI total at baseline displayed a multimodal distribution. There were no significant differences in cognition, functional capacity, functional outcome, symptoms and metacognitive ability for those who participated in follow-up and those who did not.

Sample characteristics

This first recruitment phase took place during 2013-2015. The follow-up recruitment phase took place within 2017 after three years (average 36-month; range 26 – 45-month follow-up). The baseline sample included 80 participants with FEP (49 men, 31 female) with a mean age of 26.08 years (5.53). Seventy-seven people provided consent to re-contact. Twenty-six participants from the baseline study took part in the follow-up assessment (see figure 6 for flowchart of participation). The mean age at follow-up was 28.93 (SD=5.55, range 22-43) with 23 males and 8 females (see table 5). See appendix B for distribution of months between baseline and three years for the sample followed-up.

Figure 6: Flowchart for re-recruiting individuals from baseline study into longitudinal study.[9]



[9] 11 people were untraceable: 1 participant was not on the records system and 10 people provided contact details which were now out-of-date and were no longer connected to services.

Descriptive statistics

Table 5: Sample characteristics and descriptive and change statistics for neurocognitive measures, functional capacity, functional outcome, metacognitive ability and symptoms.

	Baseline (N=80)	Baseline (N=26)	Three-year follow-up (N=26)	Differences test (baseline to follow-up)
Age, yrs. (SD)	26.08 (5.53, range 19-39)	25.9 (5.94, range 19-39)	29.32 (6.18, range 22-43)	
Gender (M/F)	49/31	19/7	19/7	
Education (years)	12.81 (1.7) Range 11 – 17 years	13.67 (2.09) Range 11 – 16 years	13.64 (range 11-16)[10]	
Medication (Y/N)	48/32	22/4	18/8	
Matrix reasoning (t-score)	51.67 (8.48) (range 25-70)	51.6 (8.71) (range 24-68)	54.17 (5.52) (range 41-66)	*t*(23)-1.96, *p*=.06
Vocabulary (t-score)	46.47 (11.68) (range 20-68)	49.62 (12.79) (range 35-70)	54.23 (12.57) (range 21-70)	***t*(24)-2.2, *p*=.04***
UPSA total (0-100)	72.02 (14.64) (range 36.6-95.2)	74.66 (13.45) (range 42.94-93.18)	83.09 (9.18) (range 57.96-96.6)	***t*(24)-4.35, *p*<.001*****
Time Use CEA (hours in activity per week)	24.97 (23.1) (range 0-77.1)	22.07 (19.95) (range 0-70.62)	31.66 (22.87) (range .81-88.96)	***t*(25)-2.66, *p*=.01***
Time Use SU (hours in activity per week)	32.95 (26.0) (range 2.3-96.7)	29.82 (22.3) (3-74.80)	39.31 (24.81)	***t*(25)-2.47, *p*=.02***

[10] Data for follow-up was captured as categories (e.g. GCSE, A-level, Degree, higher degree) which was subsequently converted into years of education to match the baseline group.

			(range 6.06-96.46)	
MAI total (0-5)	2.77 (3.5) (range .4-4.9)	2.77 (1.32) (range .88-4.56)	3.27 (.87) (range 1.63-4.44)	***t*(25)-2.28, *p*=.03***
Symptoms (positive) (7-49)	12.0 (3.5) (range 7-19)	11.44 (3.63) (range 7-19)	11.87 (4.7) (range 7-23)	*t*(23)-1.23, *p*=.23
Symptoms (negative) (7-49)	13.6 (4.9) (range 7-36)	13.40 (4.06) (range 7-22)	10.87 (3.89) (range 7-26)	***t*(23)2.92, *p*=.01****
Symptoms (general) (16-112)	28.35 (6.7 (range 16-43)	28.68 (6.9) (range 17-43)	26.0 (5.68) (range 18-38)	*t*(23) 1.5, *p*=.15
Symptoms (total) (30-210)	53.96 (12.1) (range 30-81)	53.52 (12.36) (range 32-79)	48.73 (12.84) (range 34-85)	*t*(23) 1.2, *p*=.24

*<.05, **<.01, ***<.001

Associations between predictor variables

See table 5 for descriptive statistics and see appendix B for correlation matrix for neurocognition, metacognitive ability, symptoms, functional capacity and functional outcome at baseline and follow-up. Age at baseline was significantly associated with functional outcome at follow-up (r=.4, p=.027) and included as a covariate in subsequent analyses. For neurocognition, a Confirmatory Factor Analysis was conducted on the z scores of the cognitive variables and converted into a neurocognitive factor score for each participant.

Hypothesis 1

In order to test predictors (neurocognition, functional capacity, negative symptoms and metacognition) of functional outcome at 3-year follow-up, individual regression analyses were conducted. These demonstrated that neurocognitive ability at baseline did not significantly predict functioning at three years, p=.24. Functional capacity, F(2, 25) 6.66, p=.005, negative symptoms, F(2, 23) 5.69, p=.01, and metacognitive ability, F(2, 24)

27.97, $p<.001$, were significant predictors of functioning at three years. Including negative symptoms as a covariate in the above analyses did not substantially change the significance levels for neurocognition and metacognitive ability ($p=.44$ and $p<.001$, respectively). However, when controlling for negative symptoms functional capacity at baseline was no longer a significant predictor of functional outcome at follow-up, ($\Delta R^2=.07, p=.13$).

Next, in order to test whether metacognition predicted functional outcome at follow-up independent of other known factors, all significant predictors (functional capacity and negative symptoms) were included in the first block of the stepwise regression then the independent contribution of metacognitive ability (MAI) to recovery was assessed. This model explained 77.1% (adjusted $r^2 = .72$) of the variance in functional outcome at follow-up ($R^2=.77$, $F(4, 23)$ 16.01, $p<.001$). MAI significantly improved the model ($\Delta R^2=.35$, $p<.001$), explaining 34.6% of the 77% (adjusted $r^2 = .72$) total variance explained.

Hypothesis 2

In order to assess predictors (neurocognition, functional capacity, negative symptoms and metacognition) of a change in functional outcome from baseline to 3-year follow-up, individual regression analyses were conducted, controlling for baseline functional outcome. Neither neurocognition ($p=.22$), functional capacity ($p=.57$) or negative symptoms ($p=.35$) predicted change in functional outcome. Metacognitive ability (MAI) was a significant predictor of change in functional outcome at follow-up, when including baseline functional outcome as a covariate. This model explained 72% (adjusted $r^2 = .69$) of the variance in functional outcome at follow-up ($R^2=.72, F(3, 25)$ 19.22, $p<.001$). MAI significantly improved the model ($\Delta R^2= .12$, $p<.005$), explaining 12% of the 72% total variance explained (see table 6). VIF values were inspected to check multicollinearity and the score was acceptable (Hair, Anderson, Tatham, & Black, 1995; Ringle, Wende, & Becker, 2015).

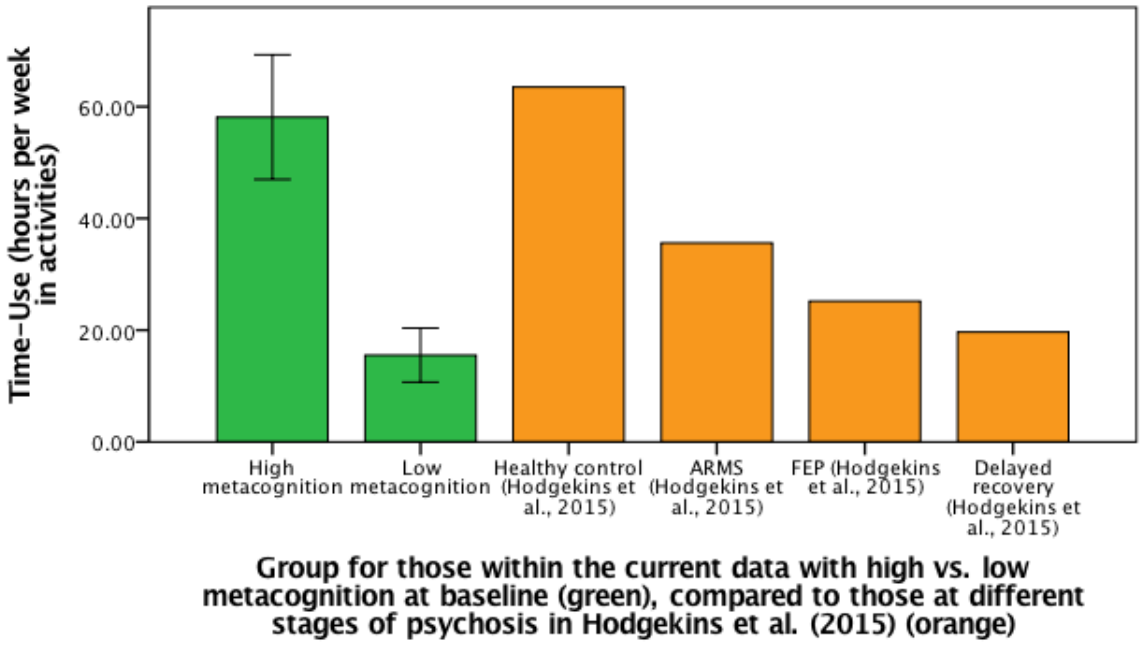
Table 6: Full regression model for predictive value of metacognitive ability on functional outcome at three years, whilst controlling for baseline functional outcome, and age.

		B	SE B	β	p value	CI
Model 2						
	Constant	-25.69	14.12			
	Age	.93	.53	.21	.09	-.18, 2.04
	Time use baseline	.21	.24	.18	.38	-.28, .70
	Metacognitive ability (MAI)	12.21	4.00	.61	.01**	3.88, 20.53
*<.05, **<.01, ***<.001						

Note: When include age as a covariate, functional outcome at baseline was no longer significant.

For those participants who were followed-up, metacognitive ability (MAI) at baseline demonstrated a bivariate distribution (Appendix B). We therefore, compared those with FEP and either high or low metacognitive ability graphically, with other previous samples. Specifically, we divided participants into two groups: high MAI at baseline (N=14) or low MAI at baseline (N=12), using mean split, to assess the changes in time-use scores between the groups. Individuals in the high MAI group demonstrated a significant difference in hours spent in structured activity between baseline (*M*=50.32, *SD*=23.98) and follow-up (*M*=58.13, *SD*=19.29), but for the low MAI group there was no significant difference (p=.17) in structured activity between baseline (*M*=13.17, *SD*=7.7) and follow-up (*M*=15.53, *SD*=7.63) (see figure 7).

Figure 7: Bar graph to demonstrate differences in mean follow-up time-use scores (including CI for current data) for those with high or low metacognitive ability at baseline compared to previous data from Hodgekins et al. (2015).



4.6 Discussion

This was the first study assessing the role of metacognitive ability on functional outcome longitudinally in First Episode Psychosis. This study was able to demonstrate that functional outcome improved over time and, whilst negative symptoms and functional capacity predicted functioning at three years, the improvement in functioning was largely predicted by metacognitive ability and baseline functioning.

The finding that functional outcome at three-years was predicted by metacognitive ability supports previous cross-sectional studies (Davies et al. 2017; Lysaker et al. 2010; Saeedi et al. 2007). Metacognitive ability was also the only significant predictor of improvement in functioning accounting for a significant change in functioning over time. This

highlights that those with higher metacognitive ability may be better able to make use of strategies and resources (e.g. from the early intervention services) to improve their functioning over time, compared to those with lower metacognitive ability who may need more guidance in order to utilize the services available to them.

In further exploring metacognitive ability at baseline, it was evident that individuals who displayed low metacognitive ability at baseline demonstrated limited change in functioning at three-year follow-up, compared to individuals who displayed adequate metacognitive ability. This may suggest that those with better metacognition were better able to reflect on their thoughts, strengths, as well as perspectives of others, and use appropriate strategies to implement in the real world. Importantly, metacognitive ability was a longitudinal predictor of functional outcome, independent of IQ. Whilst the sample size in the group is small, this supports the main hypothesis that early metacognitive factors influence change in functioning.

A large amount of the variance in time-use at follow-up was predicted by baseline time-use and age. Therefore, individuals with better initial functioning are more likely to show an improvement later on, compared to those who had lower functioning who showed no change in already poor functioning. This may suggest that those with low functioning are less likely to use metacognitive abilities or strategies to improve their poor functioning or are less motivated, due to poor cognitive and metacognitive ability (Luther et al., 2016; Tas, Brown, Esen-Danaci, Lysaker, & Brüne, 2012). This highlights the importance of the Early Interventions services to focus on improving functioning and encouraging early help-seeking to prevent low levels of functioning initially.

Within this study, individuals with FEP significantly improved in cognition, real-life functional capacity skills, metacognitive ability and negative symptoms over three years. At baseline, individuals within this sample were demonstrating typical mean activity levels for an FEP sample (29.82 hours per week) (see Hodgekins et al. 2015b), but there was an improvement of 9 hours in structured activity at the three-year follow-up, resulting in a time-use score similar to an ARMS group. There was an increase in functional capacity, in that individuals at follow-up were similar to those typically residing independently and employed (Mausbach et al., 2011). There was a significant improvement in verbal cognitive ability (vocabulary). Studies in the general population

suggest vocabulary is stable over time (Scheider, Niklas, & Schmeideler, 2010), including studies within schizophrenia (Ginett & Moran, 1964; Heaton et al., 2001). The increase in verbal cognition may be the consequence of an initial drop in cognitive ability, particularly verbal IQ (Vorstman et al. 2015; Leeson et al. 2011), which then recovered throughout the follow-up period.

Findings demonstrated that neurocognitive ability at baseline was significantly associated with real-life functional skills at follow-up, supporting previous research (Evans et al., 2003a; Vesterager et al., 2012). Functional capacity, but not neurocognition, at baseline predicted functional outcome at three years after FEP, supporting and furthering research (Bowie et al., 2008). Surprisingly, neurocognition did not directly predict functional outcome at three-years. However, studies have suggested that neurocognitive factors only predict a small amount of variance in real-world functioning (Bowie et al., 2006) and other factors have a more substantial role. Alternatively, neurocognition may have an indirect role, via functional capacity, as the present study demonstrated an association between neurocognition and functional capacity.

These findings can be taken forward in two ways: i) poor metacognitive ability may be a marker for poor outcome in psychosis later on, and ii) metacognitive ability may be a key ability for interventions to target in early psychosis to improve subsequent functioning. If metacognitive ability does play a role, metacognitive interventions which have previously demonstrated to be associated with decrease in symptoms (Lysaker, Buck, & Ringer, 2007), may also be useful for improving functional outcome in psychosis (Dubreucq et al., 2016). Metacognition Reflection and Insight Therapy (MERIT) is specifically aimed at improving metacognitive ability (Lysaker, Buck, et al., 2011). However, De Jong et al. (2018) recently demonstrated, in a trial of MERIT for individuals with schizophrenia, evidence of improved metacognitive ability but not functioning. The lack of improvement in functioning may be due to shorter follow-up period or may be accounted for by other factors, e.g. functional capacity or neurocognition (see Davies et al. 2017; Koren et al. 2006). Therefore, new interventions, such as cognitive remediation, should continue to aim to improve both cognitions and real-life skills to consider both cognitive and metacognitive ability (e.g. Cella et al. 2015).

4.6.1 Limitations

Firstly, there was a low follow-up rate. This may be due to the long period between the two assessment points and during this time participant had moved out of area, lost contact with study team, or could not remember the first study due to length of time or being unwell during the first assessment. Future studies should carefully consider the role of presentation of the study and continuity of contact across time. A consequence of this low follow-up rate was the small sample size, which limited the number of predictors included in the regression analyses. It was not possible to fully explore the role of negative symptoms, alongside metacognitive ability. Future studies using a large sample can confirm the results whilst i) controlling for all symptoms and i) exploring the interaction between symptoms and metacognitive ability.

This sample was on average lower on symptoms of psychosis at baseline and follow-up (Leucht et al., 2005) compared to other FEP samples (Fitzgerald Lucas, Redoblado, Winter, Brennan, Anderson, & Harris, 2004; McLeod et al. 2014), which may explain the lack of change in positive symptoms. Finally, age was used as a covariate within the main analyses assessing predictors of outcome, as it was associated with functional outcome at follow-up. Age was recently demonstrated as a positive predictor of structured activity in At Risk Mental State (ARMS) group (Bright et al., 2018) and it may be suggested that age is a proxy for illness severity as those who have an earlier psychosis onset may have more difficulties in functioning later on (Immonen, Jääskeläinen, Korpela, & Miettunen, 2017). However, age of onset is difficult to measure and research suggests that premorbid IQ accounts for this difference (Zammit et al., 2004). Analyses without age as a covariate demonstrated no difference in the results.

4.7 **Conclusion**

The present three-year follow-up study was able to demonstrate that metacognitive ability at baseline significantly predicted improvement in functioning after three years, in FEP. This was independent of cognitions, functional capacity and negative symptoms. This study highlighted the importance of intervening early to enhance metacognitive ability, over neurocognitive ability or functional capacity, in order to improve functioning later on, and to target interventions to improve functioning in those with poor metacognitive ability in the early stages of psychosis. In addition, this study

highlights the importance of additionally tackling cognitive ability, a predictor of metacognitive ability, within metacognitive interventions. Future studies should aim to replicate this within a larger sample.

NOTE: References at the end of the thesis.

5. Self-defining memories predict engagement in structured activity in First Episode Psychosis, independent of neurocognition and metacognition.

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Chapter 5 is published in Schizophrenia Bulletin:

Wright, A.C., Davies, G., Fowler, D. & Greenwood, K.E. (2018). Self-defining Memories Predict Engagement in Structured Activity in First Episode Psychosis, Independent of Neurocognition and Metacognition. *Schizophrenia Bulletin*, pp.1–11.

Contributions: Abigail Wright, Professor Kathryn Greenwood and Professor David Fowler developed the hypotheses the for study. Dr Geoff Davies collected the data. Abigail Wright produced the manuscript with reviewing and editing from all authors.

5.1 Abstract

5.1.1 Background

Self-defining memories (SDM) are vivid personal memories, related to narrative identity. Individuals with schizophrenia report less specific, more negative, and extract less meaning from these memories compared to control groups. Self-defining memories have been shown to be predicted by neurocognition, associated with metacognition, and linked to goal outcomes in healthy controls. As neurocognition and metacognition are known predictors of poor functioning in psychosis, self-defining memories may also be a predictor. No study has assessed the relationship to functioning or pattern of SDMs in First Episode Psychosis.

5.1.2 Methods

This was a cross-sectional study involving 71 individuals with First Episode Psychosis (FEP) and 57 healthy controls who completed a self-defining memories questionnaire. FEP participants completed measures of neurocognition, metacognition (Metacognitive Assessment Interview), functional capacity (The UCSD Performance-Based Skills Assessment) and functional outcome (Time-Use Survey).

5.1.3 Results

Self-defining memories reported by individuals with FEP were less integrated compared to healthy controls. Within the FEP sample, holding less specific memories was associated with engagement in significantly fewer hours of structured activity per week and specificity of SDMs mediated the relationship between neurocognition and functional outcome, independent of metacognition.

5.1.4 Conclusion

This is the first study to assess SDMs in FEP and to explore the important role of SDMs on clinical outcomes, compared to healthy controls. This study suggests that elaborating on specific self-defining memories is a valid therapeutic target and may be considered a tool to improve daily functioning in FEP.

5.2 Introduction

Self-defining memories (SDMs) are vivid, intense and well-rehearsed personal memories[1], related to narrative identity and 'ingredients' for the life story[2]. Prior research has considered four dimensions of interest for SDM[3]: i) specificity- the ability to provide a detailed, clear memory, ii) integration- capacity to learn from, and incorporate, the memory into self-knowledge, iii) type of event- linked to a general theme (e.g. achievements) or unresolved conflict (e.g. mental health crises)[1], and iv) content valence- the strength of affective response when recalling the SDM.

Self-defining, or autobiographical, memories reported by individuals with schizophrenia have been found to be less specific[4-6], more negative[7], and individuals extract less meaning from these types of memories compared to control groups[7], despite cues[8].

In terms of the separate dimensions of SDMs, research on autobiographical memories (ATM) highlights that specific ATM can be impacted by neurocognitive deficits in psychosis[9,10]. They may also be linked to negative symptoms in schizophrenia[11], which are related to avoidance of trauma memories, hence a lower likelihood of reporting specific memories. Specific memories are suggested to be associated with impairment in executive control and functional avoidance[12], and influence goal outcomes in control participants[1,3] as individuals who report specific memories are better able to use appropriate cognitive-affective information to achieve their goals[1]. Conway and Pleydell-Pearce's Self-Memory System[13] (SMS) suggested that ATM contain knowledge at three hierarchical levels of specificity: lifetime period, general events and event-specific knowledge, which make up the hierarchy of ATM structures. These knowledge structures are joined with the working self, which enables an individual to draw on their memory to achieve goals. Within psychosis, Mehl et al.[14] demonstrated that ATM specificity predicted social performance, involving role-play tasks, over neurocognition and symptoms. This current study aimed to understand the role of specific SDMs in predicting functional outcome, associated with mental health recovery.

Secondly, in terms of integration, individuals with psychosis extract less meaning or learn fewer lessons from the self-defining events they report, compared to healthy controls[4,8,15,16].

Greater integration is associated with greater optimism and attainment of goals within healthy controls[1,3], and may be associated with neurocognition[13].

Finally, SDM for individuals with psychosis tend to be more negative in content[17], and focused on illness[7,15,18]. This may be linked to lower self-esteem and negative outlook[3,7]. However, unlike specificity and integration, content valence has not previously been associated with neurocognition nor outcomes. Whilst Raffard[7] demonstrated that memories reported by individuals with psychosis tend to be focused on hospitalization/illness, this study was conducted in an in-patient unit which may influence the type of memory recalled, due to contextual cues[19-20]. This hospital-related contextual cue, coupled with known memory difficulties in schizophrenia[21-23], may have biased the individual to report a memory focused on hospitalization/illness. Another study demonstrated illness-related SDMs in a group of outpatients, however, this group included long-term schizophrenia patients[8], who may have integrated their illness within their self, compared to a FEP sample. This current study aimed to investigate the pattern of SDMs in FEP and healthy controls.

Whilst studies have demonstrated differences in SDMs between individuals with psychosis and healthy controls, and studies in healthy controls show these memories may predict goal outcomes, no study has assessed the impact of SDMs on outcome in psychosis. Functional outcome is a measurable aspect of an individual's activities of daily living. This has been measured using the Time-Use Survey[24,25], which captures the number of hours in structured activity per week. Time spent in structured activity is on average 63.5 hours in a healthy population, 25.2 hours in a FEP sample, and 19.7 hours in a delayed recovery group[26]. There is clear interest in the identification of those at-risk of poor functioning, to target interventions to reduce this disability.

This study will combine three theoretical frameworks of: i) cognitive and neurocognitive underpinnings of functional outcome in psychosis, ii) metacognition as a mediator of functional outcome, and iii) sense of self in psychosis. These theories will be explored in turn, to develop the rationale for the hypothesis that self-defining memories and metacognition may impact on functional outcome.

Firstly, models of functional outcome in psychosis suggest neurocognition, functional capacity and negative symptoms influence functional outcome[27-29]. However, the picture is complex as cognitions and negative symptoms are shown to have a synergistic interaction which impacts functioning[30] and the path between neurocognition and functioning has been shown to be mediated by functional capacity and cognitive processes[29,30,32]. Secondly, these cognitive processes include defeatist performance beliefs and self-stigma[33], and, recently also metacognition[34], termed 'thinking about thinking'[35], or the way one thinks about one's experience[36]. Metacognition partly mediates the link between neurocognition and functional capacity, and fully mediates between functional capacity and functional outcome[32] independently from symptoms[37-39].

Finally, SDMs are most relevant to narrative identity[2] and metacognitive ability has been associated with forming complex ideas of one's life as a narrative across a lifetime[10, 40, 41]. It may be that SDMs overlap with metacognitive ability, but involve a distinct reflective process, focusing on one memory, which, when compromised, may impact on functioning. To support this, SDMs, like metacognition, are proposed to use cognitive information to help goal outcomes[1]. Negative content and poor integration might impact on optimism towards reaching a goal and poor specificity might limit the detail available regarding actions or pathways to reach goals. Reflection on the self is shown to impact goal performance[42], which in turn impact on motivation[43], hope[44] and functional outcome. Based on the Beck and Rector functional outcome model[27] and literature within SDMs, cognitive processes could extend to SDMs and have an independent role on functioning, alongside metacognition.

Self-defining memories may contain different levels of specificity[13], which are integrated into the sense of self. These SDMs may be used by the individual, drawing on cognitive and affective information about the self, to engage in functional activities. Following the research above, it is hypothesized that SDM will be less specific, less integrated and more negative in FEP compared to healthy controls. SDM (specificity and integration) may be associated with neurocognition and metacognition. Finally, SDMs might contribute to difficulties in functioning in FEP. This is the first study to assess the role of SDMs in the relationship between neurocognition and functional outcome, independent of metacognition, in First Episode Psychosis.

5.3 Methods

5.3.1 Procedure

Ethical approval was obtained from London-Camden and Islington NHS Research and Ethics Committee (Ref: 11/LO/1877). All participants provided informed consent.

5.3.2 Design

This present study involved a cross-sectional design, with measures assessing neurocognition, metacognition, SDM, and functional outcome in FEP. Additional measures can be reviewed in Davies, Fowler and Greenwood manuscript[32]. Data from the SDM measure was compared between participants with FEP and healthy control participants.

5.3.3 Participants

Seventy-one young people with FEP were recruited, via a convenience sample, from outpatient Early Intervention in Psychosis services in UK. All had been given a formal diagnosis of First Episode Psychosis by a psychiatrist. Participants with a primary diagnosis of substance misuse disorder or organic neurological impairment were excluded.

Fifty-seven healthy control participants were matched on age, gender and education to the earlier psychosis sample (see table 7 with difference statistics). Participants were recruited through advertisement within the local community. Participants with current mental health problems or history of psychosis were excluded following screening questions.

5.3.4 Measures

Self-defining memories

Self-defining memories questionnaire[45] asked the participant to provide three descriptions of SDM. The participant was asked to provide a memory that was at least one-year-old, remembered very clearly, important to the individual, one that helped the individual to understand themselves as a person, leading to strong feelings and familiar like a picture or a song[46]. The participant had to provide a title, age at the time of the event, and a description of the event.

All scripts were coded by the first author through consultation with the classification system and scoring manual of self-defining autobiographical memories[46] (Appendix C). This manual was previously shown to have inter-rater reliability (Cohen's K 0.54 - .98) for students[44] and clinical groups[7,15].

Only the first memory was coded into: specificity (non-specific or specific), integration (integrated or non-integrated), type of event, content valence (positive or negative). Details in supplementary materials. A second independent rater, blind to the scope of the study, coded responses for 12% of the total scripts (15 scripts). Reliability between the two raters was good (specificity, integration and content valence, Cohen's kappa ($\varkappa$) coefficient was .84, $p<.001$, and for type of event, Cohen's kappa ($\varkappa$) was .83, $p<.001$).

Neurocognition

Participants completed a battery of neurocognitive measures, including Executive function (Verbal Fluency[47] and Trail-Making Task[48]), memory (Logical Memory and Letter-Number Sequencing subscales (WMS-III)[49]), and IQ (Vocabulary and Matrix reasoning tasks[50]). All raw scores were converted into Z scores using age-scaled population means and standard deviations.

Metacognition

The Metacognitive Assessment Interview[51] requires the participant to reflect on a recent difficult interpersonal experience and asked a series of questions to assess i) monitoring, identification of feelings and thoughts, ii) differentiation, distinguishing between dreams, beliefs or assumptions, iii) integration, reflection on different mental states and rules governing them, and iv) decentralization, describing the mental state of the other which is independent of their own view. These four subscales are each scored between 0-5, depending on spontaneity, use of aids/prompts and the sophistication of the answer. The scores are averaged to provide one multidimensional construct. This measure has demonstrated good inter-rater reliability and internal consistency (α=0.90 for total metacognition), factorial validity, and reliability (r=0.62 to 0.90)[51].

Measures of functioning

Functional outcome: Time Use Survey (adapted from Short[52]) provides a retrospective objective measure for hours spent engaging in structured activity per week[24]. This measure has been used within schizophrenia[53] and FEP sample[26], has good inter-rater reliability[54] (ICC=0.99)[26], and good validity at different stages of psychosis[26, 55].

Functional capacity: The UCSD Performance-Based Skills Assessment[56] provides a total score for real-life performance skills based on simulated tasks. This measure demonstrates high internal consistency (α=0.88), good validity with other scales (DAFS r=0.86) and good test-retest reliability (r=0.91)[57, 58].

Symptoms

The Positive and Negative Syndrome Scale[59] (clinical participants only) was included, a standardized instrument for assessing symptom severity in psychosis. This measure has good internal consistency (r=0.69 – 0.94), construct validity (r=0.77) inter-rater reliability (0.83 to 0.87)[59,60].

5.4 Analysis plan

Missing data was considered as 'Missing at random' (MAR). For regression analyses, listwise deletion was used, as recommended[61]. For mediation analysis, full information maximum likelihood was used which combines available information to estimate population parameters[62,63].

Chi-squared analyses assessed differences in memory reported for specificity, integration, and content valence between individuals with FEP or healthy controls. Logistic regression analyses assessed whether neurocognitive and metacognitive ability were associated with likelihood of reporting a specific or integrated SDM. Linear regression analyses assessed whether specificity and integration of SDM predicted functional outcome, controlling for neurocognition and metacognition. Finally, a mediation model was developed to assess whether specificity and integration of SDM mediate the relationship between neurocognition and functional outcome, independent of metacognition. Due to sample size, the model was built through sequential steps: i) neurocognition to functional

outcome with metacognition as a single mediator, ii) with SDM as single mediator, iii) with all significant mediators.

5.5 Results

5.5.1 Sample characteristics

A total of seventy-one participants with First Episode Psychosis completed the assessments (mean age = 25.93, S.D. 5.55, range 18-39). Fifty-seven healthy control participants completed the SDM measure (mean age = 24.84, S.D. 6.34, range 18-39).

Table 7: Sample characteristics summary table.

	FEP	Healthy control	Differences test
Age, yrs. (SD)	25.93 (5.55)	24.84 (6.34)	$F(1, 125) = 36.78, p=.31$
Gender (M/F)	44/27	41/16	$\chi^2 (1, 128) = 1.41, p = .24$
Symptoms (positive)	11.77 (3.46) Range 7-19		
Symptoms (negative)	13.21 (4.85) Range 7-36		
Symptoms (general)	27.94 (6.49) Range 16-43		
Education (years)	12.8 (1.7) Range 11 – 17 years	13.37 (1.58)[11] Range 11-17 years	$F(1, 127) = 2.86, p=.09$

[11] Data for healthy controls was captured as categories (e.g. GCSE, A-level, Degree, higher degree) which was subsequently converted into years of education to match the FEP group.

5.5.2 **Data checking**

All variables were checked for skewness, kurtosis and outliers. UPSA total was positively skewed and, therefore, transformed using square root transformation.

5.5.3 **Frequency and descriptive statistics**

Sixty% of FEP and eighty-nine% of healthy controls provided three SDMs. Due to the limited number who provided all three memories, only the first SDM was coded. Frequency statistics for SDMs are presented in table 8 and appendix C.

Table 8: The frequency statistics for self-defining memories.

	FEP sample		**Healthy control sample**		**Difference tests**
Specific vs. non-specific [12]	66%	34%	79%	21%	χ^2 (1, N = 128) = 2.54, *p*=.11
Integrated vs. non-integrated[13]	18%	82%	58%	42%	χ^2 (1, N = 128) = 21.52, *p*<.001
Positive vs. Negative content	52%	48%	65%	35%	χ^2 (1, N = 128) = 2.12, *p*=.15
Words per first memory, Mean	58.97 (S.D=47.5, median=39, range 4-202 words)		119.04 (S.D=92.5, median=98, range 21-491 words)		t(79.38)= -4.45, *p*<.001
Type of event:					
Recreation/Exploration	22% (87% positive)		33% (46% positive)		
Relationship	22% (6% positive)		28% (24% positive)		
Achievement/Mastery	24% (100% positive)		16% (24% positive)		
Guilt/shame	0%		5% (100% negative)		
Drug, alcohol or tobacco use	0%		2% (100% positive)		
Hospitalization/Stigmatization of illness	6% (100% negative)		0%		
Failure	6% (100% negative)		2% (100% negative)		
Life threatening event	20% (7% positive)		12% (100% negative)		
Event not classifiable	0%		2% (100% positive)		

[12] 33% of SDMs were coded as specific positive in FEP group, compared to 47% in control group.
[13] 9% of SDMs were coded as integrated positive in FEP group, compared to 40% in control group.

Descriptive statistics for neurocognitive, metacognitive, and outcome variables are presented in table 9.

Table 9: Descriptive statistics for neurocognition, metacognition and functioning.

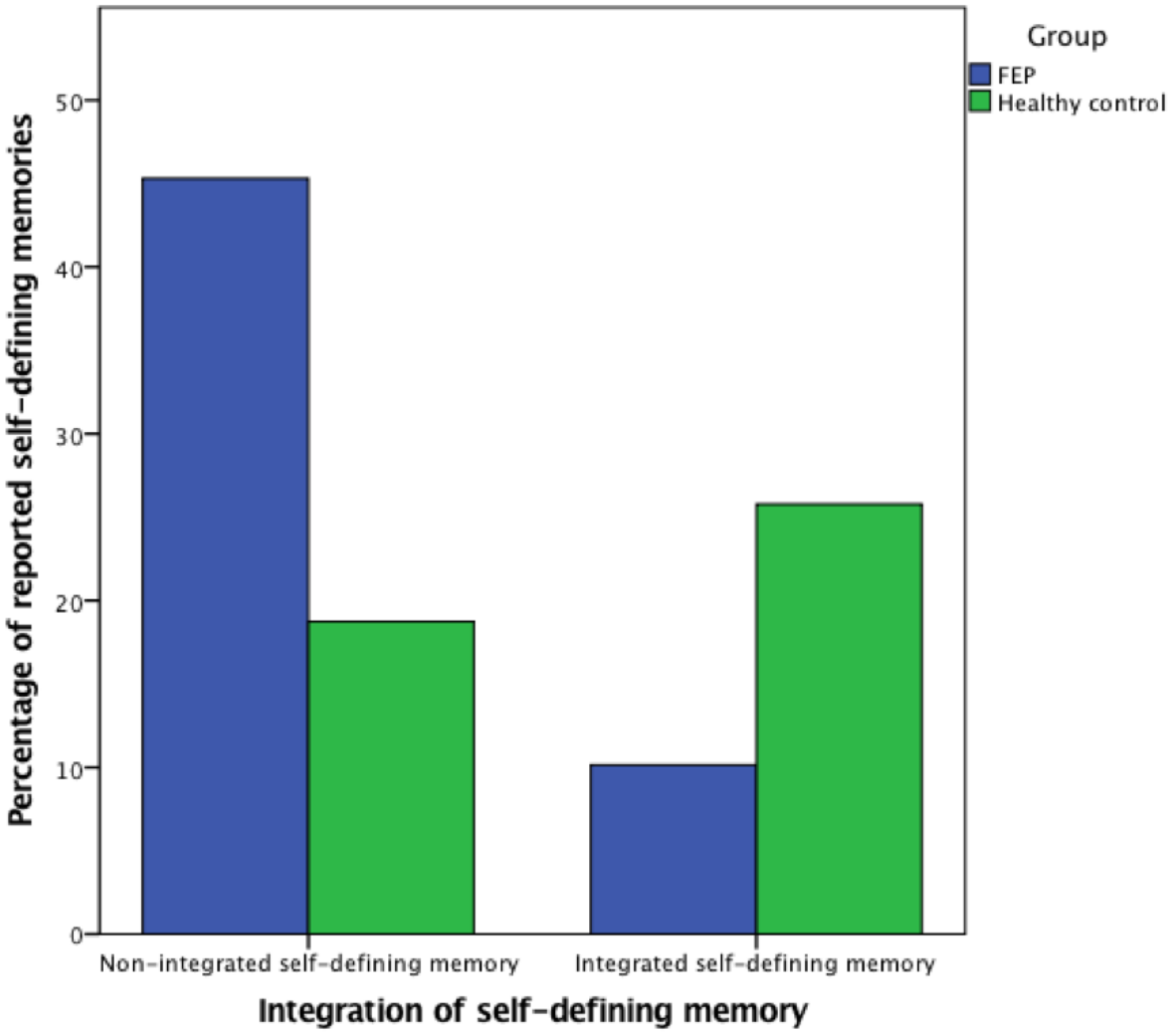
Cognitive/functioning measure	**Raw scores**		**Z scores (created from age-scaled scores)**	
	Mean (S.D)	**Range**	**Mean (S.D)**	**Range**
Immediate verbal memory (0-75)	28.76 (10.93)	10-55	-1.25 (1.13)	-3.16-1.3
Delayed verbal memory (0-50)	16.76 (8.34)	0-35	-1.21 (1.13)	-3.33-1.11
Letter-number sequence (0-21)	8.83 (2.47)	4-15	-.99 (.96)	-2.78-1.18
Verbal fluency (semantic)	18.85 (4.59)	9-29	-.34 (.87)	-2.18-1.42
Verbal fluency (phonemic)	33.09 (9.4)	15-55	-.87 (.97)	-2.85-1.5
Vocabulary (0-80)	53.63 (10.82)	31-73	-.28 (1.16)	-2.6-1.8
Matrix reasoning (0-35)	26.03 (4.16)	13-34	.2 (8.5)	-2.5-2
Trail-Making Test (B-A)	46.93 (31.24)	6.64-135.60	.97 (2.45)	-3.88-8.17
MAI total (0-5)	2.85 (1.2)	.44 – 4.88		
UPSA total (0-100)	72.98 (14.5)	36.62 – 95.24		
Time Use SU (hours in activity per week)	33.97 (26.57)	2.30 – 96.74		

5.5.4 Hypothesis testing

Hypothesis 1

Significant difference was found between groups on frequency of integrated memory reported, χ^2 (1, N = 128) = 21.52, p<.001 (see figure 8). Table 9 highlighted 13 out of 71 individuals with FEP reported an integrated memory, compared to 33 out of 57 healthy control participants.

Figure 8: Bar graph for percentage of reported integrated self-defining memories in FEP and healthy control sample.



No difference was found for frequency of specificity (p =.11) and content valence (p =.15) between the groups.

Hypothesis 2

To understand the relationship between SDMs and neurocognition, a single neurocognitive factor was created using the z-scores of all neurocognitive variables, following research which assumes a single neurocognitive factor [34, 64-67].

Logistic regression analysis assessed whether neurocognition could determine the likelihood of SDM to be specific or non-specific. This model was significant (χ^2 = 8.0, df= 1, *p*=.005). Neurocognition explained 14.8% (Nagelkerke R^2) of the variance in

specificity and correctly classified 69% of the cases. Neurocognition did not predict integration (p=.28).

Hypothesis 3

Logistic regression analysis assessed whether metacognitive ability could determine the likelihood of SDM to be specific or non-specific. The model was significant (χ^2 = 16.16, df=1, p<.001). Metacognition explained 28.7% (Nagelkerke R^2) of the variance in specificity and correctly classified 75.7% of the cases. Metacognition did not predict integration (p>.2).

Hypothesis 4

Specificity was a significant predictor of functional outcome, whilst controlling for metacognition (neurocognition was not significant after including metacognition). This model predicted 70.4% (adjusted r^2 = .70) of the variance in functional outcome score (R^2=.70, F(2, 68) = 78.67, p<.001); specificity predicted 1.8% of this variance and improved the baseline model (ΔR^2= .02, F(1, 66) = 4.08, p=.047). Individuals who reported a specific self-defining memory had a mean time-use score of 43.3 (SD=3.92) hours within structured activity per week, compared to those with non-specific SDM, mean of 14.92 (SD=2.44) hours.

When including depression as a covariate, for 21 participants with individualised PANSS scores, depression did not predict functioning (p>.05) and specificity was still a significant predictor of functioning (ΔR^2=.38, p=.003).

Integration did not predict functional outcome. Functional capacity was not predicted by any SDM variable.

Mediation model

The mediation was conducted using Mplus with Multiple Mediation Model (structural equation modelling) using Maximum Likelihood Estimation (MLE), bootstrapping and corrected confidence intervals, following Preacher and Hayes (2008)[65] causal steps of mediation.

A series of mediation models were conducted to identify the indirect mediating effect of specificity of SDM between neurocognition and functional outcome, independent of metacognition. A full multiple mediation model is presented.

We aimed to confirm a single neurocognitive factor solution using a confirmatory factor analysis of neurocognition Z scores. However, a CFA demonstrated that a 1-factor solution for neurocognition was not a good fit to the data [$\chi^2(20) = 79.5, p=.00$, CFI = .75, TLI = .65, RMSEA = 0.21]. Instead, neurocognition was a 2-factor solution containing Factor 1 representing memory: Immediate and delayed logical memory and factor 2 representing 'other' neurocognition: Letter-Number sequence, executive functioning, verbal and performance IQ. The model demonstrated an excellent fit [$\chi^2(19) = 18.92, p=.46$, CFI = 1.0, TLI = 1.0, RMSEA = 0.00]. From this point forward, all analyses are conducted first with the memory neurocognitive factor then the 'other' neurocognitive factor.

Firstly, the mediating effect of metacognition on the relationship between memory and functional outcome was tested. Significant direct pathways were found between memory and metacognition ($\beta=.62$, $p<.001$) and metacognition and functional outcome ($\beta=78$, $p<.001$). Metacognition significantly and fully mediated the relationship between memory and functional outcome ($\beta = .48$, $p<.001$, ±95% CI [0.36,0.6]).

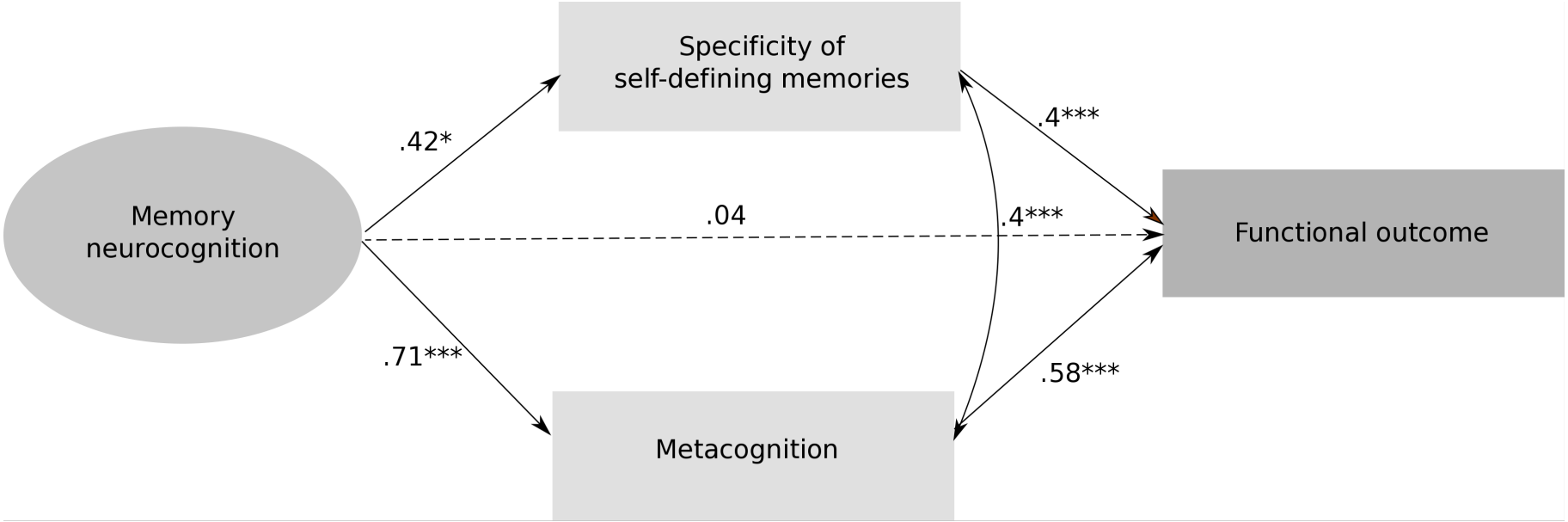
Secondly, the mediating effect of self-defining memories was tested. Significant direct pathways were found between memory and functional outcome ($\beta=.31$, $p=.01$), memory and specificity of SDM ($\beta=.41$, $p=.01$), and specificity of SDM and functional outcome ($\beta= .61$, $p<.001$). Specificity significantly and partially mediated the relationship between memory and functional capacity ($\beta = .25$, p=.02, ±95% CI [0.04,0.46]).

Finally, a full multiple mediation model was conducted with mediating effect of metacognition and SDMs on the relationship between memory and functional outcome (figure 9). A significant direct pathway was found between memory and metacognition ($\beta= .62$, $p<.001$) and specificity of SDM ($\beta = .41$, $p=.01$). A significant direct pathway was found between metacognition and functional outcome ($\beta= .58$, $p<.01$), and specificity of SDM and functional outcome ($\beta=.4$, $p<.001$). Metacognition significantly mediated the relationship between memory and functional outcome ($\beta = .36$, $p<.001$, ±95% CI [0.22,0.5]) and specificity of SDM also significantly mediated the relationship between

memory and functional outcome (β = .16, p=.05, ±95% CI [0.02,0.32]). The direct pathway was non-significant suggesting a full mediation model.

Factor 2: 'other' neurocognitive factor significantly predicted functional outcome, β = .47, p<.001. However, this factor did not predict specificity and, therefore, not included in the model.

Figure 9: Mediation of the effect of neurocognition to functional outcome through two covarying mediators: specificity of self-defining memories and metacognition. ***p<.001, **p<.01, *p<.05.



5.6 Discussion

This was the first study to demonstrate that individuals with FEP displayed different patterns of SDMs compared to healthy control participants. Those with FEP were less likely to report integrated SDMs, compared to controls. This supports research in chronic schizophrenia cohorts[8,15], but demonstrates that deficits exist at first-episode rather than as a result of chronic illness. Integration may enable the individual to interpret events as meaningful to themselves and define who they are as a person. This may be disrupted in psychosis, as outlined in the 'disrupted self' framework[69,70]. Berna et al. (2011)[8] demonstrated that individuals with schizophrenia report fewer integrated memories and more trauma-related memories. It may be suggested that trauma memories are not integrated into the self, to avoid continued distress, but consequentially leave a fractured sense of self.

Although non-significant, individuals with psychosis reported less specific memories and more negative memories which focused on i) negative relationships, ii) trauma, iii) failure, and iv) illness. This is aligned with research which suggest those with psychosis have poorer social relationships[71,72] and more interpersonal, trauma memories[73-76]. The lack of significant difference between the groups may be because these memories may be less prominent in the early stages of psychosis.

A small proportion of participants reported SDMs related to hospitalization/illness, in contrast to Raffard et al[7]. This may have been triggered by the hospital contextual cues in Raffard's study, whilst the present study was conducted in a community setting. Alternatively, this FEP group may not have integrated the illness into their identities, compared to a chronic schizophrenia group.

Memory specificity was significantly associated with functional outcome in FEP, independent of neurocognition and metacognition. This supports functional outcome models which suggest neurocognition[27,28,31,32] and metacognition[34] play an important role in functioning in psychosis, but demonstrates a role of a distinct, reflective process of reporting SDMs on functional outcome. Individuals with FEP who report a specific SDM spent 43.3 hours within structured activity per week, compared to those who reported a

non-specific SDM who were engaged in 14.9 hours. In comparison, Hodgekins et al[26] demonstrated that individuals with FEP spent 25.2 hours in structured activity compared to 19.7 hours for a delayed recovery group. The differences reflect important clinical differences in recovery trajectories.

Integration and valence are important aspects of SDMs, and the fewer integrated memories in FEP is an important finding, but these aspects of SDMs did not predict functional outcome in FEP. This may be a power issue, due to the reduced number of integrated memories in FEP, or integration may be more related to trauma, and therefore symptoms[77]. Blagov & Singer[3] and Singer, Rexhaj & Baddeley[78] demonstrated a negative correlation between specificity and integration. However, Blagov & Singer[3] explicitly requested important memories to one's life which may have encouraged a focus on integration, at the expense of specificity, and Singer, Rexhaj & Baddeley[78] demonstrated no such relationship in older participants, due to the greater ability of older adults to provide both integrated and specific SDMs. Following Conway and Pleydell-Pearce[13], specificity needs to be present within event, general and lifetime memories in order to describe how the memory was integrated. An individual may need to have a certain level of specificity in SDM, in order to integrate this memory to influence functioning.

Specificity, or the ability to report a detailed SDM, may have enabled the individual to reflect on their previous experiences in a coherent manner, to identify important memories to the self and identity. This identity may allow the individual to view themselves as a person with skills and draw specific detail into their SDMs to guide function. This ability may allow them to accurately reflect on their ability and monitor errors, which facilitates engagement in activities. This furthers research within a healthy sample[1,3].

The mean word count for the FEP group was lower than for the healthy control group and lower than that reported by Raffard et al[7]. The word count was greater than that reported by Jobson and O'Kearney[79] and similar to Singer and Moffitt[45]. This FEP sample may have written fewer words due to the lack of specific memories, supported by a previous positive association between word count and specificity[7], although it was possible to have memories that were brief (15 words) and specific. Alternatively, the lower word count may have been due to data collection (asking participants to write the memory down) or

lack of motivation, previously been linked to functioning[80,81]. Future studies should explore these hypotheses.

The impact of specificity on functioning was independent of metacognition, thus highlighting a novel contribution of SDMs. Metacognition significantly predicted the likelihood of reporting a specific memory, which suggests metacognition is associated with difficulties in recalling autobiographical memories and organizing one's experience into a coherent narrative[40].

Neurocognition also significantly predicted the likelihood of reporting a specific SDM, supporting previous research[9,10,82], however, both metacognition and SDMs have an independent role in predicting functioning. Theoretically, it is expected that SDMs are particularly pertinent to functioning in psychosis. They are associated with goal outcomes[1], and the typical age of reported SDM is 20-24 years in controls, compared to 15-19 years in a schizophrenia sample[7], which is before the onset of psychosis[83], highlighting the interest in understanding the connection between psychosis, SDMs and functioning. However, this might apply to autobiographical memories more broadly, not just self-defining memories. Future studies could include a control condition which asks participants to provide an autobiographical memory which is not self-defining.

In terms of clinical implications, Lysaker and Klion (2017)[84] recently outlined the Metacognition Reflection and Insight Therapy (MERIT), which is specifically aimed at improving metacognition[85,86]. In addition, narrative enhancement and cognitive therapy aims to construct positive narratives about the self[87]. Given the partial mediation effect of SDMs between neurocognition and functioning, therapies should focus on improving both metacognitive and neurocognition, e.g. Cognitive Remediation, shown to improve both neurocognition and real-life skills[88].

5.6.1 Limitations

Firstly, the sample was small, particularly for analysis of binary variables, as larger samples are needed for complex mediation models[89]. Hence the use of single mediation models. Future studies should aim to replicate this finding in a sufficiently powered multiple mediation model. Secondly, in a sub-sample, the results remained after

controlling for depression. However, as depression was previously shown to influence functional outcome in schizophrenia[90,91] and specificity of autobiographical memories[92], a follow-up study should consider this further in order to replicate this finding.

Thirdly, the self-defining memories questionnaire does not explicitly state that the memory description should explain why this memory is meaningful; characteristic of an integrated memory. This lack of instruction may have influenced integration in their reporting. Future studies should include a spontaneous and cued integration response; akin to Berna et al[8]. Using the Metacognitive Assessment Scale-Abbreviated[93], assessing one's acknowledgement of distress and management of difficulties, correlated with social functioning[94], may provide different outcomes to MAI. Future studies could conduct a sensitivity analysis to replicate and build on these findings using the MAS-A. Due to power, this study was unable to fully separate the variance explained by neurocognition, metacognition and SDMs. Future studies should explore whether SDM is a distinct factor, or a proxy for neurocognition.

5.7 Conclusion

This study was the first study to describe SDMs in FEP, and assess the impact on functional outcome. Specificity of SDMs predicted functioning in FEP, independent of metacognition. Individuals who reported a specific SDM were more likely to utilize their real-life functional skills to partake in structured activities. In terms of clinical importance, elaborating on specific SDMs within therapeutic contexts may be useful, and future intervention strategies should explore SDMs as a tool to improve functioning.

5.8 References

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6. What is the association between metacognition and anomalous experiences and delusional beliefs? A systematic literature review.

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Chapter 6 is written in the format to be submitted to Clinical Psychology Review.

6.1 Abstract

6.1.1 Introduction

Anomalous experiences are common within the general population, but the frequency and intensity is increased in psychosis and may later develop into anomalous (delusional) beliefs. Studies have demonstrated that perceptual biases may play a role in anomalous experiences and the appraisal of one's experience (metacognition) may also be relevant for anomalous (delusional) beliefs. Metacognition and anomalous experiences can be measured in a variety of ways. The use of these different methodologies and samples has resulted in inconsistencies within the literature.

6.1.2 Methods

Three databases were searched (PsycInfo, Scopus and Web of Knowledge) for this systematic review. Three metacognitive variables were used frequently: ability, monitoring and sensitivity, and studies in this area were used to assess the relationship between anomalous experiences and anomalous (delusional) beliefs with metacognitive components.

6.1.3 Results

Thirty-three studies were included in the review with a total of 5986 participants with a mean age of 35.1 years (SD=11.25). Three studies assessed metacognitive ability and demonstrated an association with anomalous experiences, but highlighted the role of trauma. Eighteen studies assessed metacognitive monitoring and demonstrated an association with anomalous (delusional) beliefs. However, this may be a state-like relationship, which varies throughout the course of recovery. Thirteen studies assessed metacognitive sensitivity, demonstrating a moderate association with delusional beliefs. There was inconsistent association with metacognitive monitoring and sensitivity with anomalous perceptual experiences.

6.1.4 Discussion

This review demonstrated an association between anomalous experiences/beliefs and different components of metacognition. The association between anomalous perceptual experiences and metacognition is still unclear. Future studies should assess anomalous perceptual experiences using more specific measures and appropriate experimental controls.

6.2 Introduction

Anomalous perceptual experiences are considered distortions of sensory events, such as hearing sounds which cannot be accounted for by the environment. Anomalous (delusional) beliefs are considered fixed false beliefs (Garety et al. 2001), most commonly, paranoia (Hemsley & Garety 1986). Research has suggested that anomalous (delusional) beliefs may be developed from anomalous perceptual experiences (Fletcher & Frith 2009; Corlett et al. 2009; Freeman et al. 2002). These experiences/beliefs are commonly experienced by individuals within the general population (Vaughan Bell et al. 2006; Kelleher et al. 2012). However, the frequency and intensity of these anomalous experiences/beliefs are increased in those with psychosis or those with emerging severe mental health difficulties (Brett et al. 2009; Reininghaus et al. 2016).

Many theories have been proposed to explain anomalous experiences or delusional beliefs. A literature review from Brookwell, Bentall and Varese (2013) was conducted to assess the relationship between different cognitive predictors of anomalous (hallucinatory) experiences, derived from models of source-monitoring, self-monitoring and signal detection mechanisms. This literature review demonstrated significant effects for signal detection and source-monitoring studies for explaining hallucinatory experiences in both clinical and non-clinical participants. Specifically, signal detection theory suggests that hallucinatory experiences appear due to a signal detection perceptual bias (bias towards detecting a stimulus as present within the environment, e.g. a voice) (Bentall & Slade 1985). Such perceptual biases have been consistently associated with hallucinations within the psychosis or psychosis-proneness literature (Teufel et al. 2015; Teufel et al. 2010; Mussgay & Hertwig 1990), whilst perceptual ability does not appear to be responsible for this effect (Mintz & Alpert 1972; Bentall & Slade 1985). Garety et al. (2001) suggest the role of negative (metacognitive) appraisal of the anomalous experience which leads these experiences to become distressing and, therefore, can lead to anomalous (delusional) beliefs.

Metacognition is considered ‘thinking about thinking’ (Semerari et al. 2003a; Flavell 1979) and Nelson and Narens (1990) outlined a metacognitive model suggesting an object-level (cognitive processes, such as perception and memory) and a meta-level (an abstract view of the object-level, considered metacognition), connected by metacognitive

processes. Literature highlights that metacognition may be fractionated and appear in many different forms, associated within a dynamic model (Nelson & Narens, 1990; Shea et al., 2014). Three levels of metacognition have been proposed. Firstly, metacognitive ability: capacity to think about one's own cognitions, emotions and behaviour, and to use this reflection to respond to challenges (Lysaker et al. 2010; Lysaker, Erickson, et al. 2011). Secondly, metacognitive experience: an online appraisal of one's experience or performance, and thirdly, metacognitive sensitivity[14]: a sub-conscious awareness of confidence in performance during a task, which generates a "feeling of knowing" (Nelson, 1984). These metacognitive levels may influence each other via metacognitive controlling processes, (i.e. such that knowledge is used to control, guide and correct ongoing action) (Wells & Purdon, 1999), and metacognitive monitoring processes (i.e. monitoring of ongoing experience in order to recognise anomalies and update higher level beliefs) (Efklides 2006).

It may be suggested that perceptual biases predispose an individual to have anomalous perceptual experiences. Then the individual may (metacognitively) appraise this experience as negative or threatening which can lead to the anomalous (delusional) belief. For example, if you are unable to accurately discriminate between a real or false perception, you may accept a false one as real (perceptual bias). After this, if you experience difficulty in monitoring your experiences or inaccurately interpret these experiences (metacognitive experience) or become confident in your error (metacognitive sensitivity), this may maintain this false perception or develop into an anomalous (delusional) belief. Following the range of measures of metacognition, it is important to further understand what particular aspects of the processing mechanisms are involved in anomalous experiences/beliefs. The manner in which all of these metacognitive concepts influence anomalous events has been considered in various studies. This literature review will consolidate and evaluate these studies.

[14] Some studies use a measure of *metacognitive efficiency*, which uses the metacognitive sensitivity score but also takes into account objective performance on the task to provide a more robust measure of metacognition within the moment (Fleming & Lau, 2014; Maniscalco & Lau, 2012). To avoid confusion, within this review we have termed them both under "metacognitive sensitivity".

Varese & Bentall (2011) previously conducted a literature review and meta-analysis on the association between metacognitive beliefs and hallucinatory experiences. This review solely focused on assessing metacognitive beliefs, using the Metacognitions Questionnaire (MCQ) (Wells & Cartwright-Hatton, 2004) and demonstrated little support for the association between hallucinatory experiences and metacognitive beliefs. Instead, uncontrolled comorbid symptoms may have played a role in previous significant results. Despite the systematic approach of the literature review, Varese and Bentall (2011) review only assessed hallucinations or hallucination-proneness and metacognitive beliefs.

To the knowledge of the authors, no review has yet assessed the role of different aspects of metacognition on anomalous experiences and anomalous delusional beliefs within one single review. This current literature review aims to take a holistic approach to include various anomalous events: anomalous perceptual experiences as well as anomalous (delusional) beliefs, which may display different relationships with metacognition. Given the continuum perspective of anomalous experiences which suggest these occur within the general population, but more commonly for those with an experience of psychosis (Bentall et al. 1988), this review will focus on the presence of the anomalous event across various clinical and non-clinical groups. This is instead of focusing on the concept of schizophrenia or psychosis as this can be heterogeneous in its symptom presentation (Arango et al. 2000; Carpenter et al. 1988).

6.2.1 Metacognitive variables

Whilst literature has described different metacognitive components, for consistency and conciseness, this review will explore the association between three metacognitive components described above (metacognitive ability, monitoring, sensitivity), with anomalous experiences and delusional beliefs in both clinical and non-clinical studies.

1. **Metacognitive ability**:

Metacognitive ability is the capacity to think about one's own cognitions, emotions and behaviour, as well as others', and to use this reflection to respond to challenges and link to other relevant narrative events (Lysaker et al. 2010; Lysaker, Erickson, et al. 2011). This has been measured using a narrative interview: Metacognitive Assessment Scale-Abbreviated (Lysaker, Carcione, et al. 2005) or Metacognitive Assessment Interview

(MAI) (Semerari et al. 2012) assessing the ability to understand "the self" and "the other"; termed as one multidimensional metacognitive ability construct.

2. **Metacognitive monitoring:**

Metacognitive monitoring is monitoring of ongoing experience in order to recognise anomalies and update higher level beliefs. This is measured by using the self-reflectiveness subscale of Beck Cognitive Insight Scale (Beck et al. 2004) which is an individual's current capacity to evaluate his or her anomalous experiences and atypical interpretations of events (Degirmenci et al. 2013). The self-reflectiveness subscale specifically reflects objectivity and openness to feedback; e.g. "At times I have misunderstood other people's attitudes towards me" (Engh et al. 2011).

3. **Metacognitive sensitivity**:

Metacognitive sensitivity is one's ability to discriminate between task-related correct and incorrect decisions. This has been described as a "feeling of knowing" or "knowing that you know" (Sherman et al. 2015). Metacognitive sensitivity is assessed within-the-moment using confidence ratings based on a specific task. Although some studies use a measure of metacognitive efficiency, which involves taking into account objective performance as a more robust measure (Fleming & Lau, 2014; Maniscalco & Lau, 2012). To avoid confusion, within this review we have termed them both under "metacognitive sensitivity".

This review plans to address the following questions: i) Are anomalous experiences associated with metacognitive ability, monitoring and sensitivity? If so, is this relationship positive or negative? ii) Are anomalous (delusional) beliefs associated with metacognitive ability, monitoring and sensitivity? If so, is this relationship positive or negative? iii) Are there other factors which should be considered within future research studies?

6.3 Methods

6.3.1 Identification and selection of studies

Metacognition is measured in a variety of ways. To be as inclusive as possible, the author consulted with numerous literature reviews, academics, and general metacognitive

literature to identify terms for metacognition. This incorporated metacognitive sensitivity, efficiency, experience, ability and metacognitive monitoring (e.g. cognitive insight or self-reflectiveness) and control processes, and higher-order thought.

A comprehensive search of published studies up to 06/09/2017 was conducted using the following electronic databases: Psycinfo (810), Scopus (336), and Web of Knowledge (757). The search terms were: (anomal* OR "psychotic experience" OR delusion* OR schizotyp* OR hallucinat* OR depersonalization OR derealization OR dissociat* OR "self-experience" OR "psychotic-like experiences") AND (overconfiden* OR metacogniti* OR "cognitive insight" OR self-reflect* OR "Higher-order thought").

6.3.2 **Eligibility criteria**

Inclusion criteria: Studies were considered eligible for the literature review if they investigated the relationship between anomalous experiences and metacognition OR anomalous (delusional) beliefs and metacognition.

Inclusion criteria included: i) observational studies, ii) cross-sectional studies, iii) longitudinal studies, iv) studies assessing symptomatology or anomalous events, regardless of population and diagnosis, and v) studies assessing metacognitive ability, monitoring or sensitivity.

Exclusion criteria included: i) reviews, ii) qualitative studies, iii) trials/intervention studies, iv) studies which assessed clinical status only, e.g. psychosis or schizophrenia, but did not include specific relationships with symptomatology/experiences, and v) studies which include participants from other clinical populations than psychosis (which may effect the results by involving additional confounds).

6.3.3 **Quality assessment**

Studies meeting the eligibility criteria for the literature review were assessed for methodological quality and potential for bias using an adapted framework from the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (U.S. Department of Health & Human Services. n.d.) (Appendix D). Each study was assigned

a score by allocating a value of 0 (no) or 1 (yes) to the 14 questions in the tables in supplementary materials. If the study did not report the information or the question did not apply to the study, that particular question was allocated a score of 0, following Gu, Strauss, Bond, & Cavanagh (2015).

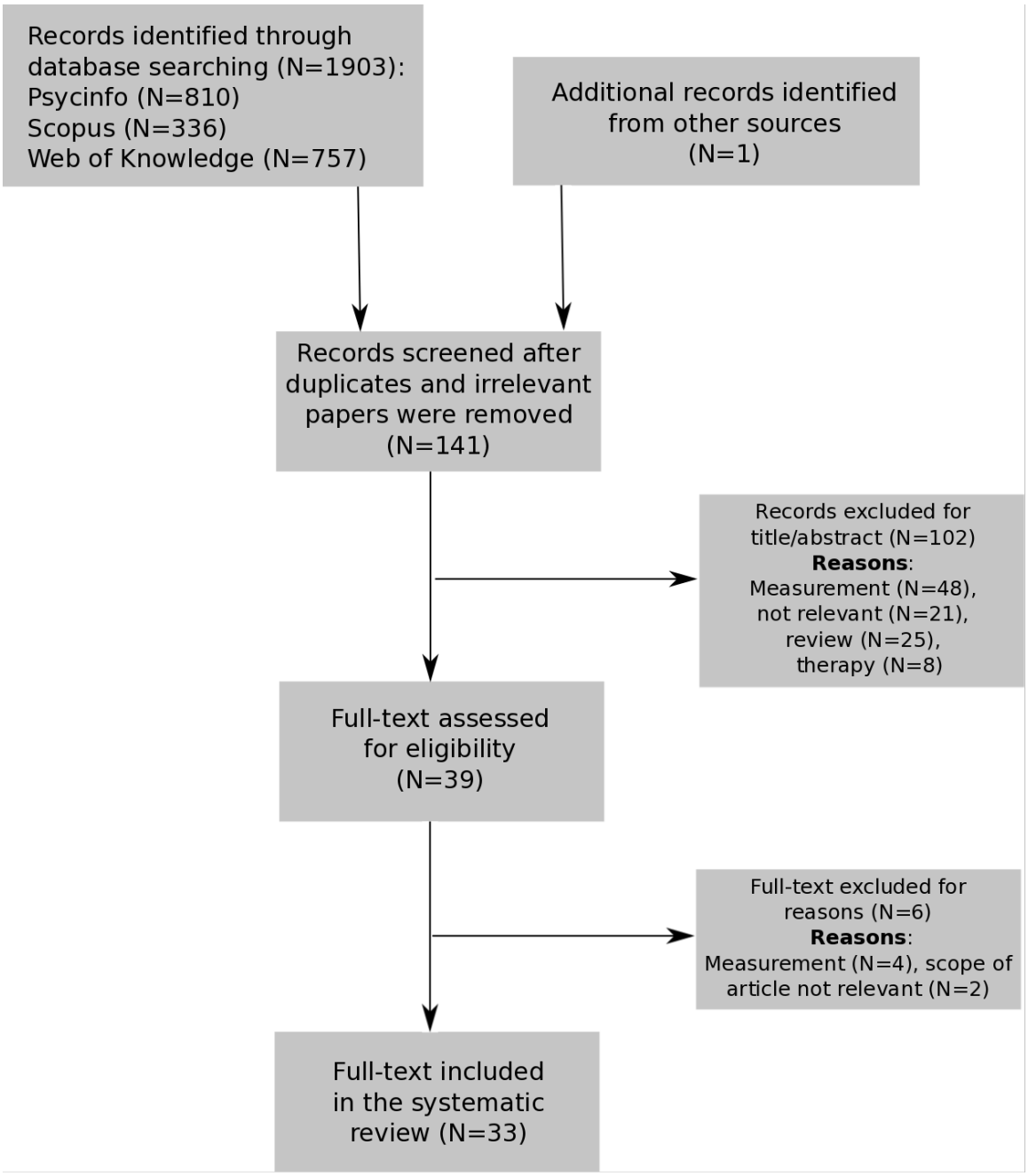
The study titles and abstracts were screened by the first author. If the abstracts were suitable, then the full texts were screened. All ineligible papers were excluded. One additional paper was included from the references of the other papers, not captured within the literature review search terms (O'Connor et al. 2017). Information from each eligible study was extracted and tabulated using Microsoft Excel. Extracted data included sample (size, population, gender, country), setting and recruitment strategy, study design and analysis of interest, measure of anomalous experience/beliefs and measure of metacognition, quality score and key findings. The heterogeneity of the studies and broad nature of the review meant that it was not appropriate to conduct a meta-analysis.

6.4 **Results**

6.4.1 Search results

The literature search yielded a number of relevant articles: Psycinfo (810), Scopus (336), and Web of Knowledge (757). Removal of duplicates, title and abstract screening left 141 articles for full-text screening. One hundred and two did not meet the eligibility criteria. Reason for exclusion included: Therapy trials, reviews, measurement of metacognition (e.g. using the Metacognitive Beliefs Questionnaire), or the aims of the project were not relevant for the present review. Thirty-nine were assessed for eligibility and six were excluded. Reasons for exclusion included: measurement or scope of the article was not relevant for the present review. Thirty-three were deemed eligible for the inclusion in the systematic review (see figure 10).

Figure 10: Flow diagram for the systematic literature search results.



Three tables summarising the 33 studies within the review.

Metacognitive Ability included 3 studies; Metacognitive monitoring included 18 studies and Metacognitive Sensitivity included 13 studies (1 assessed both metacognitive monitoring and metacognitive ability; Bruno, Sachs, Demily, Franck, & Pacherie, 2012).

In terms of the details of the articles: The number of individuals included in total = 5986 participants. The mean age was 35.1 years (SD=11.25, mean range 20-73 years). The

most common recruiting method = in/out-patient clinics and the most common design was cross-sectional. The most common measurement for metacognition within this review was using the Beck Cognitive Insight Scale and for anomalous events was PANSS positive symptoms subscale.

6.4.2 Quality assessment

Studies included were generally of moderate quality. Quality scores for included studies ranged from 7 (low quality) to 11 (high quality). For this review, 7 were classified as of lower quality (and higher risk of bias) and 20 were classified as moderate quality, 6 were high-quality (and lower risk of bias).

6.4.3 Metacognitive ability

Three studies assessed the relationship between metacognitive ability, using Metacognitive Assessment Scale-Abbreviated (MAS-A) (Lysaker, Carcione, et al. 2005), and anomalous experiences and delusional beliefs, using Positive And Negative Symptom Scale (PANSS) (see table 10).

McLeod et al. (2014) demonstrated that there was no simple correlation between anomalous experiences and beliefs (positive symptoms) and metacognitive ability. However, metacognitive ability significantly predicted positive symptoms, when controlling for gender, baseline symptoms, DUP and functioning. The use of covariates enabled the authors to detect the relationship between metacognitive ability and positive symptoms. Trauelsen et al. (2016) then aimed to clarify issues within the previous study design, suggesting an interaction between positive and negative symptoms may have concealed the association between positive symptoms and metacognitive ability. This study demonstrated, in First Episode Psychosis (FEP), even when controlling for negative symptoms, positive symptoms were not directly associated with MAS-A. Conversely, Leonhardt, Hamm, Belanger, & Lysaker (2015) demonstrated a positive association between positive symptoms; hallucinations and delusions, and metacognitive ability, for those with schizophrenia and childhood trauma. This association was not present for those with schizophrenia and no reported trauma, demonstrating a moderating role of trauma. It was unexpected that increased metacognitive ability was associated increased positive

symptoms. This result may be due to an increase in distress, as the individual becomes aware of past events/trauma, leading to positive symptoms.

The three studies above demonstrated mixed results: a lack of direct association between metacognitive ability and positive symptoms (Trauelsen et al., 2016). However, McLeod et al. (2014) there was a relationship when controlling for covariates and, importantly, there was a moderating role of trauma in the association between metacognitive ability and positive symptoms (Leonhardt et al. 2015).

Table 10: Studies including metacognitive ability and anomalous experiences/beliefs.

Author	Sample (country, population, gender)	Setting, recruitment strategy	Study design, analysis of interest	Anomalous events measure	Metacognition measure	Quality score	Results
Leonhardt et al. (2014)	USA, 62 individuals with schizophrenia, 95% male	Recruited from community mental health centres.	Cross-sectional, correlational analysis	Positive And Negative Syndrome Scale (PANSS)	Metacognitive Assessment Scale – Abbreviated [MAS-A] (and Indiana Psychiatric Illness Interview [IPII])	9	Significant positive association only in those with trauma
McLeod et al. (2014)	UK, 45 individuals with First Episode Psychosis, 69% male	Subgroup from a 12-month prospective study in FEP services in Scotland.	Longitudinal, regression analysis	PANSS	MAS-A (and Adult Attachment Interview [AAI])	10	Significant negative association when controlling for other factors
Trauelsen et al. (2016)	Denmark, 101 individuals with First Episode Psychosis and 101 controls	Clinical group: Early Intervention Centres. Control group: advertisements in newspapers, libraries, sport clubs etc.	Cross-sectional, correlation analysis	PANSS	MAS-A (and Indiana Psychiatric Illness Interview [IPII])	8	No significant association

6.4.4 Metacognitive monitoring

Eighteen studies assessed the relationship between metacognitive monitoring, using self-reflectiveness subscale of Beck Cognitive Insight Scale, and anomalous experiences/beliefs (see table 11). Six studies demonstrated lower self-reflectiveness is associated with increased anomalous beliefs in those with psychosis or an At Risk Mental State (ARMS) (Buchy et al. 2009; Kimhy et al. 2014; O' Connor et al. 2017; Bora et al. 2007; Engh et al., 2011; Engh et al., 2010). This may be explained by the appraisal of anomalous experiences as Wüsten & Lincoln (2015) demonstrated, within Chilean participants with schizophrenia, that those with lower self-reflectiveness had less normalising and less communicative responses to paranoia. This highlights the potential role of metacognitive monitoring (self-reflectiveness) in responding to anomalous events, e.g. anomalous (delusional) beliefs.

However, three studies demonstrated no association between self-reflectiveness and positive symptoms (Pedrelli et al. 2004; Kuokkanen et al. 2016; Engh et al. 2007). However, these studies did not distinguish between these different positive symptoms, instead focusing on a general psychopathology score, e.g. PANSS positive subscale (O'Connor et al., 2013), which means it is difficult to identify specific relationships. On the other hand, seven studies demonstrated anomalous (delusional) beliefs are associated with high self-certainty (overconfidence) and high (appropriate) self-reflectiveness in psychosis (Bruno et al. 2012; Warman et al. 2007; Ekinci et al. 2012; Guerrero & Lysaker 2013; Engh et al. 2007; Kimhy et al. 2014), healthy controls (Warman & Martin 2006; Carse & Langdon 2013), and those who are considered ARMS and antipsychotic naive (Uchida et al., 2014). Carese and Langdon (2013) suggested the association between high self-reflectiveness and high delusional proneness may be due to a "ruminative self-reflectiveness", which may be detrimental to reflection.

Recently, O'Connor et al. (2017) demonstrated that low self-reflectiveness predicted severity of positive symptoms in FEP at 4-year follow-up. This may highlight the prospective role of self-reflectiveness in predicting the maintenance of symptoms. Prior to this, Bora et al. (2007) previously conducted a longitudinal study within an in-patient unit and demonstrated that over time positive symptoms reduced and self-reflectiveness

improved. In both studies, self-certainty, an aspect of cognitive insight which assesses overconfidence in beliefs and may be less relevant to metacognition (Gilleen et al., 2016), demonstrated no change across time. This suggests self-certainty may be a more persistent factor of psychosis, but self-reflectiveness may be related to the fluctuation in anomalous experiences. If this is the case, it may be expected that there is a state-like association which differs depending on the stage of psychosis.

To support this, Kimhy et al. (2014) demonstrated anomalous (delusional) beliefs were associated with low self-reflectiveness in schizophrenia, but, in those with ARMS, delusional beliefs were associated with high self-reflectiveness and high self-certainty (Kimhy et al., 2014). Therefore, in those with ARMS, anomalous (delusional) beliefs may be mostly driven by high self-certainty, but, in schizophrenia, low self-reflectiveness has a key role as experiences may become more frequent and individuals with psychosis may inaccurately appraise these experiences as threatening which leads to anomalous (delusional) beliefs. Then, over time, individuals with chronic schizophrenia begin to entertain the possibility of being mistaken in the past, which increases self-reflectiveness. However, due to their overconfidence in current judgments, there are continual difficulties with self-certainty in schizophrenia (Bruno et al. 2012; Warman et al. 2007). This supports the suggestion that there may be differences in associations within different groups or at across stages of the psychotic illness. Future longitudinal studies are required to assess this further.

Five studies directly assessed this. In terms of anomalous perceptual experiences, the evidence is inconsistent. Three studies have demonstrated no association between metacognitive monitoring and anomalous perceptual experiences (Bora et al. 2007; Engh et al. 2007; Engh et al., 2011). One study demonstrated that hallucinations were associated with high self-reflectiveness and low self-certainty (Engh et al., 2010), opposite to anomalous (delusional) beliefs, which may potentially reflect open-mindedness in accepting the presence of unknown stimulus (e.g. a voice). When using more detailed assessments of anomalous perceptual experiences (e.g. Eppendorf Schizophrenia Inventory), one study demonstrated associations with both high self-certainty and high self-reflectiveness for individual aspects of anomalous experience (Mass, Wolf and Lincoln, 2012). For example, high self-certainty was associated with attention and speech impairment “if someone speaks to me, I often have trouble grasping

the meaning of the world correctly" and ideas of reference "Now and then events, broadcasts etc. seem to be related to me". High self-reflectiveness is associated with ideas of reference, deviant perception "sometimes a part of my body seems to be smaller than it really is"; and auditory uncertainty "Even if I hear something very clearly, sometimes I am not sure whether I just imagined it", rather than all anomalous perceptual experiences are associated with both cognitive insight mechanisms.

Overall, these studies demonstrated a relationship between high self-certainty and anomalous (delusional) beliefs in schizophrenia, FEP, ARMS and healthy control groups. However, the relationship between lower self-reflectiveness and anomalous (delusional) beliefs appears more complicated and may change overtime with fluctuations of experiences/beliefs, being most prominent in schizophrenia or FEP. Finally, the literature within anomalous perceptual experiences is still fairly inconsistent with studies demonstrating no association or an association with self-reflectiveness. Future studies should aim to assess the relationship between metacognitive monitoring and specific anomalous perceptual experiences, e.g. visual, auditory, olfactory experiences.

Table 11: Studies including metacognitive monitoring and anomalous events.

Author	Sample (country, population, gender)	Setting, recruitment strategy	Study design, analysis of interest	Anomalous events measure	Metacognition measure	Quality score	Results
Bora et al. (2007)	Turkey, 93 currently psychotic, 45 currently non-psychotic patients, 60% male	Patients were recruited within an inpatient and outpatient unit.	Longitudinal cross-sectional design with comparison groups, t-test and correlational analyses	PANSS	Beck Cognitive Insight Scale (BCIS); Scale of Unawareness of Mental Disorder (SUMD)	9	Self-reflectiveness improved and symptoms reduced overtime, but self-certainty did not change.
Buchy et al. (2009)	Canada, 13 individuals with psychosis and active delusions, 53 individuals with psychosis and no active delusions, 73% male	Participants were part of a longitudinal naturalistic outcome study, both in- and out-patients.	Cross-sectional design, ANOVA analyses	PANSS	BCIS	8	Those with FEP and delusions had lower self-reflectiveness, but equal self-certainty to those without active delusions
Carse et al. (2013)	Australia, 152 psychology students, 11% male	Recruited via email invitation and social networks	Cross-sectional design, regression analyses	Peters Delusion Inventory (PDI)	BCIS	7	Those with delusion proneness had higher self-reflectiveness and higher self-certainty. Relationship between self-reflectiveness was reduced when

							controlling for rumination.
Ekinci et al. (2012)	Turkey, 121 patients with deficit or non-deficit schizophrenia, 64% male	Patients were recruited from an outpatient clinic	Cross-sectional design, correlational analyses	Scale for the Assessment of Positive Symptoms (SAPS)	BCIS; SUMD	8	Within those with deficit psychosis, no associations. Within those with non-deficit psychosis, only self-certainty was positively associated with delusional beliefs.
Engh et al. (2011)	Norway, 102 patients with psychosis, 59% male	Patients were recruited within an inpatient and outpatient units.	Cross-sectional design, correlational analyses	PANSS	BCIS; Birchwood Insight scale (IS)	7	Delusions were associated with low self-reflectiveness and high self-certainty.
Engh et al. (2010)	Norway, 143 patients with schizophrenia with hallucinations and delusions, 55% male	Patients were recruited within an inpatient and outpatient units.	Cross-sectional design, correlational analyses	PANSS; grouping of patients with hallucinations and delusion	BCIS	8	Delusions were associated with low self-reflectiveness and high self-certainty. Hallucinations, without delusions, were associated with high self-reflectiveness and low self-certainty.
Engh et al. (2007)	Norway, 143 patients with schizophrenia,	Patients were recruited within	Cross-sectional design,	PANSS	BCIS; PANSS insight scale.	7	No associations with self-reflectiveness and PANSS measure.

	92 with bipolar, 64 controls, 49% male	an inpatient and outpatient units.	correlational analyses				
Guerrero and Lysaker (2013)	Spain, 92 participants with schizophrenia spectrum disorder, 87% male	Participants recruited outpatient psychiatry service or mental health centre.	Cross-sectional design, regression and moderation analyses	PANSS	BCIS	9	PANSS positive symptoms were associated with high self-reflectiveness and high self-certainty. Those who were considered more socially naïve and had high self-certainty scores also had greater levels of delusions.
Kuokkanen et al. (2016)	20 inpatient males with schizophrenia, 100% males	Participants recruited using hospital's patient registry and screened for diagnosis of schizophrenia.	Cross-sectional design, correlational analysis	PANSS	BCIS	9	No associations with self-reflectiveness and PANSS measure.
Kimhy et al. (2014)	USA, 62 ARMS, 59 with schizophrenia-spectrum disorders, 37 healthy controls, 37% male	ARMS and schizophrenia sample from a psychiatric institute; Healthy controls using 3 previous studies	Comparison cross-sectional design, correlational analyses	Structured Interview for Prodromal Syndrome (SIPS); Scale of Prodromal Symptoms (SOPS)	BCIS	8	In schizophrenia sample, delusions were associated with high self-certainty. In ARMS, delusions (unusual thought content) was associated with lower self-reflectiveness.

Mass et al. (2012)	Germany, 88 patients with psychosis, clinical control participants, healthy control participants, 49% male	Clinical participants were inpatients, control participants were clinical staff or were friends/family.	Comparison cross-sectional design, regression analyses	Eppendorf Schizophrenia Inventory (ESI)	BCIS	8	High self-certainty and high self-reflectiveness for individual aspects of anomalous perceptual experience.
O'Connor et al. (2017)	UK, 90 FEP participants, 62% male	Participants were recruited through mental health services through screening case notes.	Longitudinal design, regression analysis	PANSS	BCIS	11	Low self-reflectiveness predicted severity of positive symptoms at 4-years.
Pedrelli et al. (2004)	USA, 164 participants with schizophrenia spectrum disorder, 69% males.	Participants recruited from the treatment and research centre.	Cross-sectional design, correlational analyses	PANSS	BCIS	8	No associations with self-reflectiveness and PANSS measure.
Uchida et al. (2014)	Japan, 60 ARMS, 200 healthy students, 40% male	ARMS from a specialised clinic, healthy controls from University.	Comparison cross-sectional design, t-test and correlational analyses	Comprehensive Assessment of At-Risk Mental States (CAARMS)	BCIS	9	High self-certainty was associated with delusional symptoms in ARMS. No association with self-reflectiveness. Relationships not assessed in healthy control group.

Warman & Martin (2006)	USA, 200 healthy students, 23% male	Recruited via course credits	Cross-sectional design, regression analyses	PDI	BCIS	7	High self-certainty and high self-reflectiveness was associated with delusion proneness
Warman et al. (2007)	USA, 37 individuals with psychosis and active delusions, 12 individuals with psychosis and inactive delusions and 60 healthy controls, 54% male	VA medical centre (psychosis patients) or a college (healthy controls)	Cross-sectional design, ANOVA and regression analyses	PANSS	BCIS	7	Individuals with psychosis and delusions had high self-certainty. Those without delusions had lower self-reflectiveness.
Wusten et al. (2015)	Chile, 36 patients with schizophrenia-spectrum disorders, 39 controls, 55% male	Patients from in- or out-patient clinics, healthy controls from neighbourhood initiative	Cross-sectional design, regression analyses	Paranoia checklist; Responses from paranoia checklist (RePT)	BCIS	10	Those with high self-reflectiveness and self-certainty had more normalising responses to paranoid thoughts.

6.4.5 Metacognitive sensitivity

Thirteen studies assessed the association between metacognitive sensitivity, using confidence ratings, and anomalous events (see table 12). Six studies have demonstrated that individuals who had high confidence, during a cognitive task, for incorrect responses were more likely to report higher level of anomalous (delusional) beliefs (Moritz et al., 2005; Bruno et al. 2012), across a variety of tasks (Moritz et al., 2014) within clinical samples, including FEP and ARMS (Eisenacher et al., 2015; Moritz, Woodward, & Chen, 2006), and controls (Warman, 2008). Eisenacher et al. (2015) demonstrated using a memory task, within FEP participants, that the confidence gap (decreased ability to distinguish between errors and correct responses) was significantly associated with positive symptoms. In addition, knowledge corruption (inaccurate, but confidently held errors; Eifler et al., 2015) was significantly associated with delusional conviction in FEP (Eisenacher et al., 2015). This association was not present within ARMS and healthy control groups, who displayed better metacognitive sensitivity.

Six studies demonstrated no significant association between Positive And Negative Symptom Scale (PANSS) and metacognitive sensitivity (Moritz, Woodward, et al. 2006; Moritz et al. 2008; Kircher et al. 2007; Eifler et al. 2015a; Balzan et al. 2016; Cella, Swan, Medin, Reeder, & Wykes, 2014). This is unlike Moritz et al. (2005), although it should be noted that Moritz et al., (2005) was a lower quality study as i) it did not control for IQ between groups and ii) the controls were staff within the hospital, which may have biased the result with a specific demographic.

The inconsistences within the overall literature described may be due to subjective competence as Moritz et al. (2015) demonstrated the overconfidence in errors in individuals prone to paranoia was exaggerated if the person felt competent or deemed the question easy. When the question was difficult, the differences were no longer significant highlighting the moderating role of subjective competence for the relationship between anomalous (delusional) beliefs and metacognitive biases (overconfidence). More recently, Balzan, Woodward, Delfabbro, & Moritz (2016) suggested individuals with anomalous (delusional) beliefs have poorer performance insight, making them unaware of their poor performance. Balzan et al. (2016) demonstrated there was a trend towards

higher overconfidence for incorrect answers in a group of individuals with schizophrenia and delusions, compared to high/low-delusion proneness control groups, showing that this group had greater confidence-accuracy miscalibration as they had little awareness of their performance. This suggests that cognitive deficits play a role (see Eifler et al., 2015) or difficulty of the task, which needs to be controlled for in future research. In addition, there is a need for future studies to directly assess metacognitive sensitivity, instead of overconfidence.

In terms of anomalous perceptual experiences, three studies demonstrated a lack of association with metacognitive sensitivity (Gaweda, Woodward, Moritz, & Kokoszka, 2013; Moritz et al., 2008; Moritz et al., 2005). Instead, it may be suggested that anomalous perceptual experiences (hallucinations) are related to objective performance on a task, rather than on metacognitive sensitivity or overconfidence on the task (Gaweda, Woodward, Moritz and Kokoszka, 2013).

Overall, for metacognitive sensitivity, there is a large amount of inconsistency with few studies demonstrating an association with anomalous (delusional) beliefs. Instead, the differences may be due to varying experimental controls across the tasks, e.g. subjective competence or lack of experimental control of the objective performance, in order to accurately assess metacognition. Anomalous perceptual experiences show limited association with metacognitive sensitivity, but equally supports the extraneous role of objective performance.

Table 12: Studies including metacognitive sensitivity and anomalous events.

Author	Sample (country, population, gender)	Setting, recruitment strategy	Study design, analysis of interest	Anomalous events measure	Metacognition measure	Quality score	Results
Balzan et al. (2016)	Australia, 75 participants (25 schizophrenia; 50 non-clinical), 50% male	Schizophrenia group recruited via local health centre network, control group recruited using advertisements.	Experimental design, ANOVA and correlational design	PANSS and PDI-21	General knowledge (half- or full-scale answers) with confidence scale (50-100).	8	Trend towards poorer metacognitive sensitivity and delusions for half the metacognitive items. Half the items showed a negative relationship with clinical delusions.
Bruno et al. (2012) **metacognitive monitoring and metacognitive sensitivity**	France, 28 schizophrenia (with and without delusions); 14 healthy controls, 71% male	Schizophrenia group recruited via outpatient services; healthy controls recruited staff at hospital	Experimental design, ANOVA	SAPS	WCST metacognitive assessment (Koren, 2006); BCIS	10	Those with delusions had high self-certainty (no association with self-reflectiveness), poor metacognitive sensitivity.

Cella et al. (2014)	UK, 100 schizophrenia, 63% male	Recruited within clinical teams and part of a CRT study	Cross-sectional, regression analysis	Positive and negative symptoms scale (PANSS)	Subjective scale to investigate cognition in schizophrenia: (SSTICS)	10	PANSS positive did not contribute to metacognitive sensitivity (awareness) score.
Eifler et al. (2015)	Germany, 32 schizophrenia, 25 matched controls, 75% male	Recruited within mental health centres	Cross-sectional, correlational analysis	PANSS; Psychotic Symptom Rating scales (PSYRATS)	Metamemory task: Confidence gap, knowledge corruption	9	No significant associations between metamemory and delusions
Eisenacher et al. (2015)	Germany, 32 At Risk Mental State (ARMS), 38 controls, 21 FEP, 69% male	FEP via inpatient unit; ARMS via help-seeking individuals; controls closely matched	Experimental design, correlational analysis	PANSS; PSYRATS	Metamemory task: Confidence gap, knowledge corruption	10	In FEP, poor metacognitive sensitivity was associated with delusional conviction. No associations within ARMS and healthy control groups.
Gaweda et al. (2013)	Poland, 28 psychosis with auditory hallucinations; 26 psychosis without AH; 34 healthy	Participants with psychosis recruited via in- and outpatient clinics in Warsaw; control participant's	Experimental design, ANOVA	PANSS	Action memory task with confidence ratings	9	Self-monitoring deficits were associated with auditory hallucinations. But not directly with metacognitive sensitivity.

	controls, 64% male	recruited via word of month and matched with psychosis group.					
Kircher et al. (2007)	Germany, 27 participants with schizophrenia and 19 healthy controls, 63% male	Schizophrenia group were recruited from outpatient University hospital and healthy controls from community.	Experimental design, correlational design	PANSS	Metamemory with confidence ratings; self- or other-characterisation with confidence ratings	8	No significant association between PANSS and metamemory.
Moritz et al. (2005)	Germany, 30 chronic schizophrenia group; 15 healthy controls, 60% male	Schizophrenia group recruited within an in-patient unit; Controls recruited from hospital staff and general population	Experimental design, correlational analysis	Signs and symptoms of psychotic illness (SSPI) rating scale (Liddle et al., 2002)	Metamemory task: Confidence gap, knowledge corruption	7	Delusions were associated with poorer metacognitive sensitivity, but hallucinations were not.
Moritz et al. (2006)	China, 49 FEP and 21 healthy control, 43% male	FEP early psychosis clinics, controls matched and assessed on mental health	Experimental design, correlational analysis	PANSS	Metamemory task: Confidence gap, knowledge corruption	9	No significant association between metacognitive sensitivity and anomalous experiences/beliefs.

Moritz et al. (2014)	55 schizophrenia; 45 healthy controls; 58 OCD, 36% male	OCD and schizophrenia via lists of discharged patients; Healthy controls via online panels and word of mouth	Experimental design, correlational analysis	Community Assessment of Psychic Experiences Scale (CAPS); Paranoia checklist	Perceptual detection task with confidence ratings	9	Metacognitive sensitivity was associated with self-reported paranoia.
Moritz et al. (2015)	Germany, 2321 healthy controls, 41% male	Online recruitment	Online experimental design, ANOVA and correlational analysis	Paranoia checklist	Knowledge quiz with confidence ratings	9	Poor metacognitive sensitivity was associated with increased paranoia; particularly when the items were considered easy on the task.
Moritz et al. (2008)	Germany, 68 participants with schizophrenia spectrum disorder, 57% males	Participants recruited from University medical centre and University hospital.	Experimental design, correlational analysis	PANSS	Visual memory task with confidence ratings	9	No significant association between PANSS and metacognitive sensitivity.
Warman (2008)	USA, 70 healthy controls: high vs. low delusion-proneness, 26% male	Recruited via undergraduate degrees for course credits	Experimental design, correlational analysis	PDI	Jumping To Conclusions (JTC) beads task with confidence ratings	8	Individuals who were delusion prone, were more confident on the task.

6.5 Discussion

This literature review assessed, evaluated and summarised the relationship between anomalous events, including anomalous perceptual experiences and anomalous (delusional) beliefs, and three types of metacognition: metacognitive ability, metacognitive monitoring and metacognitive sensitivity. Metacognitive ability overall had a lack of direct association with anomalous experiences/beliefs. On the other hand, metacognitive monitoring and metacognitive sensitivity appear to demonstrate similar relationships with anomalous (delusional) beliefs, suggesting they may be assessing similar concepts. A lack of direct association between anomalous perceptual experiences and all three metacognitive components suggests the role of additional factors (e.g. objective performance, or subgroups of individuals with these additional experiences or difficulties) or the relationship may be present for specific types of anomalous perceptual experience.

In terms of metacognitive ability, the three studies demonstrated a lack of direct association with overall anomalous experiences/beliefs. Instead, metacognitive ability may be more likely associated with negative symptomatology (McLeod et al. 2014; Trauelsen et al. 2016) and highly correlated with functioning (Grant & Beck 2009b). There was a positive association between metacognitive ability and positive symptoms, in the presence of trauma (Leonhardt et al. 2015). The role of trauma was previously highlighted within the metacognitive belief literature, as Morrison and Petersen (2003) demonstrated that psychotic experiences may emerge as a coping strategy for trauma. In addition, Morrison and colleagues previously suggested that metacognitive beliefs (measured using Metacognition Questionnaire) were associated with anomalous experiences (Morrison, Haddock, & Tarrier, 1995; Morrison, Wels, & Nothard, 2000), however, once emotional distress has been controlled for, this relationship was weaker (Debbané et al. 2009; Gaweda et al. 2013; Varese et al. 2011). This was later confirmed by systematic literature and meta-analysis (Varese & Bentall 2011).

In terms of metacognitive monitoring, this metacognitive component entails the capacity and willingness to observe one's own mental products, consider alternative explanations and own confidence in one's beliefs (Engh et al. 2010). Metacognitive monitoring was

most closely associated with anomalous (delusional) beliefs in both clinical and non-clinical samples. However, there were some inconsistent findings within this area as some studies demonstrated anomalous (delusional) beliefs were associated with lower self-reflectiveness and other studies suggested self-reflectiveness was not related to these anomalous (delusional) beliefs. It may be suggested that the association between self-reflectiveness and anomalous experiences or delusional beliefs may be a state-like relationship, which changes over time and is particularly prominent in FEP. Future research should aim to consider these associations longitudinally. It also appears that self-certainty may play a role. Whilst this was not considered a metacognitive component (see Gilleen et al., 2016), this form of self-evaluation may have a key role in the maintenance of anomalous (delusional) beliefs.

The relationship between anomalous perceptual experiences and metacognitive monitoring was less clear and mostly absent. Metacognitive monitoring appeared to be associated with individual aspects of anomalous perceptual experiences (e.g. Auditory or speech impairment, ideas of reference, deviant perception and auditory uncertainty; Mass et al., 2012), requiring future research to conduct more detailed assessments of anomalous perceptual experiences. Consideration should be given to the role of confounding variables, e.g. cognitive ability (Engh et al. 2011). Studies outside the scope of the review have previously demonstrated that difficulties with metacognition may be associated with poorer cognitions (Lepage et al. 2008) and anomalous events may occur due to cognitive disturbances (Garety et al. 2001). Following Garety et al.'s (2001) model, if cognitive ability has a role in anomalous experiences, and cognitive ability is associated with metacognition, then it may be expected that anomalous experiences are associated with metacognitive monitoring.

For metacognitive sensitivity, there appears to be some evidence suggesting anomalous (delusional) beliefs are associated with overconfidence in errors. Although future studies need to consider the role of subjective competence and identify whether, in fact, it is metacognitive sensitivity which plays a role in development or maintenance of these beliefs. In terms of anomalous experience, these experiences may be more related to objective performance, although recent studies using ERP (not included within this review) suggest these experiences could be associated with monitoring errors (Chan et al. 2015; Chan et al. 2015).

These results suggest that metacognitive components may be distinct and have independent connections to anomalous experiences and delusional beliefs. Therefore, future studies assessing metacognition should be clear on which metacognitive components are involved, in order to develop appropriate interventions to tackle these metacognitive components.

6.5.1 Studies not included

This review did not include studies on anomalous self-experience, e.g. dissociation, depersonalization or out-of-body experiences, due to the lack of research assessing the relationship with metacognition. Recent research has suggested anomalous self-experiences are associated with positive symptom expression (Brent, Seidman, Thermenos, Holt, & Keshavan, 2014; Nelson & Raballo, 2015; Preti, Cella, Raballo, & Vellante, 2012) so it would be important to empirically test the connection between anomalous self-experiences and metacognition; a relationship considered Dokic & Martin (2012, 2015). This study did not include studies assessing metacognitive processes, using error monitoring (ERP) (Chan et al. 2015) and their association with anomalous perceptual experiences or delusional beliefs. It is unclear whether this is classified as 'metacognition' and the limited number of studies in this area (N=2) meant that conclusions are still tentative. Finally, this review did not include another metacognitive component: metacognitive beliefs. These metacognitive beliefs are positive or negative beliefs about one's own thoughts. The association between metacognitive beliefs and hallucinatory experiences have been explored in a review elsewhere (see Varese and Bentall, 2011).

6.5.2 Limitations and future studies

Metacognition is measured in a variety of different ways and the concept can be elusive and difficult to define. For example, metacognition in some studies involves actively taking part then later reviewing one's abilities (Moritz et al., 2014, 2015), compared to others which involves predicting abilities (Cella et al. 2014). The research area needs a clearer understanding of the connection between the different metacognitive components. Due to this variability in measures, it was not possible to conduct a meta-analysis. Future

reviews could aim to conduct a smaller meta-analysis on this topic to clearly examine the size of the relationship.

Equally, anomalous experiences or delusional beliefs were measured using a variety of assessments; some studies measuring general psychotic symptoms (PANSS) and others using a specific scale of anomalous-perceptual experiences (e.g. Eppendorf Schizophrenia Inventory). Whilst PANSS was the most commonly used scale, many studies typically assessed PANSS positive as a whole, rather than the individual items. This traditionally combines delusions, conceptual disorganization, hallucinations, excitement, grandiosity, suspiciousness/persecution, and hostility into one score (Kay et al. 1987); and in some factor analyses, this includes unusual thought content (van der Gaag et al. 2006). As this literature review describes specific relationships between metacognitive components and anomalous (delusional) beliefs, rather than anomalous perceptual experiences, the combination of various anomalous experiences or delusional beliefs does not allow for researchers to conclusively describe the association with metacognition. Future studies should assess specific anomalous experiences and their association with metacognition.

In terms of the quality assessment, studies including control samples were not always appropriately matched on criteria important for metacognitive skill: such as Age (Palmer et al. 2015), Education, which is demonstrated to be a confound in the overconfidence measure so lower education is associated with overconfidence (Gaweda et al., 2013; Moritz et al., 2014), and IQ, although this was not necessarily correlated with knowledge corruption nor confidence in errors (Moritz et al., 2005). Some studies scored lower as they did not control for educational level of the participants or match IQ between the groups (Engh et al., 2011, 2007; Moritz et al., 2005), which may be a confound when assessing metacognition. Alike to this, studies which included University students only (Carse & Langdon, 2013; Warman & Martin, 2006), may not be directly applicable to psychosis samples. Despite this, studies which matched consistently on age, gender and educational level, demonstrated similar findings to the general consensus (Bruno et al., 2012; Eisenacher et al., 2015; Ekinci et al., 2012).

Within many of the clinical studies, medication was not controlled within the analysis. Antipsychotic medication aims to reduce unusual experiences or dampen the salience of

these experiences (Kapur, 2003) and dopamine is also shown to decrease certainty and confidence (Andreou et al. 2014; Lou et al. 2011). Therefore, studies which included chronic schizophrenia samples, who may have been taking antipsychotics for a longer period of time, may present different associations due to medication rather than anomalous experiences/beliefs per se. Associated with this, a number of studies recruited participants within both in-patient and out-patient units (those within inpatient settings may typically experience higher levels of anomalous experiences compared to a community based sample), but these samples were not differentiated within the studies. Future studies should clearly separate in-patient and community samples.

6.6 Conclusion

This was a large and broad review of the association between anomalous experiences and delusional beliefs with metacognition in both clinical samples (e.g. psychosis), schizotypy and control samples. This review assessed a range of anomalous experiences and delusional beliefs and metacognitive components (ability, monitoring and sensitivity). The studies reviewed demonstrated a relationship between metacognitive ability and anomalous experiences, but factors such as trauma or negative symptoms may play a key role. In terms of metacognitive monitoring, this appeared to be related to anomalous (delusional) beliefs, but less so with anomalous perceptual experiences. Although this may be explained by a state-like relationship between these variables, which may change during the course of psychotic illness and recovery. In terms of metacognitive sensitivity, there appears evidence that anomalous (delusional) beliefs are associated, but future studies need more thorough, controlled assessment surrounding competence or objective performance. This review demonstrates a relationship between anomalous (delusional) beliefs and metacognition, with some evidence for the association with anomalous experiences. Future studies should aim to understand more about which particular aspects of anomalous events are related to these metacognitive components.

NOTE: References at the end of the thesis

7. Understanding the association between anomalous experiences, perceptual biases and metacognitive ability within a non-clinical sample: a pilot study.

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Chapter 7 is a two-part developmental pilot study.

7.1 Abstract

7.1.1 Introduction

Anomalous experiences occur frequently within the general population and these anomalous experiences have been described to be a pre-requisite to positive symptoms. Signal detection theory (SDT) has been used to explain anomalous experiences in psychosis, but, recently, metacognition; appraisals of experience, has been suggested to play a role in maintaining these anomalous experiences. However, studies tend to focus on assessing only the auditory modality.

7.1.2 Methods

This study was a two-part experimental pilot study which investigated the modality-specific association between anomalous experiences, metacognitive efficiency and perceptual biases within 125 non-clinical student controls. These associations were measured using anomalous experience questionnaires and two signal detection tasks, including a metacognitive measure.

7.1.3 Results

This pilot study developed and adapted two metacognitive tasks in a non-clinical group and developed the tasks to be applicable for testing within a clinical sample. This study demonstrated that anomalous perceptual and self-experiences are associated within the general population. However, there was no significant relationship between anomalous experiences and perceptual biases or metacognitive efficiency in this sample. This may be due to the low variance in scores within this heathy sample.

7.1.4 Discussion

The developments from this study will be applied to a large clinical study comparing individuals with FEP with age and education matched controls to assess both between-group differences and anomalous experiences on a continuum.

7.2 Introduction

Anomalous perceptual and self-experiences have been defined in this thesis (see introduction section 1.11) as referring to a rich number of various psychic phenomena. These experiences can be divided into i) anomalous self-experiences; the sense that you are not "real" (distortions in experience of self and being) and ii) anomalous perceptual experiences; hearing sounds which cannot be accounted for by the environment (distortions of sensory events in various modalities; auditory, visual; touch; taste). Anomalous experiences (e.g. hallucinations) most commonly occur within the auditory modality (Waters, Allen, et al. 2012; Shergill et al. 1998; McCarthy-Jones et al. 2017). Visual hallucinations are suggested to represent a more severe psychopathological profile; associated with stress or trauma (Read, Agar, Argyle, & Aderhold, 2003; Waters et al., 2014; Mueser et al., 1990) and commonly co-occurring with auditory hallucinations (McCarthy-Jones et al. 2017). Modality-specific anomalous perceptual experiences can be captured using the new measure: Multimodal Unusual Sensory Experiences Questionnaire (Mitchell et al. 2017), assessing experiences within 6 modalities: visual, auditory, taste, smell, touch, sensed presence. Using this measure, it may be possible to assess modalities of anomalous experiences, to understand their cognitive underpinnings.

Studies using Signal Detection Theory (SDT) have demonstrated that anomalous perceptual experiences are associated with perceptual signal detection biases (Bentall & Slade 1985; Kok et al. 2015), present within both psychosis and psychosis-proneness samples (Mussgay & Hertwig, 1990; Teufel et al., 2015; Teufel, Kingdon, Ingram, Wolpert, & Fletcher, 2010; Varese, Barkus, & Bentall, 2011). However, Varese et al. (2012) demonstrated, within a smaller group of patients with schizophrenia, no significant association between anomalous self-experience (dissociation) and auditory perceptual bias. The lack of association may be due to statistical power, which the authors note as a limitation.

Garety et al. (2001) suggest the role of negative (metacognitive) appraisal of an anomalous experience which leads this to become distressing and, therefore, can lead to positive symptoms of psychosis. Metacognition is considered "thinking about thinking" (Semerari et al. 2003b). Metacognitive sensitivity, measured using confidence ratings

within a certain task (when controlling for objective performance this is termed metacognitive efficiency), has been demonstrated as poor in those with First Episode Psychosis (Davies et al. 2018; Bliksted et al. 2017), those with a propensity to psychotic symptoms (Bhatt et al. 2010), those with a history of hallucinations (Gaweda et al. 2013) and those at high risk (Gawęda et al. 2018). This supports that metacognitive sensitivity/efficiency may contribute to anomalous perceptual experiences. No study has yet assessed the role of metacognitive sensitivity/efficiency on anomalous self-experiences.

However, other studies which have assessed metacognitive sensitivity/efficiency and anomalous perceptual experiences demonstrated no significant association between anomalous experiences and metacognitive sensitivity (Moritz, Woodward, et al. 2006; Kircher et al. 2007; Eifler et al. 2015b). Chapter 6 highlighted the importance of assessing specific types of anomalous experiences and to identify clear associations with metacognitive sensitivity. Both perceptual ability and metacognitive ability are considered to be modality-specific (Segal & Fusella 1970; Fleming et al. 2014) and anomalous perceptual experiences (e.g. hallucinations) can vary in modalities (Mitchell et al. 2017). It is currently unclear whether there is also a modality-specific association between visual perceptual biases/metacognition with visual anomalous-perceptual experiences or whether auditory perpetual biases/metacognition may also predict visual anomalous experiences. Chapter 6 also suggested inconsistences in the literature may be due to additional factors, e.g. subjective competence (Moritz et al. 2015). Following the literature review in chapter 6, metacognitive sensitivity tasks should be designed with appropriate controls to assess metacognition, independent of objective performance. The main aim of the study is to develop two new signal detection tasks (visual and auditory) to capture modality-specific perceptual and metacognitive ability. From Varese et al. (2011), a small to moderate effect size (0.2) is expected for the relationship between anomalous experiences and perceptual biases and metacognitive efficiency within this study. This pilot study will assess associations of interest for a larger clinical study within an FEP sample.

Once developed, these tasks will be assessed within a large clinical sample of individuals with FEP. Signal detection theory studies typically involve a large number of trials (400 trials), as smaller trials (~50 trials) show statistical bias and had higher variance in

measure of *d'* (Barrett et al. 2013; Green, 1966). To ensure the feasibility of conducting this study within a clinical group, who may experience difficulty with attention and concentration (Silverman 1964), the two computer tasks will be developed in order to aid completion and a sensitivity analysis will be conducted to assess the number of trials to include.

7.3 Phase 1 developmental phase

7.3.1 Methods

Participants

All participants were aged between 18 and 65 years, had normal or corrected to normal (with glasses/lenses) hearing and vision and were not currently experiencing mental health difficulties. Participants were recruited through the University of Sussex via word of mouth, University student pool and social media. Non-University students were recruited via word of mouth and social media. Data collection was undertaken between June and September 2016.

Design

This present study was a developmental pilot study. This involved the development of two metacognitive tasks with a pilot phase and a main experimental phase. The first phase aimed to develop the two metacognitive tasks for later testing in a clinical psychosis sample and the second phase aimed to use these developed tasks to assess the relationship associations between perceptual biases, metacognitive ability and anomalous experiences in a healthy non-clinical sample.

Procedure

This study was approved by University of Sussex Cross-School Research Ethics Committee (C-REC) (ER/AW395/7-8, appendix I). All participants provided written informed consent before proceeding with the study. Participants were asked to complete questions on demographics (Date Of Birth, gender, handedness, educational level) anomalous experiences questionnaires and two signal detection tasks (visual and auditory), counterbalanced between participants. Participants were asked for verbal feedback on the experience of completing the task.

Measures

Perceptual bias and metacognitive efficiency

Two experimental tasks were programmed in MATLAB using Cogent 2000. The task stimuli were presented on a Dell Desktop Monitor and participants wore Psyc Wave S1 Wireless Bluetooth Headphones (Psycs1) for the auditory stimulus presentation. The critical task in each paradigm is to make forced-choice binary judgments: A first order judgment of whether a visual or auditory stimulus (dot or tone) was present or absent within a noisy picture or a presentation of white noise, and then a second order judgment of either 'confident' or 'guess' with regard to their confidence.

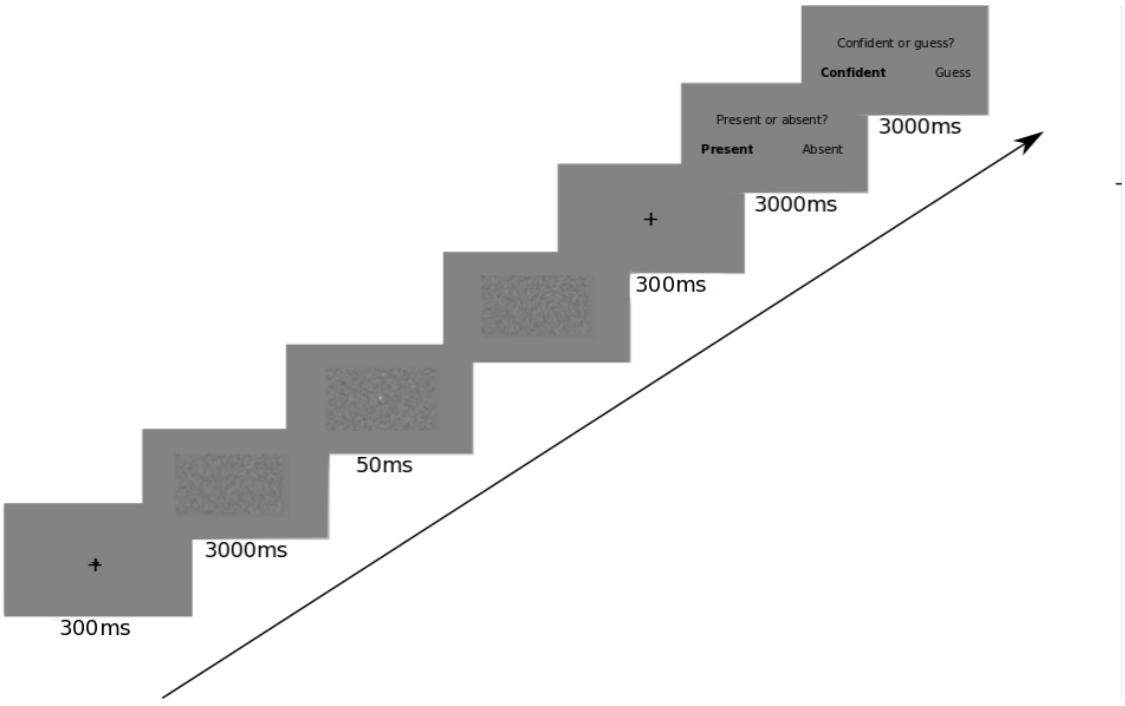
Visual paradigm

Visual perceptual and metacognitive ability was assessed using a computerised visual detection task. The task involved reporting whether a Gaussian dot flashed in the middle of the screen within a display of moving noise. The participants were given a verbal explanation of the task and a demonstration to familiarise them with the task. The main experimental trials began with the presentation of a central fixation cross on a grey background followed by the presentation of moving static noise for 3000ms. In the stimulus present trials only, at a random time during the 3000ms display of moving noise, the Gaussian dot was flashed in the middle of the screen. To ensure the task was a visual detection task, not visual search task, the dot was presented to the fovea in the centre of the screen, associated with attention and raised visual detection thresholds (Juola, 1987; Plainis, Murray & Chauhan, 2001). The contrast of the dot was titrated for each participant at ~67% correct responses, using a staircase procedure which adjusted the dot contrast from a standardized starting contrast. Participants were told prior to starting the task that the probability of the target being present would be 50%. Participants had up to 3000ms to make a decision (present or absent) before the program timed out. No feedback was given. Participants were then asked to indicate either confidence or guess decision. Participants completed 200 trials (see figure 11).

The first judgment captured hits (positive responses given when the stimulus was present), false alarms (positive responses given when the stimulus was absent), misses (negative responses when the stimulus was present), and correct rejections (negative responses when the stimulus was absent). This was used to calculate *perceptual sensitivity*

(*d'*): the ability to correctly report the stimulus (dot/tone) as either present or absent. A higher perceptual sensitivity score suggested better ability to detect stimuli. These four scores can also be used to calculate *perceptual bias* (*B*): the tendency to report one decision over the other, i.e. stating the stimuli was present when it was in-fact absent, or vice versa. A perceptual bias score was calculated according to Bentall and Slade (1985). A score below 1 suggests a bias towards reporting presence when absent and a score above 1 suggests a bias towards reporting absence of stimuli when present. Equally, the second judgment captures the same four scores for confidence which can be used to calculate a score for *metacognitive sensitivity* (meta-*d'*): the ability to discriminate between correct and incorrect judgments. Meta-*d'* greater or less than *d'* indicates metacognition is better or worse than *d'* (Morales et al. 2017). *Metacognitive efficiency* involves taking into account objective performance and is calculated as meta-*d'*/*d'* (metacognitive sensitivity divided by perceptual sensitivity) (Fleming & Lau 2014; Maniscalco & Lau 2012).

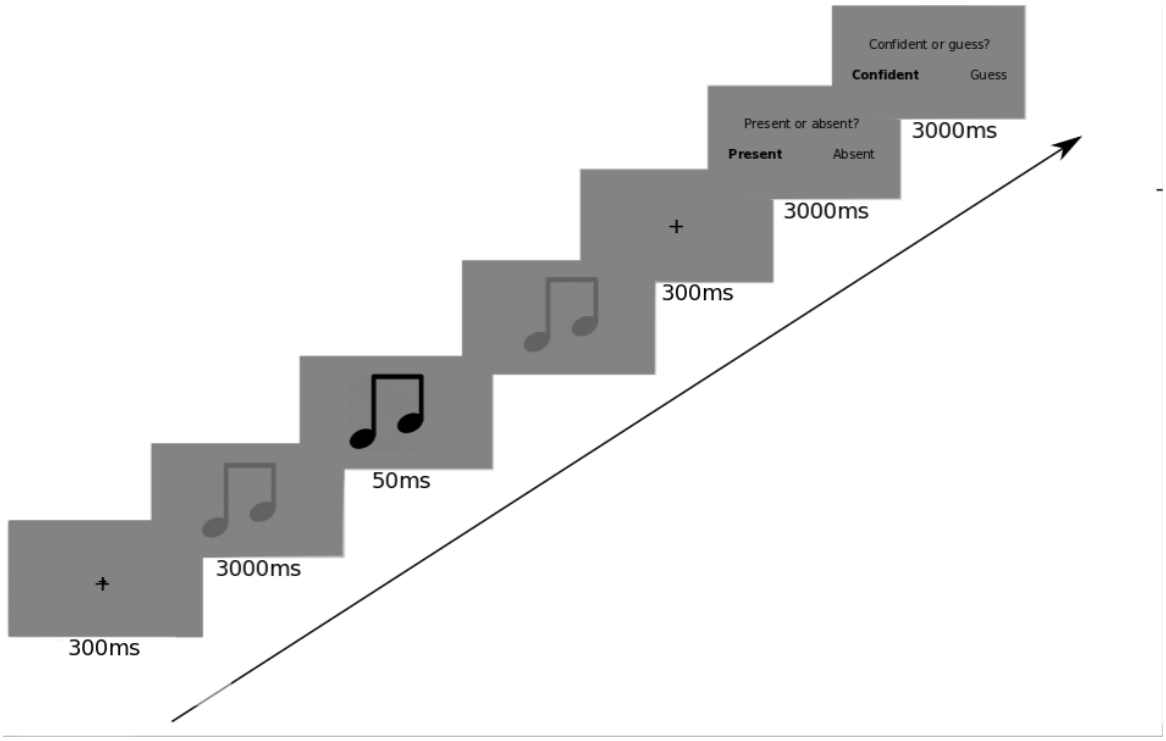
Figure 11: Visual metacognitive paradigm procedure.



Auditory paradigm

Auditory perceptual and metacognitive ability was assessed using a computerised auditory detection task, matched with the visual paradigm in terms of structure, number of trials and procedure. The trials began with a presentation of auditory white noise for 3000ms. In the stimulus present trials only, at a random time during the 3000ms of white noise, a brief tone was presented to both ears. The volume of the tone was titrated at ~67% correct, using a staircase procedure which adjusted the tone volume. Participants responded whether the tone was present or absent and rated their confidence in that decision (high/low confidence). Perceptual sensitivity/biases and metacognitive sensitivity/efficiency scores were also derived from this auditory task. Participants completed 200 trials (see figure 12).

Figure 12: Auditory metacognitive paradigm procedure.



Staircase

The detection tasks required performance to be equated across the participants as this enabled an accurate measurement metacognitive sensitivity, independent of individual performance on the task. This involved ensuring individuals were scoring ~67% level of performance on the main task. This level of performance is standard for metacognitive tasks as this gives an individual the opportunity to detect the stimulus and rate both high

and low confidence. To do this, a staircase procedure was implemented which adjusted the dot contrast or tone volume/contrast, during the main trials, using a standardised starting contrast for all participants. This procedure was done before the main trials to generate a single individualised figure for the starting contrast of the dot or the volume of the tone within the two detection tasks.

The staircase task involved detecting a stimulus (dot or tone) with either a first or second trial, e.g. "did the dot appear in the first or second screen?". The staircase task was slightly different to the main task in order to prevent creating a potential bias towards stimulus-present trials in the main task, as the participant's performance would only be titrated for stimulus-present trials. The staircase procedure, on average, took 63 trials for visual paradigm and 76 trials for auditory paradigm to reach 67% accuracy.

7.3.2 **Results**

Fifty-one participants took part in this phase (*M*=25.08, *SD*=4.36, range 18-37). The majority of the participants were students recruited from University of Sussex. Data collection was undertaken between June and September 2016.

Within the 200 main trials, the objective performance scores (e.g. % of correct responses to present vs. absent) was highly variable and individuals were scoring too high: Visual, (*M*=76%, *SD*=8%, range=56%-89%) and auditory (*M*=75%, *SD*=10%, range=53%-93%). This suggests the staircase procedure at the start of the task did not appropriately titrate performance. This staircase was only used at the start of the task, not throughout. This procedure was insufficient to hold performance constant throughout the task, which impacted on the validity of the metacognitive scores. This was potentially due to the separate titration task being different to the main task which may have resulted in the differences in performance when transferred to the main task (e.g. scores range from 53-93 in the main auditory task). This separate task for the staircase (different compared to the main trials) was used in order to prevent the possibility of titrating the participant's performance only on present trials. Whereas the staircase task (see staircase section), which involved the stimuli being present in either the first or second screen, enabled the titration of both present and absent performance. This avoided a bias in response. To rectify this issue, the staircase procedure was included within the main task itself. This

involved a 1-up-2 down staircase procedure to maintain performance at ~67% throughout the task.

A sensitivity analysis was conducted to assess the number of trials to be included in the main analysis to ensure feasibility for a clinical group, whilst maintaining reliable and valid scores. To do this, we assessed the relationship between visual and auditory sensitivity and bias in 200 trials, 150 trials and 100 trials with the expectation that perceptual sensitivity and bias should not be associated, in order to confirm the number of trials chosen can accurately measure sensitivity, as an independent component to bias. For the auditory task, no significant associations between sensitivity and bias were demonstrated in any of the three groups of trials. For the visual task, a significant association between sensitivity and bias for 100 trials (r=.39, p=.02), for 150 trials (r=.56, p=.01). However, no significant association was demonstrated for 200 trials (p<.05). This suggests the use of 200 trials appears to be most appropriate number of trials.

Participants were asked about their experience in completing the two studies. Some participants noted it was tiresome and suggested the inclusion of more frequent breaks and longer breaks. A previous study using an auditory and visual psychophysical detection task demonstrated the use of breaks (e.g. 10-minute task followed by 5-minute break) restored performance on the task (Arrabito et al. 2015). From this, more breaks were included (1 break every 5 minutes) and breaks were made longer (30-seconds x 4 breaks and 1-minute x 1 break), whilst keeping testing time to a minimum.

7.4 Phase 2 full study

7.4.1 Methods

Participants

The inclusion and exclusion criteria and recruitment strategy was the same as phase 1. Data collection was undertaken between October and December 2016.

Procedure

This study was approved by University of Sussex Cross-School Research Ethics Committee (C-REC) (ER/AW395/7-9). Participants were asked to complete questionnaires on demographic information and anomalous experience scales.

Participants then completed two signal detection tasks (visual and auditory) with the confidence ratings (metacognitive efficiency). See page 115 for full details of the procedure.

Measures

Perceptual bias and metacognitive efficiency

The procedure was the same as phase 1. However, following phase 1, an additional staircase procedure was included within the task (in addition to the staircase before the start of the main trials) which involved a 2-up-1-down procedure to titrate performance at ~67% throughout the task.

Anomalous experience measures

Anomalous self-experiences: Cambridge depersonalisation scale (trait and state versions) (Sierra & Berrios, 2000). The trait version includes 29 items assessing anomalous self-experiences over the last 6 months, with 4 suggested subscales: 'alienation from surroundings', 'anomalous subjective recall', 'emotional numbing' and 'anomalous body experience' (Sierra et al., 2005). For example: "Out of the blue, I feel strange, as if I were not real or as if I were cut off from the world". Participants respond on frequency of each statement, ranging from 0 (never) to 5 (all the time), and the duration of this experience, ranging from 1 (few seconds) to 6 (more than a week). Four scores are calculated from this measure: number of items endorsed (0-29), average frequency (0-5), average duration (1-6), and a total score calculated by summing total scores for both frequency and duration, ranging from 0 to 319. For alienation from surroundings (9 items with total score 0-99), anomalous subjective recall (6 items with total score 0-66), emotional numbing (5 items with total score 0-55) and anomalous body experience (4 items with total score 0-44). This scale demonstrates high internal consistency (>0.6) and good construct validity with Dissociative Experiences Scale (DES) (r= .48*) and with depersonalisation subscale of DES (r= .8***), and good reliability (α= 0.89) (Sierra & Berrios, 2000). This scale is useful for assessing depersonalisation in a schizophrenia group (Perona-Garcelán et al. 2011) and the general population (Perona-Garcelán et al. 2012).

The state version includes 22 items measuring anomalous self-experiences in a 'here and now' rating. The scale includes statements such as "I am feeling so detached from my

thoughts that they seem to have a 'life' of their own". Participants respond on a visual analogue scale from 0-100. Scores range from 0 to 2200 and the total score is used in the analysis. The scale shows validity as it is sensitive to symptom change in depersonalization disorder (Hunter et al. 2005; Jay et al. 2016). Studies have validated this measure in non-clinical participants (Hunter et al. 2013).

Anomalous perceptual experiences: Multimodal Unusual Sensory Experiences Questionnaire (Mitchell et al. 2017) is a 43-item scale measuring anomalous perceptual/sensory experiences with 6 subscales: auditory, visual, smell, taste, bodily sensations, and sensed presence, e.g. auditory: "My ears have played tricks on me". Participants are asked to respond to the statements on a 5 point likert scale from never (0) to frequently (4). Scores are totalled for each modality (auditory [0-28], visual [0-32], smell [0-32], taste [0-32], bodily sensations [0-32], and sensed presence [0-16]). MUSEQ total score is obtained by summing all the subscale scores (0-172). Both the full scale and subscales have been demonstrated as possessing good reliability (auditory r=0.72, visual r=0.72), internal consistency (auditory α=0.82, visual α=0.88), discriminant validity between clinical and non-clinical groups (Cohen's d = 0.96) and construct validity with other anomalous experience scales [e.g. Launay-Slade Hallucination Scale (L-SHS) (*r*= .75**) and Cardiff Anomalous Perception Scale (CAPS) (*r*= .69**)] (Mitchell et al. 2017) . The auditory subscale (7 questions with score total of 28), visual subscale (8 questions with a score total of 32) and total (total of 172) will be used.

Cardiff anomalous perceptions scale (CAPS) (Bell et al. 2006) is a well-established measure used to assess anomalous perceptual experiences within the general population (Bell et al. 2006). This measures a range of anomalous experiences and will be used to validate data from the MUSEQ. This is a 32-item questionnaire asking for a binary judgment of presence and then 3 subscales assessing distress, intrusiveness and frequency of the anomalous experience. For example, "Do you ever notice that sounds are much louder than they would normally be?": yes or no. If the participant answers "yes", they are subsequently asked to rate on three scales, each ranging from 1-5, how distressing, intrusive and frequent those experiences are. Four scores are calculated: total number of items endorsed [0 (low) to 32 (high)], distress (0-160), intrusiveness (0-160), and frequency (0-160) of endorsed experiences. Bell et al. (2006) demonstrated a mean total score for number of items endorsed of 7.3 (S.D=5.8) from the general population, 18.3

for distress, 21.9 for intrusiveness, 18.2 for frequency. Bell, Halligan & Ellis (2006) highlighted that the CAPS has good internal reliability (Cronbach's alpha coefficient of .87) and good test-retest reliability (Cronbach's alpha coefficient of .92) for both clinical and non-clinical samples and also has good convergent validity with the PDI-21 (r=.61*) and O-LIFE (r=.57*) (Bell, Halligan & Ellis, 2006).

7.4.2 **Planned analysis**

Firstly, a correlational matrix will be used to assess the relationship between the anomalous experience scales. Next, regression analyses will be conducted to assess the modality-specific relationship between perceptual biases, metacognition sensitivity/efficiency and the anomalous experience measures. The regression analysis will be used to assess the selective predictions by modality, e.g. between visual perceptual biases and metacognition with visual subscale of MUSEQ, compared to auditory subscale of MUSEQ, to assess the strength of correlation, and vice versa for auditory perceptual biases and metacognition.

7.4.3 **Results**

Seventy-four participants took part. This sample had a mean age of 21.66 (SD=6.67, range 18-55), 14% male (10 males and 64 females) and 96% were right-handed (71 right and 3 left handed). The majority of the participants were students from University of Sussex (85% had A-level qualifications, 21% had a degree-level qualification and 3% had a higher degree qualification).

This study used a strict 1.5 S.D. from the mean performance accuracy as an exclusion threshold for the two tasks. We used the 1.5 S.D. from the mean as a limit for inclusion and exclusion as this allowed for a small amount of flexibility in the performance level, but excluded those scoring too high or too low. This limit was previously used in metacognitive studies (Sherman et al., 2015). Due to the variation in scores within the visual and auditory tasks, the 1.5 S.D. from the mean range resulted in different ranges: auditory task between 56% and 79.9% and visual task between 59% and 78%.

For the visual task, 56 participants were included in the main analysis. For the auditory task, 68 participants were included in the main analysis. As studies using psychophysical

signal detection tasks requires the participant to achieve a specific level of performance to assess metacognitive ability, it is usual to remove ~10% of the participants due to poor performance (Palmer, David & Fleming, 2015; Sherman et al., 2015).

Eight participants scored perfect accuracy on one of the tasks, implying an infinite *d'* for absent trials only. Following current research, there is an adjustment which can be used to avoid infinite values which is common use (Macmillan & Creelman, 2005). This involves converting proportions of 0 and 1 to 1/(2N) and 1-1/(2/N), respectively, where N is the number of trials on which the proportion is based. This strategy was used and resolved the infinity scores. Due to the differences in acceptable ranges for the two metacognitive tasks, auditory and visual task were analysed separately. After these participants were removed from the data analysis, data was checked for skewness and outliers. Data was within acceptable limits.

The new staircase within the task appropriately titrated performance for both tasks: Visual (*M*=68%, *SD*=6%, range=55%-86%) and auditory (*M*=67%, *SD*=6%, range=43%-91%).

Participants were asked about their experience completing the two tasks. Some participants noted that it was difficult to decide whether they were confident or guessing as they felt they were not fully confident, whilst not completely guessing, which led them to commonly choose one decision over the other. It was suggested that the wording could be changed to "high confidence" or "low confidence" to enable opportunity to rate each option.

Correlational analysis

A correlational matrix was conducted to assess the relationship between anomalous experiences for all participants in phase 1 and phase 2 (N=125) (See table 13).

Table 13: Correlational matrix for anomalous experience measures for 125 participants in phase 1 and phase 2.

	CAPS total endorsed	CAPS Distress	CAPS intrusiveness	CAPS frequency	MUSEQ auditory	MUSEQ visual	MUSEQ total	CDS trait total	CDS state total	CDS (trait) ABE	CDS (trait) EN	CDS (trait) ASR	CDS (trait) AFS
CAPS total	1	***r*=.89 *p*<.001**	***r*=.93 *p*<.001**	***r*=.9 *p*<.001**	***r*=.59 *p*<.001**	***r*=.66 *p*<.001**	***r*=.72 *p*<.001**	***r*=.54 *p*<.001**	*r*=.4 *p*<.001	***r*=.5 *p*<.001**	***r*=.51 *p*<.001**	*r*=.49 *p*<.001	*r*=.4 *p*<.001
CAPS distress		1	***r*=.95 *p*<.001**	***r*=.87 *p*<.001**	***r*=.5 *p*<.001**	***r*=.6 *p*<.001**	***r*=.65 *p*<.001**	***r*=.5 *p*<.001**	*r*=.4 *p*<.001	*r*=.49 *p*<.001	*r*=.47 *p*<.001	*r*=.42 *p*<.001	*r*=.36 *p*<.001
CAPS intrusiveness			1	***r*=.9 *p*<.001**	***r*=.56 *p*<.001**	***r*=.62 *p*<.001**	***r*=.65 *p*<.001**	***r*=.5 *p*<.001**	*r*=.4 *p*<.001	*r*=.49 *p*<.001	*r*=.47 *p*<.001	*r*=.42 *p*<.001	*r*=.36 *p*<.001
CAPS frequency				1	***r*=.57 *p*<.001**	***r*=.65 *p*<.001**	***r*=.72 *p*<.001**	***r*=.51 *p*<.001**	*r*=.41 *p*<.001	*r*=.46 *p*<.001	*r*=.49 *p*<.001	*r*=.45 *p*<.001	*r*=.36 *p*<.001
MUSEQ Auditory					1	***r*=.7 *p*<.001**	N/A	*r*=.46 *p*<.001	*r*=.33 *p*<.001	*r*=.41 *p*<.001	*r*=.38 *p*<.001	*r*=.46 *p*<.001	*r*=.43 *p*<.001
MUSEQ Visual						1	N/A	***r*=.51 *p*<.001**	*r*=.34 *p*<.001	*r*=.45 *p*<.001	*r*=.42 *p*<.001	*r*=.49 *p*<.001	*r*=.4 *p*<.001
MUSEQ Total							1	***r*=.55 *p*<.001**	*r*=.37 p<.001	***r*=.5 *p*<.001**	*r*=.47 *p*<.001	***r*=.54 *p*<.001**	*r*=.41 *p*<.001
CDS trait total								1	***r*=.7 *p*<.001**	N/A	N/A	N/A	N/A

CDS state total	1	***r*=.69 *p*<.001**	***r*=.57 *p*<.001**	***r*=.62 *p*<.001**	***r*=.55 *p*<.001**
CDS (trait) ABE		1	***r*=.7 *p*<.001**	***r*=.72 *p*<.001**	***r*=.65 *p*<.001**
CDS (trait) EN			1	***r*=.73 *p*<.001**	***r*=.71 *p*<.001**
CDS (trait) ASR				1	***r*=.68 *p*<.001**

NOTE: CDS ABE = Anomalous Bodily Experience; CDS EN = Emotional Numbing; CDS ASR = Anomalous Subjective Recall; CDS AFS = Alienation From Surroundings. All correlations were significant so **bold** signifies moderate-high correlations, when controlling for multiple comparisons. N/A = Scores are not able to be correlated as they contain the same data, e.g. total vs. subscales of a measure.

Table 14: Descriptive statistics for anomalous experiences in main analysis sample.

	Healthy non-clinical sample (N=74)	**Full sample (125)**
CAPS total (0-32)	9.32 (5.42)	8.5 (5.3)
CAPS distress (0-160)	21.62 (16.84)	19.57 (15.9)
CAPS Intrusiveness (0-160)	25.14 (18.28)	22.52 (17.3)
CAPS frequency (0-160)	18.35 (13.11)	16.9 (12.97)
MUSEQ auditory (0-28)	19.8 (5.9)	18.86 (6.1)
MUSEQ visual (0-32)	18.53 (5.83)	17.91 (6.1)
MUSEQ total (0-172)	92.93 (26.17)	88.8 (27.27)
CDS state total (0-2200)	192.6 (226.4)	164.7 (209.7)
CDS trait total (0-319)	43.3 (35.5)	41.34 (33.5)
CDS trait – anomalous bodily experience (0-99)	9.1 (10.1)	8.59 (9.42)
CDS trait – emotional numbing (0-66)	8.8 (9.25)	8.46 (9.0)
CDS trait – anomalous subjective recall (0-55)	10.14 (7.22)	9.63 (7.05)
CDS trait – alienation from surroundings (0-44)	8.36 (6.84)	8.25 (6.9)

Note: CAPS = Cardiff Anomalous Perceptions Scale; MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale.

Perceptual biases and metacognition

Firstly, descriptive statistics were provided, separately, for the visual and auditory metacognitive paradigm (see table 15).

Table 15: Descriptive statistics for signal detection tasks.

	Visual (N=56)	**Auditory (N=67)**
Perceptual sensitivity	1.09 (S.D .32)	1.09 (.28)
Perceptual bias (increased score = bias towards absent)	.48 (S.D .31)	.56 (.33)
Metacognitive sensitivity	.83 (S.D .31)	.79 (.28)
Metacognitive efficiency	.76 (S.D .22)	.74 (.25)

Note: See section 7.3.1 for details

Next, correlational analysis were conducted to assess the relationship between perceptual biases and metacognition sensitivity/efficiency, separately for the visual and auditory task. For the visual modality, visual perceptual sensitivity was significantly associated with metacognitive sensitivity (r=.68, p<.001) and visual perceptual biases (r=.39, p=.003).

For auditory modality, auditory perceptual sensitivity was significantly associated with metacognitive sensitivity (r=.38, p=.002) and auditory perceptual biases (r=.65, p<.001). Auditory perceptual bias was significantly associated with metacognitive efficiency (r= -.41, p<.001).

Correlational analysis

In order to test the modality-specific relationship between perceptual biases, metacognition sensitivity/efficiency and the anomalous experience measures, regression analyses were conducted (see table 16 and 17). These analyses were conducted separately for each task with visual and auditory anomalous experiences, to assess the selected predictions by modality, e.g. visual perceptual biases and metacognition with MUSEQ visual will be stronger than relationship between to auditory perceptual biases and metacognition with MUSEQ auditory, and CAPS scores as validation.

Visual computer task

Table 16: Pearson correlations between visual perceptual and metacognitive ability with anomalous experience measures.

N=56	**MUSEQ visual**	**MUSEQ auditory**	**MUSEQ total**	**CAPS total endorsed**	**CDS state**	**CDS trait**
Visual perceptual sensitivity	*r*= -.03 *p*=.82	*r*=.07 *p*=.62	*r*= -.08 *p*=.55	*r*= -.17 *p*=.2	*r*= -.02 *p*=.9	*r*= -.1 *p*=.46
Visual perceptual bias	*r*= -.05 *p*=.69	*r*=.07 *p*=.59	*r*= -.05 *p*=.69	*r*= -.14 *p*=.29	*r*=.01 *p*=.96	*r*= -.03 *p*=.83
Visual metacognitive sensitivity	*r*= -.03 *p*=.84	*r*=.03 *p*=.8	*r*= -.12 *p*=.37	*r*= -.14 *p*=.28	*r*= -.1 *p*=.43	*r*=.0 *p*=.99
Visual metacognitive efficiency	*r*= .08 *p*=.57	*r*=.08 *p*=.58	*r*=.05 *p*=.74	*r*=.06 *p*=.67	*r*=.02 *p*=.88	*r*=.2 *p*=.14

CAPS = Cardiff Anomalous Perceptions Scale; MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale.

Auditory computer task

Table 17: Pearson correlations between auditory perceptual and metacognitive ability with anomalous experience measures.

N=67	MUSEQ visual	MUSEQ auditory	MUSEQ total	CAPS total endorsed	CDS state	CDS trait
Auditory perceptual sensitivity	*r*= -.09 *p*=.49	*r*=.02 *p*=.89	*r*= -.07 *p*=.58	*r*= -.06 *p*=.66	*r*= -.1 *p*=.42	*r*= -.06 *p*=.62
Auditory perceptual bias	*r*= -.09 *p*=.5	*r*=-.14 *p*=.26	*r*= -.15 *p*=.22	*r*= -.09 *p*=.45	*r*=-.08 *p*=.54	*r*= -.12 *p*=.35
Auditory metacognitive sensitivity	*r*=.03 *p*=.79	*r*=.09 *p*=.5	*r*= -.02 *p*=.89	*r*= -.02 *p*=.87	*r*= -.1 *p*=.41	*r*=-.11 *p*=.36
Auditory metacognitive efficiency	*r*=.1 *p*=.44	*r*=.07 *p*=.56	*r*=.02 *p*=.87	*r*=-.01 *p*=.94	*r*=-.05 *p*=.71	*r*=-.09 *p*=.49

CAPS = Cardiff Anomalous Perceptions Scale; MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale.

There were no significant relationships between the perceptual/metacognitive measures and anomalous experiences in the non-clinical sample. Due to this, no further regression analyses were conducted.

7.5 Discussion

This two phase pilot study involved the development of two metacognitive signal detection tasks (visual and auditory) in a large sample of non-clinical students. Within the second piloting stage, the relationship between modality-specific perceptual biases and metacognitive ability with anomalous experiences was explored.

7.5.1 **Development of the task**

The staircase procedure was better able to titrate objective performance within phase 2 of this study. However, participants were still performing too high or too low which led to the removal of a number of participants from the main analysis, particularly for the visual task. Participants may have been scoring too high because i) the staircase at the start did not properly converge or ii) the separate staircase task, before the main trials, was significantly more difficult to complete. This meant that the separate staircase procedure may have been a hindrance. From this, the first staircase procedure will be removed, continuing to use the staircase procedure within the main task, following recent metacognition research (Fleming & Dolan 2014; Fleming et al. 2014). The sensitivity analysis in phase 1 suggested the use of 200 trials for appropriate scoring and the removal of the staircase procedure at the start enable us to continue to include 200 trials per paradigm at a maximum of 30 minutes per task. On the other hand, some participants were scoring too low because of i) attention/fatigue, ii) failure to follow instructions or iii) lack of motivation. Studies have demonstrated that providing financial reimbursement may undermine the intrinsic motivation for an activity (Frey & Gotte 1999; Kressler 2003), leading participants to underperform. Future studies should discuss the importance of appropriate effort and involvement with participants to produce valid results.

Whilst this current study was being conducted, the author met with a service user involvement forum; a group of service users who provide consultation on research studies. The group suggested including a large number of trials would not be feasible within a sample of individuals with FEP, due to difficulty with attention and concentration; a documented issue (Silverman 1964). Following this and feedback from this study, we included more frequent and longer breaks within the main trials and the exclusion of staircase procedure, at the start of the task, to ensure each paradigm took 30 minutes to complete.

Another development for this study concerned the confidence rating. The confidence rating within these current signal detection task: “confident” or “guess” were used as they were considered easy for individuals to quickly decide. However, some participants expressed difficulty using these binary ratings as participants noted that they were usually ‘confident’ or ‘slightly confident’, but rarely would state their decision was a complete

'guess'. Previous metacognition measures have used a likert scale (0-7) (Palmer et al. 2015; Fleming et al. 2014). Given the difficulties with a likert scale, e.g. it is unclear what constitutes a difference between a 5 or 6 rating, and the ease of rating for clinical participants, the task will keep the binary rating but alter the names to 'high' or 'low' confidence, to align with up-to-date metacognitive tasks (Maniscalco & Lau 2014; Kok et al. 2015). From these changes, the task could be feasibly conducted in a clinical sample whilst upholding the validity of the task and provides reliable results.

It should be noted that within the main analysis, only 14% were male which is not typical of the psychosis group. Psychosis samples are usually ~70% males, as risk ratios for men to develop schizophrenia relative to women were 1.42 (Aleman et al. 2003), particularly at the start of the illness (Häfner et al. 1995). Females display better metacognitive abilities; unrelated to intelligence or psychopathology (Abu-Akel & Bo 2013), which could have an influenced the results. The next study will include a FEP group and a non-clinical control group who will be matched on gender, age, and educational level to ensure gender differences do not impact the results between the groups.

7.5.2 **Application to theory**

There were high levels of anomalous experience within this non-clinical student sample for both MUSEQ (Mitchell et al. 2017 demonstrated a score in the general population of 77.38 and this study had a score of 88.8) and CAPS scores (Bell et al., 2006 demonstrated a score in the general population of 7.3 and this study had a score of 8.5). This supports the use of these scores in the general population (Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012) and that different anomalous experiences are associated (Nelson et al. 2014). As CAPS is highly associated with MUSEQ, this suggests it is feasible and useful to capture anomalous perceptual experiences using this new measure.

Despite the presence of anomalous perceptual and self-experiences, the results demonstrated no significant association between perceptual biases and metacognitive efficiency with anomalous experiences within this non-clinical sample. This is inconsistent with previous research (Bentall & Slade, 1985; Mussgay & Hertwig, 1990; Varese et al., 2011), but may be due to limited sample size and consequential lack of variance to detect associations. Following this, chapter 8 will explore these associations

within a clinical (FEP) and non-clinical group to enable more variance in the scores, as research has demonstrated those with psychosis have poorer metacognition (Bliksted et al. 2017; Davies et al. 2018) and higher likelihood of perceptual biases (Varese et al., 2012). Following the effect size (.2) from Varese et al. (2012), a sample size calculation with 80% power suggests a sample of 150.

Alternatively, anomalous experiences may be present within the non-clinical group, via an alternative route, e.g. through anxiety (Garety et al., 2001), rather than perceptual biases. Whilst experiencing high levels of anomalous experience, this current sample were not experiencing difficulties with mental health, suggesting presence of a protective factor; high metacognition. A recent study from Rouault, Seow, Gillan, & Fleming (2018) suggested that those within the general population and high anxiety, demonstrated high levels of metacognitive sensitivity/efficiency. This study, alongside Garety et al. (2001) model, suggests that those in the general population with high anxiety may experience more anomalous experiences, but possessing high metacognitive sensitivity may prevent those individuals from experience distress from the experiences or from transitioning into psychotic episode. Whilst this study aimed to exclude those with current mental health difficulties, this was not confirmed using questions. Future studies should include more rigorous screening methods.

7.6 Conclusion

This was a large cross-sectional experimental pilot study assessing the associations between metacognitive efficiency/sensitivity, perceptual biases and anomalous experiences within a non-clinical population. This study demonstrated that anomalous perceptual and self-experiences occur within the general population and are associated. However, the small non-clinical sample size within the main analysis resulted in lack of variance in the perceptual biases and metacognition scores. Moving forward from this study, this pilot study will enable us to conduct this study within a clinical group to assess associations between metacognition and anomalous experience, with more variance in scores.

NOTE: References at the end of the thesis.

8. Perceptual biases, metacognition and their association with anomalous self-experiences in individuals with and without First Episode Psychosis.

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Chapter 8 is written in the format to be submitted in Abnormal Psychology.

Contributions: Abigail Wright, Professor Kathryn Greenwood and Professor David Fowler developed the hypotheses for the study. Professor Barnaby Nelson provided comments on the draft manuscript. Abigail Wright produced the manuscript with reviewing and editing from all authors.

8.1 Abstract

8.1.4 Introduction

Anomalous self-experiences have been described as a prerequisite for anomalous perceptual experiences. Whilst research has proposed that perceptual biases may be associated with the presence of anomalous perceptual experiences, limited research has assessed the association with anomalous self-experiences. These anomalous perceptual experiences may then be metacognitively appraised as distressing, maintaining these experiences and later leading to anomalous (delusional) beliefs. This model of anomalous events may potentially be driven by perceptual biases and metacognitive deficits.

8.1.5 Methods

This cross-sectional study explored the association between perceptual biases, metacognition and anomalous self- and perceptual experiences and delusional beliefs in First Episode Psychosis (FEP) and a matched healthy control sample. Two signal detection tasks (visual and auditory paradigms) were used to measure perceptual sensitivity, bias, metacognitive sensitivity (meta-*d'*) and efficiency (meta-*d'*/*d'*) and anomalous experience measures were used (Multimodal Unusual Sensory Experiences Questionnaire; Cambridge depersonalization scale [state and trait]; Schizotypal Symptom Inventory).

8.1.6 Results

Fifty-eight individuals with FEP and seventy-two healthy controls were included in the main analysis. Increased auditory perceptual biases were significantly associated with increased state and trait anomalous self-experiences, in particular alienation from surroundings and emotional numbing. No significant associations were found between metacognitive efficiency and anomalous experiences.

8.1.7 Discussion

These findings may be consistent with the minimal self-disturbance model of schizophrenia spectrum vulnerability, particularly with the hyperreflexivity concept. The lack of significant association with explicit anomalous perceptual experiences suggests the relationship may be more implicit, related to an underlying causal vulnerability to anomalous experiences.

8.2 Introduction

Anomalous experiences refer to a rich variety of psychic phenomena. These experiences can be divided into three main categories: anomalous self-experiences (distortions in experience of self and being); anomalous perceptual experiences (distortions of sensory events); and anomalous (delusional) beliefs (unusual thoughts or beliefs). Anomalous self-experiences may precede and generate anomalous perceptual experiences (hallucinations) (Nelson, Parnas, & Sass, 2014; Nelson & Raballo, 2015; Raballo, 2012; Raballo, 2017) and anomalous (delusional) beliefs may develop from anomalous perceptual experiences (Corlett, Frith, & Fletcher, 2009; Fletcher & Frith, 2009). These experiences/beliefs may be common within the general population (Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012) but their intensity and/or frequency is increased in those with psychotic or other mental disorders (Brett, Johns, Peters, & McGuire, 2009; Reininghaus et al., 2016; Yung, Phillips, Yuen, & McGorry, 2004). Therefore, understanding the cause of such experiences may be important for understanding factors that drive the onset of psychosis. As existing models suggest that these anomalous experiences/beliefs work in a hierarchy, it is important to understand anomalous self-experiences (the foundational level of this hierarchy) first.

Studies have suggested anomalous self-experiences may be explained by the following factors: perceptual biases (Varese, Barkus, & Bentall, 2011), e.g. perceiving a stimulus (a voice) as present when it was absent; source-monitoring deficits (Nelson, Whitford, Lavoie, & Sass, 2014), e.g. difficulties in the internal monitoring and comparator system (Frith, 1987; Frith 1992; Blakemore et al. 1999); and aberrant salience (Nelson, Whitford, Lavoie, & Sass, 2014b), e.g. difficulty in failing to suppress attention to irrelevant or familiar information (Hemsley, 1993). The aberrant salience hypothesis suggested that aspects of the environment are more salient in order to help the individual avoid threatening situations (Dodgson & Gordon, 2009). This aberrant salience may, in fact, at times lead to perceptual biases, which have been tested using signal detection theory (SDT). SDT studies have demonstrated that anomalous experiences are associated with perceptual signal detection biases (Bentall & Slade, 1985; Kok, Kouider, Lange & Supe, 2015; Barkus et al., 2010; Mussgay & Hertwig, 1990). These studies also highlight that those with psychosis have a lower threshold for accepting a stimulus as present (Moritz,

Woodward, Jelinek, & Klinge, 2008; Moritz et al., 2017; Veckenstedt et al., 2011), which has recently been associated with aberrant salience in vivo (Reininghaus et al., 2018).

Together, these neurocognitive factors (aberrant salience, source-monitoring deficits, and perceptual biases) may contribute to i) diminished self-presence, i.e. a weakened sense of existing as a *subject* of awareness and ii) hyperreflexivity, i.e. a heightened awareness of or attention to aspects of experience that are normally implicit (Nelson et al., 2014a, 2014b). This has been recently described in a bio-pheno-social model of anomalous self-experiences (Sass, Borda, Madeira, Pienkos and Nelson, 2018). This model suggests the role of "primary" hyper-reflexivity or diminished self-presence, as a result of salience/bias, can undermine an individual's sense of being grounded within a shared world and is likely to alienate the self, possibly leading to an array of "secondary" anomalous self-experiences (varieties of depersonalisation, disturbances in stream of consciousness, distorted bodily experiences and existential reorientation (Nelson, Sass, & Škodlar, 2009; Sass & Parnas, 2017). As a result of the perceptual biases and diminished self-presence/hyperreflexivity an individual overly focuses on (generally implicit) bodily sensations (*anomalous bodily experiences*), may find it difficult to make sense of their surroundings or previous events, as there is an overload of information (*alienation from surroundings; anomalous subjective recall*) and may therefore downregulate emotional responsivity in order to prevent overstimulation or distress (*emotional numbing*) (Sierra, Baker, Medford, & David, 2005).

Anomalous self-experiences are suggested to give rise to anomalous perceptual experiences (Nelson, Parnas, & Sass, 2014; Raballo, 2017; Raballo & Preti, 2018a) as these experiences become strengthened and thematized (Raballo, 2012; Raballo & Preti, 2018b). Hemsley (1993) described the presence of anomalous perceptual experience as a "weakening" of top-down influences, leading to a mismatch between top-down and bottom-up processing (John & Hemsley, 1992; Gray, 1995). Predictive processing framework has been used to explain how individuals understand or interpret their environment or experiences, using a combination of bottom-up and top-down processes. These models have suggested that, within psychosis, there is a disruption in this predictive coding in such that there is a weakening of use of prior beliefs and overrelliance on sensory occurrences (Sterzer et al., 2018). This loss of top-down predictions leads extra weight to be given to external influences which means everything becomes salient and

surprising to the individual (Adams et al., 2013). This results in ambiguous sensory processing and may explain the presence of perceptual biases. Auditory perceptual biases are higher in a group of individuals with schizophrenia and hallucinations than those with schizophrenia and no hallucinations (Varese, Barkus, & Bentall, 2012), suggesting a specific association with hallucinatory experiences. Therefore, anomalous perceptual experiences may be predicted by perceptual biases, via anomalous self-experiences, or directly.

In comparison to anomalous self-experiences, anomalous perceptual experiences are more explicit and can be modality-specific; occurring in a variety of modalities, e.g. visual, auditory, gustatory, olfactory, and touch. For example: "I have heard my phone ring then found it wasn't ringing at all" or "I have looked at a pattern object and a figure or face has emerged" (Mitchell et al., 2017). These experiences involve an aspect of (metacognitive) appraisal to understand the experience. Metacognition is defined as "thinking about thinking" (Flavell, 1979; Semerari et al., 2003) and an appraisal of cognitive processes, self, abilities and experiences (Nelson & Narens, 1990). Metacognitive efficiency, assessed by within-task confidence ratings, has been shown to be significantly poorer in psychosis compared to a control group (Bliksted et al., 2017; Davies et al., 2018) and those with psychosis have a tendency to be overconfident in incorrect responses (metacognitive bias) (Gaweda, Woodward, Moritz, & Kokoszka, 2013; Gaweda, Holas, Kokoszka, & Gaweda, 2012). These metacognitive deficits are present in those with a history of hallucinations (Gaweda et al., 2013) and those at high risk (Gawęda et al., 2018). This suggests the role of perceptual biases and metacognitive sensitivity/efficiency in psychosis and anomalous experiences.

However, this research has not been consistent (see Chan, Spencer, West, Viegas and Bedwell, 2015; Gaweda et al., 2013). The inconsistencies in this area may be due to varying experimental controls across the tasks, e.g. subjective competence of the task; shown to exaggerate metacognitive deficits (Moritz et al., 2015), and objective performance; associated with anomalous perceptual experiences (hallucinations) (Gaweda, Woodward, Moritz and Kokoszka, 2013). The lack of experimental control of the objective performance, in order to accurately assess metacognition, which may have impacted metacognitive efficiency scores (Balzan, Woodward, Delfabbro, & Moritz, 2016; Fleming & Lau, 2014). In addition, perceptual ability/metacognition can be

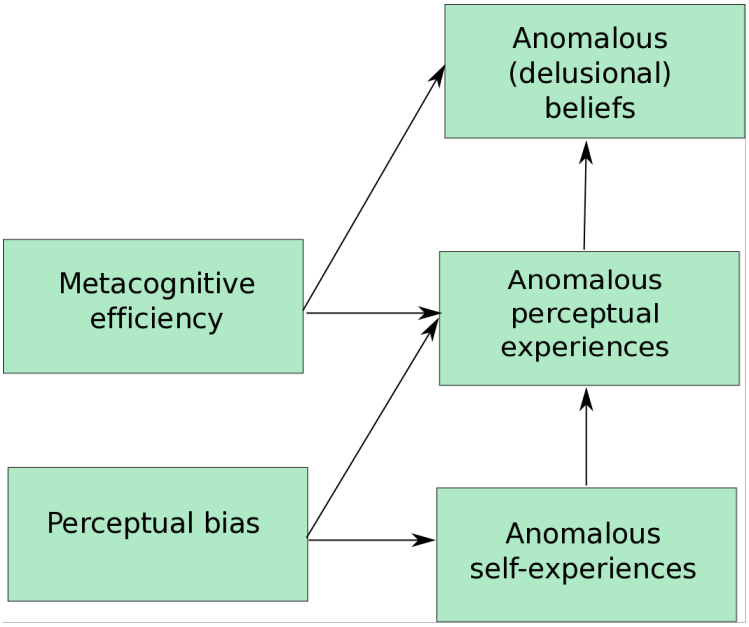
modality-specific abilities (Fleming, Ryu, Golfinos, & Blackmon, 2014; Morales, Lau, & Fleming, 2017) and anomalous perceptual experiences can occur across several modalities (see Mitchell et al., 2017). It may be suggested that as experiences become more explicit or conscious, there may be potential for a modality-specific association between perceptual biases, metacognition and anomalous perceptual experiences.

Metacognitive appraisal not only maintains the anomalous perceptual experience but, later, this higher-level, metacognitive strategy may be used to interpret the anomalous perceptual experiences (Corlett et al., 2007). The interpretation of these anomalous experiences as distressing can lead to anomalous (delusional) beliefs (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001), e.g. paranoia (Maher, 1974; 1988; 2005). This hierarchical framework from anomalous experiences to beliefs has been suggested by many theories (Corlett et al., 2009; Fletcher & Frith, 2009; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002). Therefore, metacognitive efficiency may also predict anomalous (delusional) beliefs; supported by current research (Cella, Swan, Medin, Reeder, & Wykes, 2014; Moritz et al., 2014; Moritz, Woodward, & Moritz, 2006; Moritz, Woodward, Whitman, & Cuttler, 2005; Warman, 2008). Paranoia is particularly of interest as it is most commonly experienced in psychosis and in the general population (Freeman et al., 2011; Freeman et al., 2002; Hemsley & Garety, 1986) and Moritz et al. (2015) has demonstrated that metacognitive errors were present in paranoia-prone individuals. This highlights the potential importance of metacognition for anomalous (delusional) beliefs.

Integrating this research, it may be suggested that anomalous self- and perceptual experiences and delusional beliefs are associated within a hierarchical framework. It is hypothesized that there is an indirect relationship between anomalous self-experience and anomalous (delusional) belief, mediated by anomalous perceptual experiences. It is hypothesized that anomalous self-experiences may be predicted by perceptual biases and hyperreflexivity. Then, as anomalous self-experiences may predict anomalous perceptual experiences, it is hypothesized that there is an association between perceptual biases and anomalous perceptual experiences. These anomalous perceptual experiences may be metacognitively interpreted and if metacognition is poor then these may be interpreted as distressing or unwanted, leading to anomalous (delusional) beliefs. As experiences become more explicit/conscious, it is hypothesised that there is a modality-specific

association; visual perceptual biases and metacognitive efficiency may be associated with anomalous visual experiences and auditory perceptual biases and metacognitive efficiency may be associated with auditory anomalous experiences (see figure 13).

Figure 13: Proposed theoretical model for the associations between anomalous self- and perceptual experiences, anomalous delusional beliefs, perceptual biases and metacognitive efficiency.



8.3 **Methods**

8.3.1 Design

This present study involved a cross-sectional design with experimental tasks and questionnaires to investigate the association between perceptual biases, metacognition and anomalous self- experiences, anomalous perceptual experiences, and delusional experiences in FEP and healthy controls matched on age, gender and education level.

8.3.2 Procedure

Ethical and Health Research Authority approval was obtained through Camberwell St. Giles Research Ethics Committee (reference number: 17/LO/0055, appendix F and G). All participants provided informed consent to take part. Participants were asked to complete two signal detection tasks, counterbalanced between participants. They also

completed additional measures, which can be reviewed in Wright, Fowler and Greenwood (2018) (chapter 2).

8.3.3 Participants

Individuals with psychosis were recruited through a convenience sample from Early Intervention in Psychosis services in Sussex Partnership NHS Foundation Trust, and a minority were re-recruited from a previous first episode psychosis (FEP) sample (Davies, Fowler & Greenwood, 2017). All had been given a formal diagnosis of First Episode Psychosis (F29), including both affective and non-affective psychosis, by a psychiatrist at entry into the study. As this study involved re-contacting individuals from an early cohort study, one participant was above the 18-40 range. Participants with primary diagnoses of substance misuse disorder or organic neurological impairment were excluded. Healthy control participants were recruited as a comparison group, matched with the FEP group on age and gender (Table 18 provides information on difference statistics). Participants with current mental health problems or family history of psychosis were excluded following screening questions. Data collection was undertaken between March 2017 and May 2018.

8.3.4 Measures

Anomalous experience measures

Anomalous self-experiences: Cambridge depersonalisation scale (trait and state versions) (Sierra & Berrios, 2000). The trait version includes 29 items assessing anomalous self-experiences over the last 6 months, with 4 suggested subscales: 'alienation from surroundings', 'anomalous subjective recall', 'emotional numbing' and 'anomalous body experience' (Sierra et al., 2005). For example: "Out of the blue, I feel strange, as if I were not real or as if I were cut off from the world". Participants respond on frequency of each statement, ranging from 0 (never) to 5 (all the time), and the duration of this experience, ranging from 1 (few seconds) to 6 (more than a week). Four scores are calculated from this measure: number of items endorsed (0-29), average frequency (0-5), average duration (1-6), and a total score calculated by summing total scores for both frequency and duration, ranging from 0 to 319. For alienation from surroundings (9 items with total score 0-99), anomalous subjective recall (6 items with total score 0-66), emotional numbing (5 items with total score 0-55) and anomalous body experience (4 items with

total score 0-44). Psychometrics and further details of this measure (and all others below) can found in the protocol paper in BMJ open (Wright et al., 2018). The state version includes 22 items measuring anomalous self-experiences in a 'here and now' rating. The scale includes statements such as "I am feeling so detached from my thoughts that they seem to have a 'life' of their own". Participants respond on a visual analogue scale from 0-100. Scores range from 0 to 2200 and the total score is used in the analysis.

Anomalous perceptual experiences: Multimodal Unusual Sensory Experiences Questionnaire (Mitchell et al., 2017) is a 43-item scale measuring anomalous perceptual/sensory experiences with 6 subscales: auditory, visual, smell, taste, bodily sensations, and sensed presence, e.g. auditory: "My ears have played tricks on me". Participants are asked to respond to the statements on a 5 point likert scale from never (0) to frequently (4). Scores are totaled for each modality (auditory [0-28], visual [0-32], smell [0-32], taste [0-32], bodily sensations [0-32], and sensed presence [0-16]). MUSEQ total score is obtained by summing all the subscale scores (0-172). The auditory subscale (7 questions with score total of 28), visual subscale (8 questions with a score total of 32) and total (total of 172) was used.

Anomalous (delusional) beliefs: Schizotypal Symptom Inventory (Hodgekins et al., 2012). This is a 20-item measure assessing subthreshold psychotic symptoms which provides a total score with separate subscales for paranoia, anomalous experience and social anxiety (Hodgekins et al., 2012). Participants are asked to rate statements or questions on a five-point Likert scale to assess the recent frequency of each item (0 = not at all, 1 = occasionally, 2 = sometimes, 3 = often, 4 = all of the time). Scores on the SSI range from 0 to 296. This study used the paranoia subscale [6 items with a score total of 24 (e.g. "I often feel that others have it in for me").

Symptom measure

Positive and Negative Syndrome Scale (Kay & Fiszbein, 1987) (clinical participants only) is the mostly widely used standardised instrument for assessing symptom severity in schizophrenia (Hermes, Sokoloff, Scott Stroup, & Rosenheck, 2012). This measure provides three separate scores for positive and negative symptoms and general psychopathology.

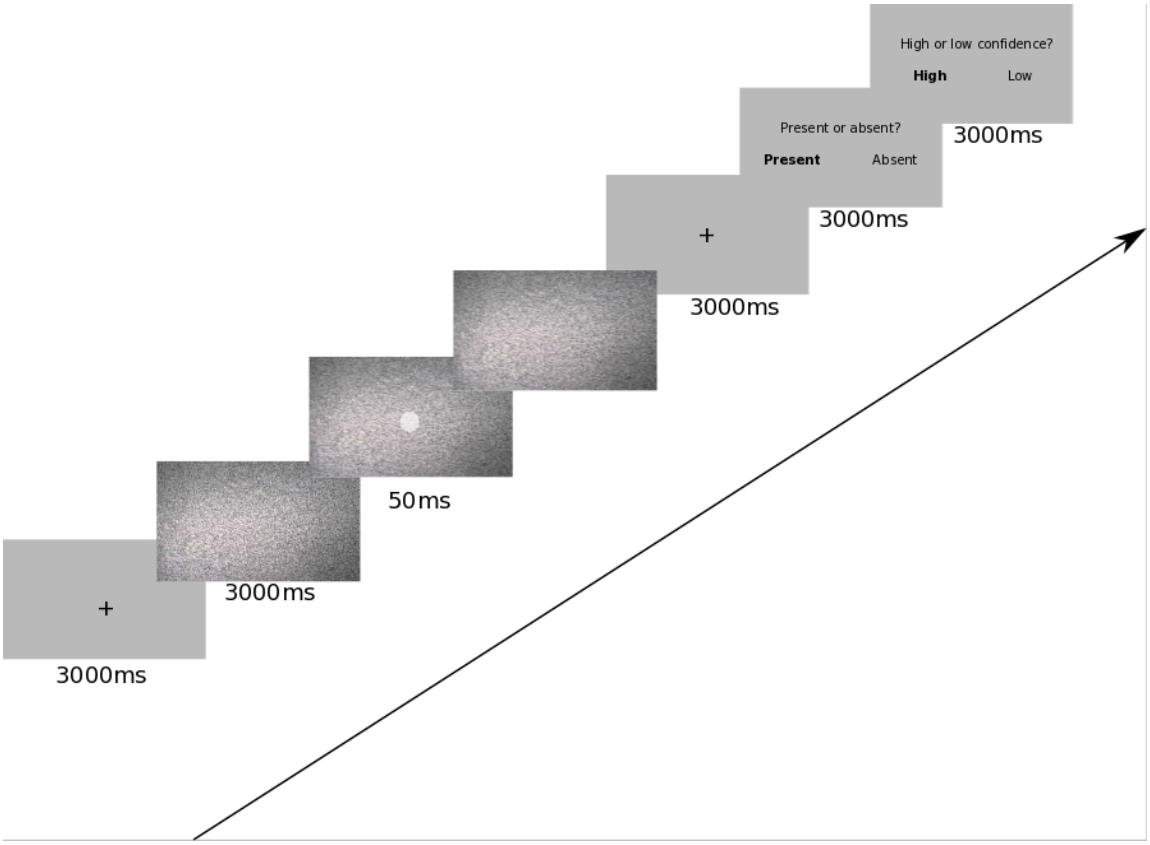
Perceptual biases and metacognitive efficiency

Experimental tasks were programmed in MATLAB using Cogent 2000. The task stimuli were presented on a Dell Laptop and participants wore Psyc Wave S1 Wireless Bluetooth Headphones (Psycs1) for the auditory stimulus presentation.

Visual paradigm

Visual perceptual biases and metacognitive efficiency were assessed using a computerised visual detection task. The task involved reporting whether a Gaussian dot flashed in the middle of the screen within a display of moving visual noise. The participants were given a verbal explanation of the task and a demonstration to familiarise them with the task. The main experimental trials began with the presentation of a central fixation cross on a grey background followed by the presentation of moving static noise for 3000ms. In the stimulus present trials only, at a random time during the 3000ms display of moving noise, the Gaussian dot was flashed in the middle of the screen. The contrast of the dot was titrated for each participant at ~67% correct responses, using a staircase procedure which adjusted the dot contrast with a standardized starting contrast. Participants were told prior to starting the task that the probability of the target being present would be 50%. Participants had up to 3000ms to make a decision (present or absent) before the program timed out. No feedback was given. Participants were then asked to indicate either high or low confidence decision (see figure 14).

Figure 14: Visual detection metacognitive paradigm.



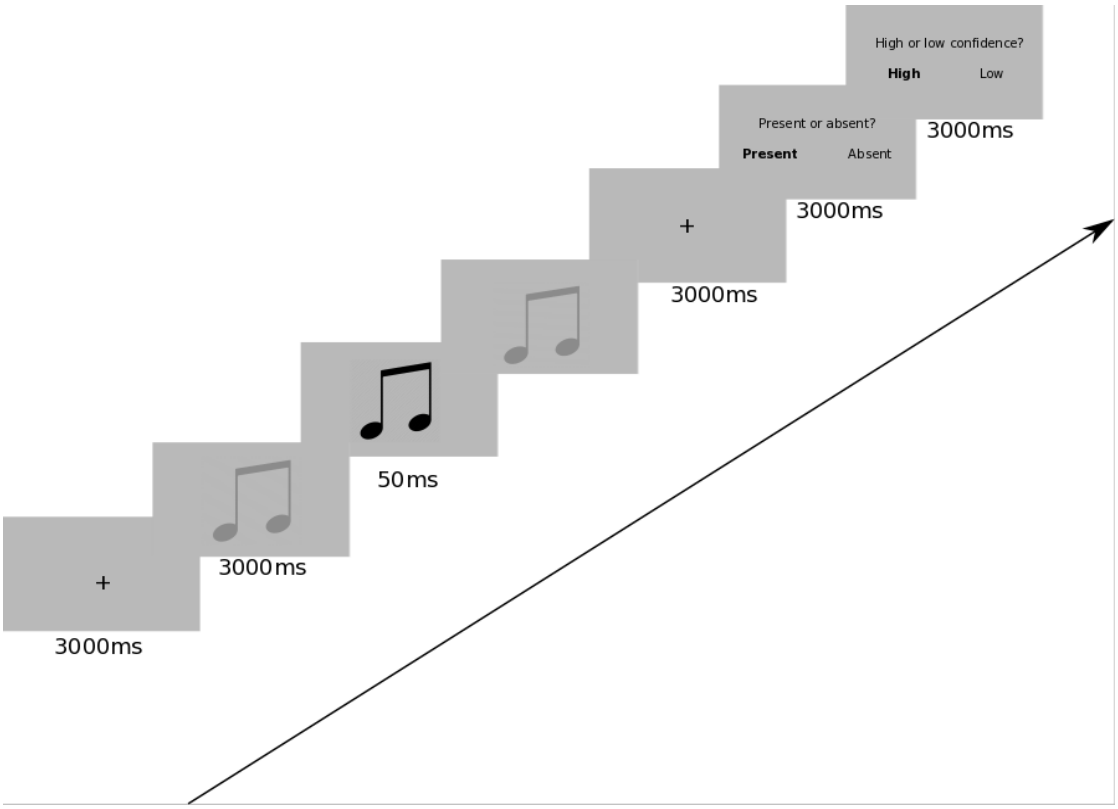
The first judgment captured hits (positive responses given when the stimulus was present), false alarms (positive responses given when the stimulus was absent), misses (negative responses when the stimulus was present), and correct rejections (negative responses when the stimulus was absent). This was used to calculate perceptual sensitivity (*d'*): the ability to correctly report the stimulus (dot/tone) as either present or absent. A higher perceptual sensitivity score suggested better ability to detect the stimulus. These four scores can also be used to calculate perceptual bias (B): the tendency to report one decision over the other, i.e. stating the stimuli was present when it was in fact absent, or vice versa. A perceptual bias score was calculated according to Bentall and Slade (1985). A score below 1 suggests a bias towards reporting presence when absent and a score above 1 suggests a bias towards reporting absent of stimuli when present. Equally, the second judgment captures the same four scores for confidence which can be used to calculate a score for metacognitive sensitivity (meta-*d'*): the ability to discriminate between correct and incorrect judgments. Meta-*d'* greater or less than *d'* indicates metacognition is better or worse than d' (Morales et al., 2017). Metacognitive efficiency involves taking into account objective performance (Fleming & Lau, 2014; Maniscalco

& Lau, 2012), and is calculated as meta-*d'*/*d'* (metacognitive sensitivity divided by perceptual sensitivity) (Rounis, Maniscalco, Rothwell, Passingham, & Lau, 2010).

Auditory paradigm

Auditory perceptual biases and metacognitive efficiency were assessed using a computerised auditory detection task, matched with the visual paradigm in terms of structure, number of trials and procedure. The trials began with a presentation of auditory white noise for 3000ms. In the stimulus present trials only, at a random time during the 3000ms of white noise, a brief tone was presented to both ears. The volume of the tone was titrated at ~67% correct, using a staircase procedure which adjusted the tone volume. Participants responded whether the tone was present or absent and rated their confidence in that decision (high/low confidence). Perceptual sensitivity/biases and metacognitive sensitivity/efficiency scores were also derived from this auditory task (see figure 15).

Figure 15: Auditory detection metacognitive paradigm.



8.4 Planned analysis

A correlational matrix assessed the relationship between the anomalous self- and perceptual experiences and delusional beliefs within the full sample. A mediation model was used to explore the indirect relationship between anomalous self-experience and anomalous (delusional) beliefs to confirm this hierarchical framework. Next, correlational analysis were used to assess the relationship between perceptual biases, metacognition sensitivity/efficiency and the anomalous experience/beliefs measures. A Bonferroni-corrected p-value (in this case, p-value divided by the total number of comparisons, Weissten, n.d) accounted for multiple comparisons. Multiple regression analyses were conducted to assess the role of perceptual biases on anomalous experiences/beliefs, whilst controlling for perceptual sensitivity.

8.5 Results

Missing data

Five participants did not complete both metacognitive tasks (4 FEP and 1 control), due to an inability to finish assessment or not consenting to the tasks. A threshold cut-off for performance above or below 61-71% for both auditory and visual task as this was within 1.5 to 2 S.D from the mean [Visual (*M*=65.7%, *SD*=2.5, range=59%-73%); Auditory (*M*=64%, *SD*=5%, range=49%-92%)]. This was considered an appropriate threshold for signal detection tasks that have assessed metacognitive efficiency (Sherman et al., 2015) (see appendix E for additional information). Data from 58 FEP and 72 healthy control participants were used for analysis.

Sample characteristics

Data was analysed from 58 FEP and 72 healthy control participants. Thirty-eight FEP participants were using psychotropic medication.

Table 18: Sample characteristics and descriptive statistics summary table.

	FEP (N=58)	**Healthy Control (N=72)**	**Difference tests**
Age, yrs. (SD)	27.17 (S.D 1.3) range 18-43	25.7 (S.D 6.6) range 18-40	*t*(128) -1.34,p=.18
Gender M/F (% males)	42/16 (72%)	51/21 (71%)	$\chi^2(1, N = 128) = .04$, *p*=.84
Education (level, %)	No qualifications-GCSE: 33% A-levels: 37% Degree or higher: 30%[15]	No qualifications-GCSE: 8% A-levels: 64% Degree or higher: 28%	**χ^2 (2, N = 129) = 14.79, *p*=.01**
2-part IQ	105.32 (S.D 14.9)	106.2 (S.D 10.75)	*t*(124) -.38, *p*=.7
MUSEQ Auditory (0-28)	19.2 (7.2)	17.9 (5.64)	*t*(106.1) 1.21, *p*=.24
MUSEQ Visual (0-28)	18.3 (8.0)	16.7 (5.8)	*t*(100.7) 1.37 *p*=.17
MUSEQ full total (0-172)	89.7 (34.8)	86.0 (26.2)	*t*(128) .69, *p*=.49
CDS trait total (0-319)	49.95 (45.2)	40.7 (28.9)	*t*(93.0) 1.41, *p*=.16
CDS state total (0-2200)	185.9 (255.5)	87.4 (125.2)	***t*(77.12) 2.87, *p*=.01**
CDS trait ABE (0-44)	11.2 (13.8)	8.9 (9.11)	*t*(94.9) 1.09, *p*=.28
CDS trait EN (0-55)	10.9 (10.4)	8.89 (7.8)	*t*(128) 1.28, *p*=.2

[15] Due to the way educational level was measured and the assumptions of Chi-Square tests, we had to collapse the groups into GCSE (no qualifications or GCSE-level), A-levels, Degree (degree or higher degree). 1 FEP participant preferred not to state but this was removed from this analysis.

CDS trait ASR (0-66)	10.6 (8.9)	8.96 (6.6)	*t*(103.2) 1.17, *p*=.24
CDS trait AFS (0-99)	10.6 (10.1)	7.9 (6.0)	*t*(88.3) 1.83, *p*=.07
SSI paranoia (0-24)	12.98 (6.0)	11.1 (4.0)	***t*(95.5) 2.05, *p*=.04**

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; ABE = Anomalous Bodily Experiences; EN = Emotional Numbing; ASR = Anomalous Subjective Recall; AFS = Alienation From Surroundings; SSI = Schizotypal Symptom Inventory. **Bold**: These ANOVAs were significant.

Anomalous experience measures

A correlation matrix was created for association between anomalous self- and perceptual experiences and delusional beliefs measures in the full sample (See table 19).

Table 19: Correlation matrix for associations between anomalous experiences measures in the full sample.

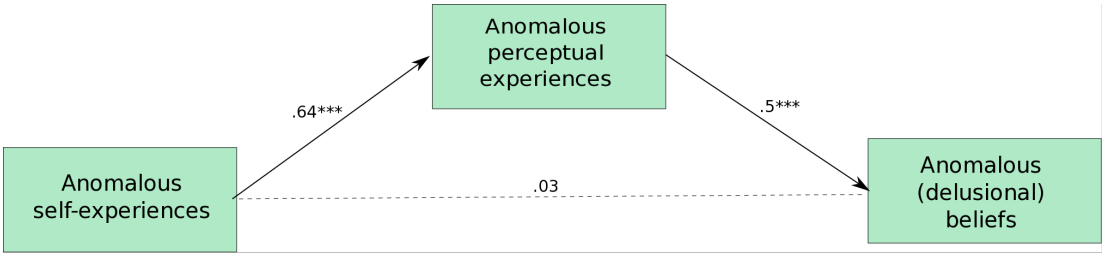
N=130	MUSEQ Auditory	MUSEQ Visual	MUSEQ Total	CDS state total	CDS trait total	CDS ABE	CDS EN	CDS ASR	CDS AFS	SSI Paranoia	SSI Anomalous experiences
MUSEQ Auditory	1	***r*=.77 *p*<.001**	***r*=.81 *p*<.001**	***r*=.43 *p*<.001**	***r*=.54 *p*<.001**	***r*=.43 *p*<.001**	***r*=.47 *p*<.001**	***r*=.52 *p*<.001**	***r*=.49 *p*<.001**	***r*=.54 *p*<.001**	***r*=.56 *p*<.001**
MUSEQ Visual		1	**N/A**	***r*=.44 *p*<.001**	***r*=.56 *p*<.001**	***r*=.55 *p*<.001**	***r*=.46 *p*<.001**	***r*=.46 *p*<.001**	***r*=.48 *p*<.001**	***r*=.54 *p*<.001**	***r*=.65 *p*<.001**
MUSEQ Total			1	***r*=.48 *p*<.001**	***r*=.64 *p*<.001**	**r=.58 *p*<.001**	***r*=.55 *p*<.001**	***r*=.58 *p*<.001**	***r*=.5 *p*<.001**	***r*=.57 *p*<.001**	***r*=.65 *p*<.001**
CDS state total				1	***r*=.6 *p*<.001**	***r*=.5 *p*<.001**	***r*=.47 *p*<.001**	***r*=.55 *p*<.001**	***r*=.57 *p*<.001**	***r*=.43 *p*<.001**	***r*=.59 *p*<.001**
CDS trait total					1	N/A	N/A	N/A	N/A	***r*=.45 *p*<.001**	***r*=.49 *p*<.001**
CDS (trait) ABE						1	***r*=.69 *p*<.001**	***r*=.64 *p*<.001**	***r*=.69 *p*<.001**	***r*=.35 *p*<.001**	***r*=.42 *p*<.001**
CDS (trait) EN							1	***r*=.73 *p*<.001**	***r*=.74 *p*<.001**	***r*=.42 *p*<.001**	***r*=.37 *p*<.001**
CDS (trait) ASR								1	***r*=.66 *p*<.001**	***r*=.48 *p*<.001**	***r*=.58 *p*<.001**
CDS (trait) AFS									1	***r*=.38 *p*<.001**	***r*=.44 *p*<.001**
SSI Paranoia										1	***r*=.6 *p*<.001**

Note: MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; CDS ABE = Anomalous Bodily Experience; CDS EN = Emotional Numbing; CDS ASR = Anomalous Subjective Recall; CDS AFS = Alienation From Surroundings; SSI = Schizotypal Symptom Inventory.

Mediation model

A mediation analysis was conducted using Mplus with Multiple Mediation Model (structural equation modelling) using Maximum Likelihood Estimation (MLE), bootstrapping and corrected confidence intervals, following Preacher and Hayes (2008) causal steps of mediation. This mediation model was used to identify the indirect mediating effect of anomalous perceptual experiences between anomalous self-experience and anomalous (delusional) beliefs to confirm a hierarchical framework within the full sample. All scores were converted to z scores using sample means and standard deviations. Significant direct pathways were found between anomalous self-experience and anomalous perceptual experience (β=.64, p<.001) and anomalous perceptual experiences and anomalous (delusional) beliefs (β=.5, p<.001). Anomalous perceptual experiences significantly and fully mediated the relationship between anomalous self-experiences and anomalous (delusional) beliefs (β = .32, p<.001, ±95% CI [0.19, 0.45]). The pathway between anomalous self-experience and anomalous delusional beliefs was non-significant (p>.05) (see figure 16).

Figure 16: Mediation model for anomalous self-experiences, anomalous perpetual experiences and anomalous (delusional) beliefs within the full sample (N=130).



Comparison between groups

Table 20 reported ANOVAs used to assess the differences in perceptual sensitivity, bias, metacognitive sensitivity and efficiency across FEP and healthy control groups.

Table 20: Descriptive statistics for the two signal detection tasks, with difference tests.

	FEP sample (N=58)	Healthy control sample (N=72)	Difference tests
Visual perceptual sensitivity[16]	1.25 (S.D .33)	1.09 (S.D .39)	$F(1, 117)= 3.65, p=.059$
Visual perceptual bias (increased score = bias towards absent)[17]	.76 (S.D .35)	.74 (S.D .38)	$F(1, 117)= .97, p=.33$
Visual metacognitive sensitivity	.69 (S.D .42)	.78 (S.D .37)	$F(1, 117)= .09, p=.77$
Visual metacognitive efficiency	.58 (S.D .37)	.7 (S.D .33)	$F(1, 117)= 1.44, p=.23$
Auditory perceptual sensitivity[18]	1.11 (S.D 4.2)	1.19 (S.D .39)	$F(1, 113)= .05, p=.8$
Auditory perceptual bias (increased score = bias towards absent)	.77 (S.D .47)	.72 (S.D .45)	$F(1, 113)= .28, p=.6$
Auditory metacognitive sensitivity	.66 (S.D .44)	.67 (S.D .31)	$F(1, 113)= .34, p=.56$
Auditory metacognitive efficiency	.62 (S.D .37)	.67 (S.D .31)	$F(1, 113)= .78, p=.38.$

There were no significant differences in measures (table 20). Therefore, the next analyses will be conducted on the full sample.

[16] Due to threshold, 6 participants were excluded for the visual task analysis (4 FEP and 2 controls).

[17] Twenty-four participants (9 FEP and 15 controls) had a perfect score on absent trials, implying an infinite d'. We converted proportions of 0 and 1 to 1/(2N) and 1-1/(2/N), respectively, where N is the number of trials on which the proportion is based; following recommended research (Macmillan & Creelman 2005)

[18] Due to threshold, 13 participants were excluded for the auditory task analysis (7 FEP and 6 controls).

Correlational analyses - Visual signal detection task

Table 21: Correlational matrix for association between visual signal detection task measures and anomalous experiences in full group.

N=114	**Visual perceptual sensitivity**	**Visual perceptual bias**	**Visual metacognitive sensitivity**	**Visual metacognitive efficiency**	**MUSEQ visual**	**MUSEQ auditory**	**MUSEQ total**	**CDS trait**	**CDS state**	**SSI paranoia**
Visual perceptual sensitivity	1	*r*= .81*** *p*<.001	*r*= .11 *p*=.24	*r*= -.64*** *p*<.001	*r*= -.15 *p*=.11	*r*= .02 *p*=.88	*r*= .19* *p*=.04	*r*= -.18 *p*=.06	*r*= -.12 *p*=.21	*r*= -.02 *p*=.87
Visual perceptual bias		1	*r*= .13 *p*=.15	*r*= -.48*** *p*<.001	*r*= -.09 *p*=.33	*r*= -.04 *p*=.66	*r*= -.1 *p*=.3	*r*= -.12 *p*=.19	*r*= -.04 *p*=.7	*r*=.06 *p*=.51
Visual metacognitive sensitivity			1	N/A	*r*= -.01 *p*=.91	*r*= .14 *p*=.14	*r*= -.07 *p*=.48	*r*= -.14 *p*=.13	*r*= -.07 *p*=.43	*r*= -.11 *p*=.23
Visual metacognitive efficiency				1	*r*= .06 *p*=.5	*r*= .1 *p*=.32	*r*= .05 *p*=.6	*r*= -.01 *p*=.88	*r*= -.04 *p*=.7	*r*= -.11 *p*=.25

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory. Bold: These correlations held after multiple comparison correction.

After correcting for multiple comparisons, there were no significant associations between visual perceptual biases or metacognitive efficiency with anomalous self- or perceptual experiences nor with anomalous (delusional) beliefs. No further analyses were conducted.

Auditory signal detection task

Table 22: Correlational matrix for association between auditory signal detection task measures and anomalous experiences in full group.

N=114	Auditory perceptual sensitivity	Auditory perceptual bias	Auditory metacognitive sensitivity	Auditory metacognitive efficiency	MUSEQ Auditory	MUSEQ Visual	MUSEQ Total	CDS Trait	CDS State	SSI Paranoia
Auditory perceptual sensitivity	1	*r*= .79*** *p*<.001	*r*= .3*** *p*<.001	*r*= -.64*** *p*<.001	*r*= .02 *p*=.9	*r*= .04 *p*=.68	*r*= -.03 *p*=.73	*r*= -.19* *p*=.04	*r*= -.21* *p*=.03	*r*= .08 *p*=.41
Auditory perceptual bias		1	*r*= .24* *p*=.01	*r*= -.51*** *p*<.001	*r*= -.04 *p*=.72	*r*= -.04 *p*=.7	*r*= -.13 *p*=.19	*r*= -.27** *p*=.004	*r*= -.3** *p*=.001	*r*= .03 *p*=.73
Auditory metacognitive sensitivity			1	N/A	*r*= .13 *p*=.17	*r*= .06 *p*=.53	*r*= .04 *p*=.66	*r*= -.19* *p*=.05	*r*= -.16 *p*=.09	*r*= .18 *p*=.06
Auditory metacognitive efficiency				1	*r*= .1 *p*=.32	*r*= .01 *p*=.93	*r*= .06 *p*=.51	*r*= .02 *p*=.84	*r*= .05 *p*=.61	*r*= .11 *p*=.24

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory. Bold: These correlations held after multiple comparison correction.

After multiple comparison correction, there was a significant negative relationship between CDS state with auditory perceptual biases. Following this, a stepwise regression analysis was conducted with auditory perceptual bias (independent variable) and CDS state (dependent variable), with auditory perceptual sensitivity as a covariate. Even when controlling for auditory perceptual sensitivity, this model was significant and explained 10.3% of the variance in CDS score, R^2=.32, [adjusted r^2 .1], $F(2, 112)$ 6.35, p=.002). Auditory perceptual biases predicted a significant change in CDS state score, (ΔR^2=.06, $F(1, 110)$ 7.16 p=.009 (see table 23). As the perceptual bias measure is negatively scored, this result demonstrates that increased perceptual biases towards rating 'present' was associated with increased CDS state measure.

Table 23: Regression table to demonstrate associations with state anomalous experiences.

		B	SE B	β	p value	CI
Model 2						
	Constant	189.9	50.68			
	Auditory perceptual sensitivity	44.53	67.31	.097	.51	-88.95, 177.81
	Auditory perceptual bias	-160.29	59.92	-.39	.009	-279.03, -41.55

*= p<.05, **=p<.01

There was also a significant negative relationship between CDS trait with auditory perceptual biases (see table 22). Further analyses were conducted to assess the associations with individual subscales of CDS trait measure (table 24). After multiple comparisons, there was a significant negative relationship between auditory perceptual bias and CDS trait emotional numbing (EN) and alienation from surroundings (AFS) subscale in the full sample.

Table 24: Correlational matrix for association between auditory perceptual sensitivity, bias, metacognitive sensitivity and efficiency with subscales of anomalous self-experiences in full sample.

N=109	**CDS trait ABE**	**CDS trait EN**	**CDS trait ASR**	**CDS AFS**
Auditory perceptual sensitivity	*r*= -.17 *p*=.07	*r*= -.18 *p*=.05	*r*= -.14 *p*=.16	*r*= -.18 *p*=.06
Auditory perceptual bias	*r*= -.21* *p*=.03	*r*= **-.28**** *p*=**.01**	*r*= -.12* *p*=.03	*r*= **-.27**** *p*=**.01**
Auditory metacognitive sensitivity	*r*= -.19* *p*=.04	*r*= -.16 *p*=.09	*r*= -.12 *p*=.21	*r*= -.14 *p*=.15
Auditory metacognitive efficiency	*r*= -.11 *p*=.26	*r*= -.05 *p*=.62	*r*= -.03 *p*=.76	*r*= -.04 *p*=.7

Note: CDS = Cambridge Depersonalisation Scale; ABE = Anomalous Bodily Experiences; EN = Emotional Numbing; ASR = Anomalous Subjective Recall; AFS = Alienation From Surroundings. **Bold**: These correlations held after multiple comparison correction.

A stepwise regression analysis was used to assess the association between auditory perceptual bias and CDS alienation from surroundings (AFS), independent of auditory perceptual sensitivity. Even when controlling for auditory perceptual sensitivity, this model was significant and explained 7.8% of the variance in CDS AFS score, R^2=.078, [adjusted r^2 .06], $F(2, 113)$ 4.69, p=.011). Auditory perceptual biases predicted 4.6% of this variance and improved the model (ΔR^2= .046, $F(1, 111)$ = 5.55, p=.02). Another stepwise regression analysis was conducted to assess the association between auditory perceptual bias and CDS emotional numbing (EN), independent of auditory perceptual sensitivity. Even when controlling for auditory perceptual sensitivity, this model was

significant and explained 7.9% of the variance in CDS EN score, R^2=.079, [adjusted r² .062], $F(2, 113)$ 4.74, p=.011). Auditory perceptual biases predicted 4.5% of this variance and improved the model (ΔR^2= .045, $F(1, 111)$ = 5.46, p=.021). As the perceptual bias measure is negatively scored, these results demonstrate that increased perceptual biases towards rating 'present' was associated with higher scores on the CDS AFS/EN measure.

Finally, the correlations were split by group (FEP and healthy control) to assess differences in the groups. In the FEP group, there was a significant negative relationship between auditory perceptual bias and AFS (r=.48, p=.002) and anomalous bodily experiences (ABE) (r=.42, p=.002) subscales, which held after multiple comparison corrections. However, these two correlations were non-significant in the control group.

After correcting for multiple comparisons, there were no significant associations with auditory perceptual biases and metacognitive efficiency and anomalous perceptual experiences or with anomalous (delusional) beliefs.

8.6 Discussion

This experimental cross-sectional study demonstrated that auditory perceptual biases (a lower threshold for accepting an auditory stimulus as present) was associated with increased state and trait anomalous self-experiences (alienation from surroundings and emotional numbing) in the full sample, and specifically within the FEP group.

This perceptual bias towards noticing a stimuli as present (within the environment) may be closely linked with the phenomenological concept of hyperreflexivity (heightened awareness of aspects of experience that are normally sub-conscious/implicit (Sass et al., 2018) and the neurocognitive concept of aberrant salience (Kapur, 2003). Therefore, an individual who has a lower threshold for noticing auditory stimulus within the environment may be overly aware of themselves or their environment which makes aspects are overly salient. A lower threshold for detecting a signal (message) from meaningless noise was demonstrated in those deemed as Ultra-High Risk (UHR) and later transitioned to psychosis (Hoffman et al., 2007). It may be this hypervigilance and hyperawareness of stimuli can alienate the individual, leave them feeling detached and experience difficulty identifying themselves from their environment (alienation from

surroundings). From this hyperawareness, the individual may feel an information overload and as a consequence they "shut-down" their emotions or reactions to these anomalous experiences (emotional numbing); potentially as a compensatory mechanism to avoid further distress.

Recently, Powers et al. (2017) demonstrated the role of top-down cognitive biases, via predictive processing models, on auditory hallucinations in clinical participants. In a response to Powers et al., Nelson and Hartmann (2017) suggested that predictive processing models could also explain disturbance of the "minimal" self; in this case, dissociation. The use of predictive processing to explain self-disturbance has also been suggested by Clowes et al. (2017) as imprecise predictions must be explained, which may lead to hyperreflexivity and, therefore, dissociation (Seth, Suzuki & Critchley, 2011; Seth, 2013). Recently, Garfinkel et al. (in preparation) was able to demonstrate an association between interoceptive metacognition, e.g. confidence in detecting heart rate, and alienation from surrounding and anomalous subjective recall from CDS, with a trend negative relationship observed with emotional numbing subscale. The similarity of the subscales with this current study suggests a potential overlap between auditory perceptual biases and interoceptive awareness. Difficulties with both perceptual biases and interoceptive awareness may lead to hyperreflexivity; heightened awareness or/attention to aspects of experience that are normally implicit (Nelson et al., 2014a, 2014b), which can undermine an individual's sense of being grounded within a shared universe and is likely to alienate the self, leading to the anomalous self-experiences (see Sass et al., 2018).

Both perceptual biases and anomalous self-experiences may be considered low-level or sub-conscious (e.g. not involving higher-level cognitive appraisals/interpretations). It is important to note, in this sample, individuals with FEP had fewer symptoms and better functioning compared to other FEP studies (Leucht et al., 2005; Fitzgerald et al. 2004; McLeod et al., 2014; Hodgekins et al. 2015), and intact metacognitive efficiency. As a result, this underlying, low-level, causal relationship between perceptual biases and anomalous self-experiences may have been easier to capture as it was not confounded by symptoms. Perceptual biases may be a cognitive marker for individuals who may have a propensity to have anomalous-self experiences. This is a tentative hypothesis and future studies should aim to assess this within a large model, e.g. with groups of individuals at

ranging levels of psychotic experiences/symptoms [Ultra High risk (UHR), FEP, chronic schizophrenia].

Mediation model supported the hierarchical framework (Fletcher & Frith, 2009), in which anomalous self-experiences may lead to surface-level anomalous perceptual experiences then, after appraisal, may develop into higher-level (delusional) beliefs (Garety et al., 2001; Freeman et al., 2002; Nelson, Parnas & Sass, 2014). However, despite the association between perceptual biases and anomalous self-experiences, contrary to the literature, perceptual biases did not predict anomalous perceptual experiences (see Bentall & Slade, 1985; Kok, Kouider, Lange, & Supe, 2015; Barkus et al., 2010; Mussgay & Hertwig, 1990). Interestingly, Haarsma et al. (2018) demonstrated strong evidence for weakened perceptual priors in ARMS group, compared to FEP and healthy controls. But stronger cognitive priors in the FEP group, compared to ARMS and healthy controls. Haarsma et al. suggested that high-level cognitive priors may develop from weak low-level priors as a compensation (see Adams et al., 2013; Sterzer et al., 2018; Heinz et al., 2018). Future studies could assess perceptual biases and metacognitive efficiency within various different clinical groups, e.g. UHR, FEP, chronic psychosis, schizotypal personality disorder and psychometrically-defined schizotypy, to assess presence of these relationships across groups of individuals with varying symptomatology.

Of importance here is that metacognitive efficiency was not associated with any of these anomalous experiences or beliefs. As suggested above, these individuals with FEP had fewer symptoms and both groups had intact metacognitive efficiency. Therefore, intact metacognitive efficiency may prevent the negative appraisal of anomalous experiences, which typically maintains anomalous perceptual experiences and can develop into delusional beliefs.

This lack of association with anomalous perceptual experiences/delusional beliefs may be because individuals within this FEP sample were currently, or recently, involved within the Early Intervention Service (EIS) which provides pharmacological (typically, antipsychotic medication to reduce the salience of anomalous experiences) or psychological interventions (typically, CBT-p to alter the response to anomalous experiences and prevent maintenance of anomalous delusional beliefs), this may have had an impact on improving metacognitive capacities. Kapur (2003) suggested antipsychotics

"dampen the salience" of these anomalous experiences, which means individuals experience reduced salience of anomalous experiences; hence equal levels of anomalous experiences between the clinical and non-clinical groups. Next, CBT-p aims to reduce distress associated with anomalous experiences (Birchwood & Trower, 2006), by changing the way in which an individual (metacognitively) appraises these experiences. This has shown positive effects (Gould et al., 2015; Turner et al., 2014; Hazell et al., 2016; Tarrier et al., 1998). This highlights the importance of a well-resourced Early Intervention Services (Bertolote & McGorry, 2005; Marshall & Rathbone, 2011), to intervene with metacognitive difficulties and distressing anomalous experiences. From this, it may be hypothesized that metacognitive efficiency has a key role in anomalous experiences/beliefs, and is more impaired, when more symptomatic in psychosis. Assessing these variables across clinical groups will enable detection of core difficulties at different stages of illness to identify which factors are the main triggers of anomalous experiences.

It is important to also consider the alternative argument that metacognitive efficiency may not be associated with anomalous experiences. A small number of studies have assessed metacognitive efficiency, using meta-*d'*, and those that have have demonstrated limited association with brain function or other psychotic symptoms in psychosis and healthy controls (Davies et al., 2018; Powers et al., 2017; Corcoran et al., 2018).

8.7 **Limitations**

There are limitations to the study. Firstly, many participants were biased towards the stimuli being absent, showing a strict and conservative approach to accepting the stimulus as present. For the FEP group, the progressed stage of their recovery may explain their conservative approach. Future studies could aim to assess the fluctuations in symptoms over time using a repeated longitudinal measure. Secondly, the study demonstrated an association within only the auditory modality. Auditory anomalous experiences were slightly higher than other modalities; in support of research suggesting hallucinations are most common within the auditory modality (McCarthy-Jones et al., 2017; Shergill, Murray, & McGuire, 1998; Waters et al., 2012). Therefore, this modality-specific result may be an effect of the nature of the experience. Future studies could explore this within individuals with and without auditory hallucinations compared to other modalities.

Finally, educational level was significantly different between the groups, which has been a previous confound in metacognition measures (Gaweda et al., 2013; Moritz et al., 2014). However, IQ was not significantly different between the two groups, which is a more detailed measure. Future studies should use IQ as a measure of comparison, rather than educational level which may not be best suited to capture ability.

8.8 Conclusion

This study identified increased auditory perceptual biases were associated with increased anomalous self-experiences; in particular alienation from surroundings and emotional numbing. Anomalous self-experiences, as a result of perceptual biases, may be the underlying causal vulnerability of these experiences, which can be particularly distressing and disorienting. This study demonstrated auditory perceptual biases may represent an early causal vulnerability for anomalous self-experiences. This may be a therapeutic target for those with anomalous-self experiences to prevent initial or re-occurrence of anomalous perceptual experiences and delusional beliefs.

NOTE: References at the end of the thesis.

9. General discussion

Psychosis is a serious mental health disorder characterised by positive symptoms (experiences that are in addition to normal experience, e.g. hearing voices), negative symptoms (dampening of normal experiences, e.g. loss of motivation), cognitive deficits, disorganized symptoms and, importantly here, an impairment in functioning. Beck and Rector (2005) proposed a model of functional outcome in schizophrenia, suggesting the path between neurocognition and functioning is mediated by functional capacity and cognitive processes. These cognitive processes can include metacognition, considered 'thinking about thinking'. Metacognition was proposed to work in a hierarchy between the object- and meta-level, outlined within Nelson and Narens (1990) model, including several metacognitive components: metacognitive ability, experience and efficiency, connected by metacognitive processes (monitoring and control).

Many of these metacognitive components are impaired in psychosis and these metacognitive deficits were suggested to predict both what people do in their everyday lives (functional outcome) and how people feel about their everyday lives (subjective recovery outcome). It was also proposed that metacognition could be expanded to include the way one thinks about oneself through important memories, e.g. self-defining memories (SDMs). The role of SDMs as an additional predictor of functioning in psychosis, alongside metacognition, was explored.

Metacognitive efficiency, in particular, has been used to explain the presence of anomalous experiences. Anomalous experiences refer to a rich number of various psychic phenomena, including anomalous self-experiences (e.g. the sense that you are not "real"); anomalous perceptual experiences (e.g. hearing sounds which cannot be accounted for by the environment); and anomalous delusional beliefs (e.g. holding unusual beliefs outside the cultural norm). These experiences are common with FEP, and in those with emerging severe mental health difficulties, and may be associated with difficulties in metacognition. This thesis has presented a series of studies exploring the role of metacognitive components on anomalous experiences, functional outcome and subjective recovery outcome in young people with and without psychosis.

The thesis aim is:

The first aim of the thesis is to assess the connection between metacognitive variables and which metacognitive components are important for difficulties in functioning in psychosis (Chapter 2 & 3)

The second aim of the thesis to assess both objective and subjective function will allow a more in-depth understanding of functional recovery and the variables which are associated with this. However, limited research has assessed whether other metacognitive components are relevant in poor functional outcome in FEP (Chapter 3, 4 and 5)

Given the limited longitudinal research, **the third aim of the thesis** is to assess whether metacognitive ability can predict functional outcome across a longer follow-up period, particularly within FEP; where recovery is more likely (Chapter 4).

The fourth aim of the thesis is to assess the role of cognitive and metacognitive processes on anomalous experiences and delusional beliefs (Chapter 6, 7 and 8)

9.1 Integration overview of findings

Contrary to our hypothesis, there was not an overall metacognitive hierarchy. Instead, metacognitive factors loaded onto separate factors, with limited correlation between the metacognitive components, which supported the idea that these are distinct reflective processes. Current findings demonstrated a role for metacognitive ability and metacognitive experience in predicting functional capacity, and role for metacognitive ability and control processes for predicting functional outcome in individuals with and without psychosis. Metacognitive ability also predicted subjective recovery outcome in FEP cross-sectionally, independently of negative emotion (see figure 17).

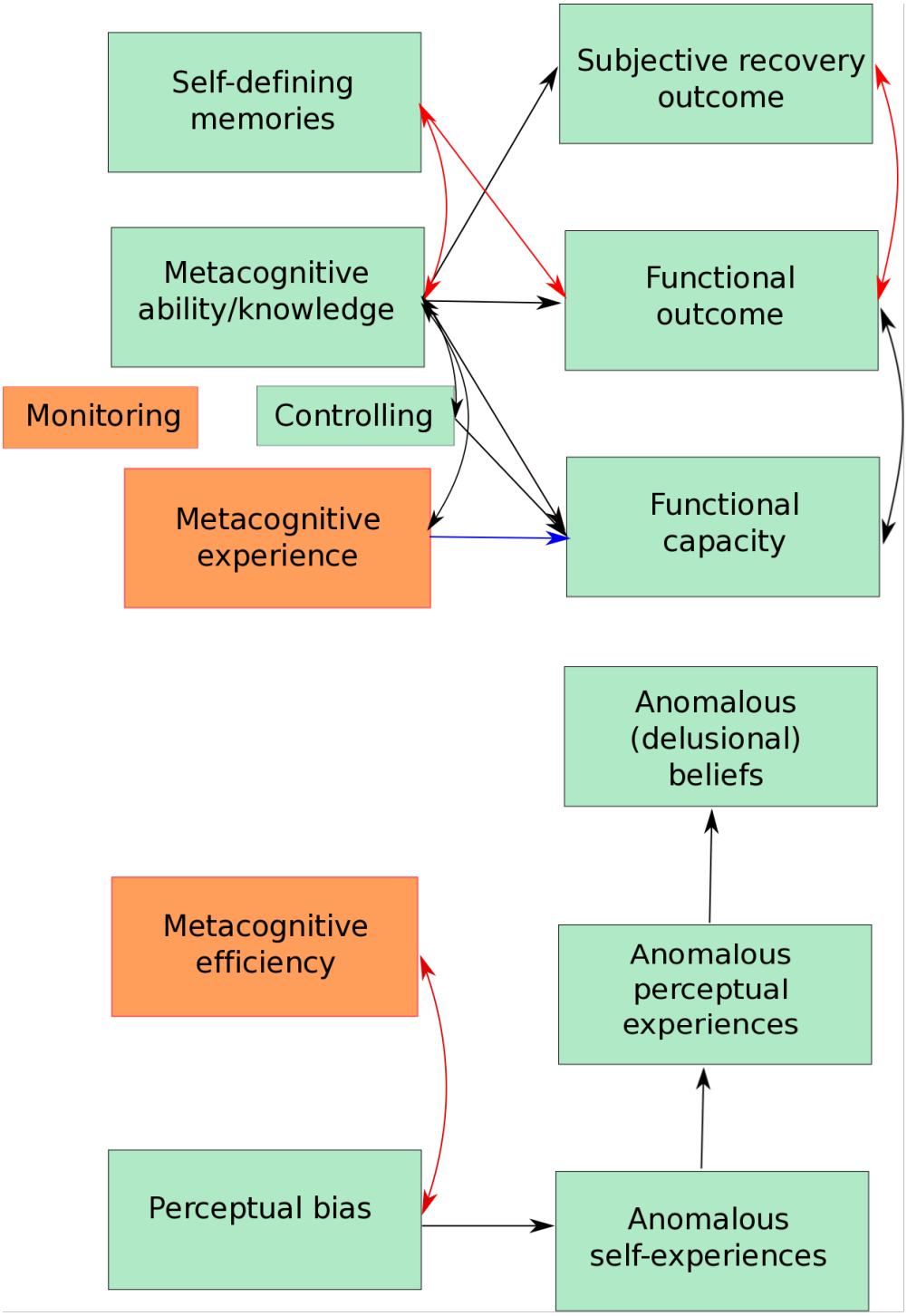
Following this, the thesis examined the role of metacognition in predicting functional outcome across a three-year period, following First Episode Psychosis (FEP). Current findings demonstrate that better metacognitive ability at baseline significantly predicted improvement in functioning in FEP, from baseline to three-year follow-up, independent of neurocognition and functional capacity. This thesis highlights that metacognitive ability, in particular, should be used as an early marker for risk of later poor functioning in psychosis and should be a target for interventions in FEP.

Current findings demonstrate that metacognition may be expanded to include the way one thinks about oneself through important memories, e.g. self-defining memories (SDMs). This highlights that reflecting on oneself and one's experiences, in a variety of different ways, is important for functioning in FEP.

In order to explore associations between anomalous experiences and delusional beliefs, this thesis initially conducted a systematic literature review. This review demonstrated that metacognitive ability was not directly associated with anomalous experiences or beliefs. For both metacognitive monitoring and metacognitive sensitivity, there was a clear association with anomalous (delusional) beliefs. Although this relationship appeared to vary across the recovery trajectory; metacognitive monitoring appears to be specifically linked to anomalous (delusional) beliefs during FEP and less so for those with an At Risk Mental State (ARMS). However, the relationship with anomalous perceptual experiences was less consistent. This was possibly due to the lack of consistent and specific measures of anomalous perceptual experiences or rigorous experimental controls.

Following this, this thesis developed and piloted two metacognitive tasks (visual and auditory tasks) in healthy student sample. These two metacognitive tasks were later used to examine the relationship between anomalous self- and perceptual experiences and delusional beliefs, metacognitive sensitivity and perceptual biases within young people with and without psychosis. This study demonstrated that those with higher dissociative experiences, particularly alienation from surroundings and emotional numbing, had higher level of auditory perceptual biases. This may be an underlying causal vulnerability for these anomalous self-experiences and, therefore, a cognitive marker for individuals who may have a propensity to have anomalous-self experiences. However, no significant associations were found between these perceptual biases or metacognitive efficiency (appraisals) and anomalous perceptual experiences or delusional beliefs. This was inconsistent with the initial hypothesis and may suggest that the presence of intact metacognitive efficiency in FEP and healthy control group may prevent the maintenance of anomalous experiences or development of anomalous (delusional) beliefs.

Figure 17: Final model of metacognitive influences on anomalous experiences and outcomes in FEP. Note: Solid lines arrows signify significant relationship demonstrated within the young people with and without psychosis. Solid red arrows signify significant relationship demonstrated within FEP only. Solid blue line demonstrated an inverse correlation. Orange boxes demonstrate intact within psychosis in this current thesis.



9.2 Main findings, clinical and research implications

9.2.1 Metacognition has a key role in First Episode Psychosis

Current findings demonstrate that all metacognitive components load onto separate factors which supports the idea that these are distinct reflective processes (chapter 3). Due to the lack of association between metacognitive components and the fractionation in metacognition, in both FEP and healthy controls, the hierarchy proposed for metacognition is not consistent within this current research. Metacognition includes a range of different, distinctive abilities or experiences. Surprisingly, the metacognitive factors were not associated with each other suggesting that either these are independent processes, or the method of assessment was not capturing the appropriate connections or, alike to the association with anomalous perceptual experiences, these metacognitive components may change over the course of recovery.

Metacognitive ability, capacity to reflect on oneself, experiences, and others in a holistic and flexible manner, is poorer in FEP, compared to healthy controls, and predicts functional and subjective recovery outcome (chapter 3, 4 and 5). Metacognitive control processes, ability to set-shift and be flexible in one's thinking, was poorer in FEP compared to the healthy control group. This suggests a potential fault within the metacognitive system in FEP. However, contrary to our hypotheses, metacognitive experience or "online" accuracy in prediction of ability, was better in FEP compared to healthy control participants (chapter 3); previously suggested by Gilleen, Greenwood and David (2014) within schizophrenia. Healthy control participants underrated their performance more than those with FEP. In the same vein, metacognitive monitoring process was higher in FEP compared to healthy controls (chapter 3). This suggests a dissociation between higher-order metacognitive ability and control processes, which is impaired in psychosis, compared to intermediate metacognitive experience and monitoring which is intact. It is metacognitive ability, and use of this ability within everyday life, which has the largest impact on functioning rather than focus on performance on a task within-the-moment. This FEP group were further along in recovery, which may have influenced by reporting within the BCIS questionnaire (see limitations section 9.3.5), but also highlights the potential persistent nature of the deficits in metacognitive ability.

To support the assumption that the FEP group may be further along in their recovery, there were no differences in metacognitive efficiency between the groups, inconsistent with previous studies in this area (Davies et al., 2018; Bilkstead et al., 2016). Following this, there was no significant association between metacognitive efficiency and anomalous experiences or delusional beliefs in our sample, despite previously being demonstrated within the literature (chapter 6). As this FEP group may have been more recovered, supported by reduced levels of symptoms and higher functioning than previous FEP samples (Hodgekins, French, et al., 2015; Leucht et al., 2005), these individuals display higher levels of metacognitive experience and self-reflectiveness which may have limited the frequency of distressing anomalous experiences/delusional beliefs.

Clinical and research implications

The different metacognitive components have seemingly separate roles or functions at different stages of the psychotic illness. Therefore, future research should aim to test these components within different clinical groups, with varying symptomatology, to explore differences across recovery. This research will enable research to identify key metacognitive components to tackle within an ARMs where metacognitive efficiency may play a large role, or chronic psychosis group where different metacognitive components may be more apparent.

All individuals were currently, or recently, involved with the Early Intervention Service (EIS) which provides pharmacological (typically, anti-psychotics) and psychological interventions (typically, CBT-p), which may have impacted on metacognition. However, this thesis was not able to empirically test these suggestions regarding interventions. Future research or clinical practice could obtain these data to replicate the findings with more explicit measures of treatment.

9.2.3 Predictors of functioning in people with and without psychosis

Functional outcome was predicted by metacognitive ability in individuals with and without psychosis, independent of IQ (chapter 3). Those who were better able to reflect on themselves as a person with skills, abilities and experiences, and were able to utilise their skills, were more likely to be engaged in more hours of structured activities per

week. The metacognitive ability measure, Metacognitive Assessment Interview (MAI), involves an individual reflecting on a difficult interpersonal situation and then explaining this situation, their experiences and how another person may have viewed the situation. The scoring is partially based on how the individual discusses this situation verbally, in terms of the spontaneity and sophistication of their answer. Whilst typically good verbal IQ is associated with good metacognitive ability, metacognitive ability still predicted functioning independent of IQ.

However, within the FEP group, the role of metacognitive ability on functional outcome did not hold after controlling for negative symptoms (chapter 3). This may suggest a role for negative symptoms such as poverty of speech/lack of spontaneity or difficulty in abstract thinking in the MAI scores. Therefore, the MAI may be capturing aspects of negative symptoms which are associated with, and difficult to separate from, metacognitive ability (Hamm et al. 2012; McLeod et al. 2014). The three-year follow-up study (chapter 4) was able to demonstrate role of metacognitive ability on functional outcome was supported longitudinally, independent of negative symptoms. This suggests that, whilst metacognitive and negative symptoms may be related, metacognition has a distinct role in predicting functioning, independent of negative symptoms across-time.

Alongside metacognitive ability, holding specific self-defining memories was demonstrated to predict engagement in more hours of structured activity in FEP (chapter 5). Therefore, this ability to reflect on one's own life experiences, more broadly; including memories and current abilities, is shown to have a role in functional outcome in FEP.

Functional outcome has been previously, and strongly, associated with functional capacity in psychosis. Metacognitive ability and metacognitive control process were shown to predict real-life functional capacity in individuals with and without psychosis, independent of IQ. This suggests that those with more flexible thinking within the moment (control) or ability to think about themselves as a person as a whole with skills (metacognitive ability), were more likely to be able to use these skills within the moment to complete a real-life task. However, metacognitive experience was shown to be a predictor of functional capacity and this was independent of both IQ and negative symptoms. However, this was an inverse relationship, suggesting those who were more accurate in rating their performance after completion of a visual task were likely to

perform more poorly on the functional capacity task. This suggests a negative effect of focusing on specific cognitive abilities. This was unexpected and may suggest that it is more useful for an individual to focus on their overall ability, experiences and themselves as a whole, to improve metacognitive ability, to later improve functional outcome for both individuals with and without psychosis.

Clinical and research implications

The predictive effects of metacognitive ability on functional outcome, both cross-sectionally and longitudinally, have important clinical implications for Early Intervention Services which provide treatment to individuals experiencing symptoms of psychosis. These findings can be taken forward in two ways: i) poor metacognitive ability may be a marker for poor outcome in psychosis later on and patients should be provided with more support, particularly to enhance their metacognitive abilities, and ii) metacognitive ability may be a key target for interventions in FEP to improve functioning. Metacognition Reflection and Insight Therapy (MERIT), specifically aimed at improving metacognitive ability (Lysaker, Buck, et al., 2011), may be a useful intervention for FEP. de Jong et al. (2018) recently demonstrated, in a trial of MERIT for individuals with schizophrenia, that MERIT improved metacognitive ability, but not functioning; which may be accounted by other factors, e.g. functional capacity or cognitions (see Davies et al. 2017; Koren et al. 2006) or the short follow-up period. The role of additional factors may suggest that the combination of training cognitive and metacognitive abilities is a more powerful intervention. RCTs for metacognitive therapies are ongoing and consideration should be made to include metacognitive therapies within UK health services.

These findings may also have important implications for healthy young people who want to engage in more activities, particularly those economically inactive adolescents and young adults, considered Not in Education Employment or Training (NEET) (Scott et al., 2013), to prevent future mental health difficulties or functional decline. In addition, research needs to focus on understanding at which point and why deficits in metacognitive ability develop. As suggested in chapter 3, the role of verbal IQ or negative symptoms (e.g. poverty of speech) may contribute but neither fully explains this deficit. Prospective longitudinal studies will help to identify at which point intervening on metacognitive ability is most appropriate, and which preventative mechanisms could be

targeted to reduce decline in metacognitive ability in psychosis. Research within NEET groups or within individuals with At Risk Mental State (ARMS) could be informative.

In terms of metacognitive experience, Cognitive Remediation Therapy (CRT) aims to improve cognitive ability (and consequentially real-world functioning) and has recently begun including metacognitive training (training and encouraging the use of strategies to improve skills) to enhance standard CRT (Breitborde et al., 2015; Reeder et al., 2017). This CRT metacognitive training particularly focuses on improving metacognitive experience; "online" awareness of abilities. Studies using CRT, alongside vocational training, demonstrated an improvement in an individual's cognitive composite score (McGurk et al., 2015) and an improvement in Trails B:A which can be viewed as a metacognitive control process (Gilleen et al., 2016). Current CRT trials using metacognitive training within EIS in the UK are ongoing and a recent trial within a schizophrenia sample provides support for this therapy (Reeder et al. 2017). Future trials should continue to focus on both cognitions, metacognitions and real-life skills in FEP to improve outcomes (e.g. Cella et al. 2015).

Metacognitive ability is a comprehensive and sophisticated skill and improving metacognitive abilities may be challenging for some, particularly those with lower cognitive ability. Alongside this, metacognitive therapy, e.g. MERIT, can be distressing for individuals who become more metacognitively aware of previous traumatic or negative life experiences. These individuals may disengage from therapy or find it too difficult. Therefore, metacognitive therapy may not be a panacea. Alternatively, in light of the findings for the impact also of self-defining memories on functional outcome, engaging in therapies which focus on reflecting on important, positive and specific self-defining memories may be a more positive and equally valuable starting point. This can help the individual develop the technique of self-reflection, laying the foundations for later metacognitive therapy once the individual is motivated and able to engage.

9.2.4 Subjective recovery in FEP

Recent research has begun to consider subjective perspective on recovery from severe mental health difficulties. This is alongside functional recovery, to understand the 'breadth of success' across various domains of recovery (Harvey & Bellack, 2009).

Current findings demonstrate subjective recovery scores were higher in this sample than in a schizophrenia group (Neil et al., 2009), suggesting recovery within an FEP group may be more likely. There was an association between functional outcome and subjective recovery outcome in FEP (Chapter 3). Current findings demonstrate that metacognition is a key factor which is associated with both modes of recovery. Importantly, an individual's ability to think about themselves, their different states of mind, and their experiences is an important aspect of mental health recovery. Whilst this is in support for previous research (Kukla, Lysaker and Salyers, 2013; Phalen, Viswanadhan, Lysaker, Warman, 2015; Lysaker et al., 2005), the current study was the first to demonstrate this within FEP, demonstrating that metacognitive ability, functional outcome and subjective recovery outcome are intertwined and inherent to the disorder, and important for recovery.

Clinical and research implications

Current findings provide additional support for the use of metacognitive therapies, e.g. MERIT, in improving both functional outcome and subjective recovery in FEP. Due to the lack of longitudinal research, it is unclear whether metacognitive ability is having a direct impact on subjective recovery or whether this is via functional outcome. Future studies exploring this can provide additional evidence to support the use of metacognitive therapies in tackling subjective recovery outcomes.

Subjective recovery outcome was only assessed within chapter 3, not in the follow-up study. Therefore, this thesis was not able to explore the direction of the relationship between functional outcome, subjective recovery outcome and metacognitive ability. In addition, the relationship between subjective recovery and functional outcome was not as high as expected which may suggest these two factors could be dissociable for some individuals, for example as a result of diminished insight, demoralization, or reduced life expectations (Goldberg & Harrow, 2005). Future research should aim to further understand the longitudinal or causal relationship between subjective recovery and functional outcome, across the recovery trajectory within psychosis.

9.2.3 Predictors of anomalous experiences

Anomalous self-experiences, particularly alienation from surroundings and emotional numbing, were associated with increased auditory perceptual biases in FEP (chapter 8). Perceptual biases are suggested to be related to hyperreflexivity which leads the individual to become overly aware of their environment and themselves such that they experience anomalous self-experiences. Recent research demonstrated a negative relationship between metacognition, in terms of detecting interoceptive signals e.g. heart rate, and dissociation (Garfinkel et al., in preparation). Perceptual biases and interoceptive awareness appear to be low-level processes and may be related to hyperreflexivity; heightened awareness or/attention to aspects of experience that are normally implicit (Nelson et al., 2014a, 2014b), which can undermine an individual's sense of being grounded within a shared universe and is likely to alienate the self, leading to the anomalous self-experiences (see Sass et al., 2018).

Auditory perceptual biases may constitute an underlying causal vulnerability or cognitive marker for propensity to anomalous self-experiences. Anomalous self-experiences were also associated with anomalous perceptual experiences, which were, in turn, associated with anomalous (delusional) beliefs (chapter 7), via a hierarchical mediation model (chapter 8). Therefore, tackling anomalous self-experiences at the lowest level may prevent further anomalous experiences or the development of anomalous (delusional) beliefs.

However, contrary to the literature, perceptual biases predicted only self-experiences and did not predict anomalous perceptual experiences directly (see Bentall & Slade, 1985; Varese et al., 2011). Importantly here also, whilst metacognitive efficiency, within-the-moment confidence ratings on a task, was associated with perceptual bias it was not associated with anomalous perceptual experiences or anomalous (delusional) beliefs in FEP nor healthy control groups. Metacognitive efficiency was intact within the FEP group (chapter 3 and 8) and, therefore, intact metacognitive efficiency may be a protective factor which prevents the individual from experiencing anomalous perceptual experiences and, from this, prevents the development of anomalous (delusional) beliefs.

Clinical and research implications

Current findings imply that auditory perceptual biases may be an underlying cognitive marker for propensity to anomalous self-experiences. Future research could aim to understand the development of auditory perceptual biases, in order to understand the causal path from auditory perceptual biases to anomalous self-experiences.

As chapter 8 did not demonstrate an association between anomalous experiences/delusional beliefs with metacognitive efficiency, this may suggest a more complex relationship which may vary across the course of recovery or psychotic illness trajectory. Future studies should aim to assess the presence of these relationships across groups of individuals with varying symptomatology. As it is evident that anomalous experiences demonstrate fluctuations across time and within daily life (Reininghaus et al., 2016), future research could investigate the fluctuations in anomalous experiences, perceptual biases and metacognitive efficiency through the use of Experience Sampling Method or Ecological Momentary Assessment. These two streams of research may highlight specific relationships during different stages of the illness or during time at which anomalous experiences are frequently present. This research could then later lead to personalised or tailored interventions, depending on the stage of illness and the most prominent difficulty.

9.3 Limitations

9.3.1 Terms used

There are debates within the metacognitive literature about the terms used and the structure of the metacognitive model. This thesis has focused on Nelson and Narens (1990) model to provide a foundation to the metacognitive components. However, other metacognitive models exist, including Morrison (2011); Wells and Matthews (1996) S-REF model; or cognitive literature which has solely focused on metacognitive sensitivity/efficiency (Fleming & Lau, 2014). The different models label metacognitive components in different ways. To overcome this, this thesis attempted to use consistent terms that had been used within earlier metacognitive models to explore various metacognitive components and their relationship.

9.3.1 Participants

Within chapter 3, 4, 5 and 8 all FEP participants had been within Early Intervention Services for at least 3 months before entry into the study. All participants received a diagnosis of F29 at entry to the study. For the majority of participants, the study was the first entry-point and for a minority, (26 participants), this study was at a later time-point as they formed part of a Psychosis Cohort Study (Davies, Fowler & Greenwood, 2017). As a result, this was a heterogeneous group. Within chapter 3 and 4, the individuals with FEP were engaged in significantly fewer hours of structured activity per week and reduced functional capacity skills, compared to the matched control group. However, this FEP sample were engaged in more hours than a typical FEP sample (Hodgekins et al., 2015), and scored higher on subjective recovery measure (Questionnaire of Process of Recovery), compared to previous studies in schizophrenia samples (Neil et al., 2009) and there was no difference in IQ between the groups. From this, the FEP sample in this study may have been further along in their recovery, supported by the relatively low symptoms on PANSS compared to other studies (Leucht et al., 2005; Fitzgerald et al. 2004; McLeod et al., 2014). Chapter 8 highlighted the possible role of medication or psychological therapy, which may also have contributed to the lack of association with metacognition in chapter 8, compared to early studies (Gaweda et al., 2013; Gawęda et al., 2018). From this, caution should be taken when comparing the results to a group of individuals with FEP who are acutely unwell or experiencing high levels of psychotic symptoms.

This may represent a wider research issue; individuals who are less symptomatic are more willing to engage in research than those who are less well; or those who are less well are less able to provide reliable responses within these research studies. Future studies could aim to accommodate for various difficulties or needs of the participants and aim to work closely with service users, continually throughout the research process, to engage service users of different abilities or experiences.

9.3.2 Sample size

All planned analyses were conducted with sufficient power. Contrary to our hypothesis, there were limited associations between the metacognitive variables despite sufficient power for these individual correlations, which meant that the final mediation model on which this last power calculation was based, was not conducted. Instead, the relationship

between the metacognitive variables were assessed using an adequately powered correlation analysis and their separate impact on functioning was assessed.

It is important to consider that the lack of significant interaction between the metacognitive components may also be due to lack of power. This may have reduced the ability to detect weaker relationships. A factor analysis was conducted in chapter 3 with 135 participants. This sample size may be considered appropriate, following MacCallum et al. (2001). Future studies could aim to replicate this study within a larger sample in healthy controls, following a 20:1 suggestion from MacCallum for factor analyses with low communalities.

The sample size for the follow-up stage chapter 4 was small (26 participants). This limited power and it was not possible to explore the full impact of negative symptoms in this model. Finally, chapter 5 sample size was small for the binary variables. The Monte Carlo method suggests that a larger sample than the current study is needed for sufficient power in complex mediation models (Thoemmes, MacKinnon, & Reiser, 2010), hence the use of single mediation models. Future studies should aim to replicate findings in a sufficiently powered multiple mediation model.

9.3.3 Omitted variables

Substance use has been previously associated with employment outcomes in Severe Mental Illness (SMI) (McGurk et al., 2009; Richardson & Stephen, 2017) and, whilst chapters 3, 4, 5 and 8 excluded individuals who had a diagnosis of substance misuse disorder, use of substances in SMI is high (Dharmawardene & Menkes, 2015; RachBeisel, Scott, & Dixon, 1999) and under-reported (Bahorik, Newhill, Queen, & Eack, 2014). Due to the high proportion of individuals using substances; potentially as self-medication (Addington & Duchak, 1997; Khantzian, 1997; Margolese, Malchy, Negrete, Tempier, & Gill, 2004), we aimed to exclude individuals with substance-induced psychosis, and initially, we attempted to also exclude individuals with 'regular' substance misuse. However, after a review of the literature and the various methods to assess substance use, it was apparent that operationalising 'regular' substance use was difficult. Therefore, we had those with a diagnosis of substance misuse disorder as an exclusion criterion. During recruitment, staff within Early Intervention Services noted that

individuals within the service commonly use substances but are rarely given the formal diagnosis of substance misuse disorder. Future research should aim to replicate this study whilst using more rigorous controls for substance use or using this as a covariate or moderating variable.

9.3.4 Self-report measurement

Functioning measures

The Time-Use Survey (Short, 2003, 2006) is an appropriate, valid and reliable measure of functional outcome in psychosis which captures functioning in an objective manner. However, this measure does rely on memory over a certain time period (one month preceding the study). This may be an issue for individuals who experience psychosis, who may experience memory difficulties; a common cognitive difficulty in schizophrenia (Aleman, Hijman, de Haan, & Kahn, 1999; Fioravanti, Carlone, Vitale, Cinti, & Clare, 2005; Forbes, Carrick, McIntosh, & Lawrie, 2009). However, this measure has been used within many cross-sectional studies within different FEP groups (Davies et al., 2017; Hodgekins, Birchwood, et al., 2015b; Hodgekins, French, et al., 2015) and clinical trials (Fowler et al., 2009). Future studies should continue to make use of apparatus such as diaries, calendars or prior notice for those who struggle with cognitive difficulties.

The UPSA was a useful measure of real-life functional capacity. However, this measure requires some level of abstract thought processes, e.g. imagine you are getting the bus, which can introduce difficulties within the scoring which may not be present in real life. UPSA measure, in parts, may reflect cognitive difficulties in abstract thinking (Harrow, Adler, & Hanf, 1974), which have been linked to functioning (Lysaker, Bryson, Davis, & Bell, 2005), rather than difficulties in applying the cognitive skill to everyday life. Difficulty in abstract thinking may be particularly prominent for those with autistic spectrum disorder (Solomon, Buaminger, & Rogers, 2011); commonly comorbid with psychosis (Konstantareas & Hewitt, 2001; Stahlberg, Soderstrom, Rastam, & Gillberg, 2004). Future studies should aim to separate these diagnoses or explore different capacity measures.

Metacognition measures

The Beck Cognitive Insight Scale (BCIS) used within chapter 3, and investigated within the literature review, aimed to capture self-reflectiveness; objectivity and openness to feedback. However, due to the state-like nature of the concepts asked within the questionnaire and the stage of recovery within the FEP group, it is unclear whether participants should rate past thinking (which may be subject to biases and appraisals) or current thinking. This was particularly difficult for individuals who were engaged in the study as part of the follow-up study, as they noted the experiences in the past were frequent, but they are infrequent now. Therefore, changes and variation over the illness impacted the way people reflected and responded. Finally, most importantly, questions could be raised as to whether it is appropriate to ask someone to reflect and rate their own metacognitive ability; a complex and comprehensive ability, using a questionnaire.

Anomalous experiences

The potential issue with regard to the trajectory of illness and self-reported behaviours or experiences are also applicable for the Schizotypal Symptom Inventory (SSI). This scale was originally developed to assess the levels of sub-threshold psychotic symptoms in the recovery phase (Hodgekins et al., 2012). However, despite being valid for healthy controls, this scale may be interpreted differently for those with an experience of psychosis (regardless of stage of illness), in comparison to individual who have not experienced difficulties with their mental health. For example, for an individual with a previous history of experiencing telepathy, the question: "Do you believe in telepathy?" may be rated at the lower end of the scale if they are now better able to reflect on their past experiences, identify this may have been linked to their mental health, and acknowledge that this belief is inconsistent with their current belief system. However, for an individual who has not experienced clinical levels of anomalous experiences/beliefs, may rate higher than the FEP group, if they have believed this throughout anytime in their life. Therefore, it appears that for the two groups there were different thresholds of reporting the experience and therefore this could have influenced the reporting. Future studies or questionnaire developments may benefit from providing a timescale to capture experiences, e.g. within the last 6 months, which provides a more current view of experiences or more informative anchors to encourage all to rate according to the same criteria.

Anomalous self-experiences

In terms of anomalous self-experiences, these experiences may be underreported due to shame, and fear of stigma, particularly for young people with emerging mental health difficulties (Nelson, Fusar-Poli, & Yung, 2012). Alternatively, Henriksson & Parnas (2014) suggested that the anomalous self-experiences have been present for so long in the psychosis group that they are inherent to the person's identity, a "trait-like feature" (p.546), which means that anomalous self-disturbance may be unreported and under-researched. Associated with this, it may be suggested that anomalous self-experiences are dampened and therefore less noticeable to the individual. Whilst Cambridge Depersonalisation Scale (CDS) was appropriate, valid and reliable for assessing anomalous self-experiences in both clinical and non-clinical groups (see Sierra & Berrios, 2000; Perona-Garcelán et al., 2011; Perona-Garcelán et al., 2012), studies have detailed interviews conducted by trained intervewers to detect subtle differences or experiences. For example, Examination of Anomalous Self-Experience (EASE (Parnas et al., 2005; Sass et al., 2013). This is a symptom checklist using a semi-structured exploration of experiential anomalies of self-awareness. This may overcome the difficulties with self-report measures and could be considered for future studies.

9.4 **Conclusion**

Findings presented in this thesis build on understanding of functional outcome and subjective recovery outcome and the role of metacognitive ability. Results lend support to current metacognitive literature suggesting the role of metacognitive ability on functioning and that metacognition is a multi-faceted phenomenon. In particular, contrary to hypothesis, metacognitive components are not related within a hierarchy and the dissociation between impaired metacognitive ability and control processes, compared to intact intermediate metacognitive experience, efficiency and monitoring processes in psychosis. It is the former, metacognitive ability, which has the largest impact on real-world functioning. Findings additionally suggest roles for self-defining memories, neurocognition and negative symptoms as additional predictors of functioning. These findings encourage a greater focus of interventions on targeting metacognition, particularly metacognitive ability and self-defining memories, to reduce functional disability and improve subjective recovery in FEP. Evidence also was obtained for the role of perceptual biases on anomalous self-experiences, which may be proposed as an

underlying, subconscious causal vulnerability which may later lead to anomalous perceptual experiences or delusional beliefs.

10. References

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11. Appendices

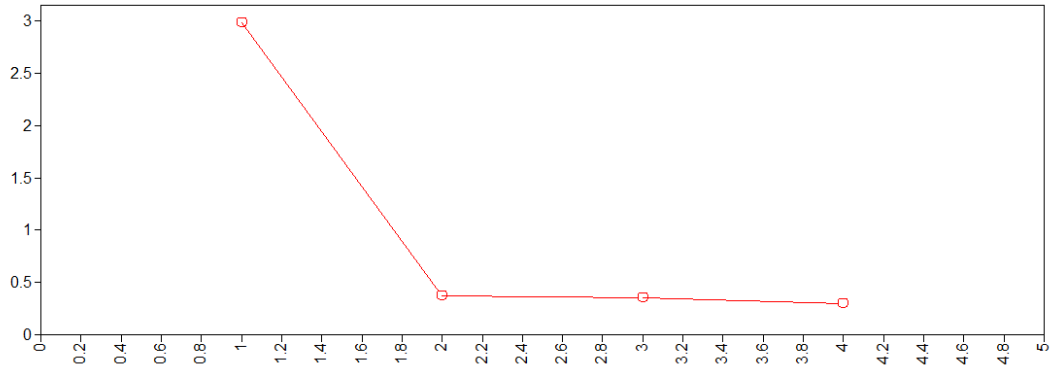
11.1 Appendix A: Supplementary material for Chapter 3

Supplement A

Table 1: Exploratory factor loadings for MAI (one factor)

Item	MAI factor (factor 1)
MAI: Monitoring	**.79**
MAI: Differentiation	**.81**
MAI: Integration	**.85**
MAI: Decentralization	**.8**

Figure 1: Scree plot for EFA for MAI.

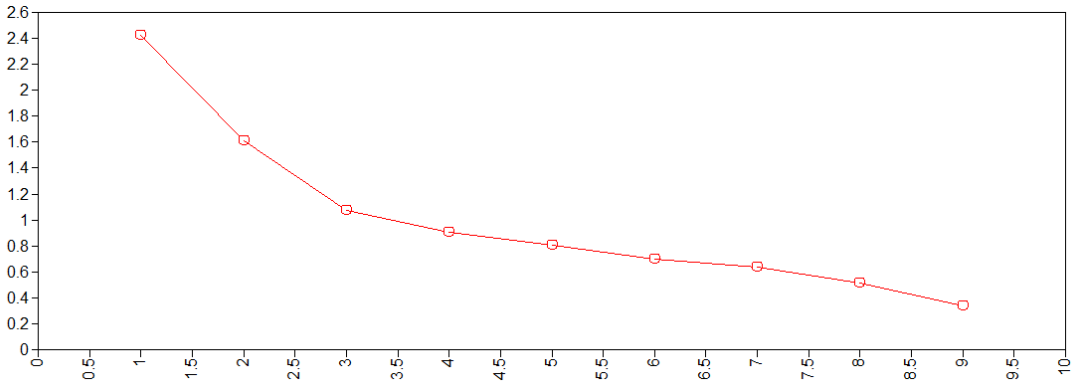


Supplement B

Table 2: Exploratory factor loadings for BCIS (SR) (one factor)

Item	BCIS (factor 1)
BCIS (SR) 1: At times, I have misunderstood other people's attitudes towards me	-.39
BCIS (SR) 2: Other people can understand the cause of my unusual experiences better than I can	-.33
BCIS (SR) 3: I have jumped to conclusions too fast	-.36
BCIS (SR) 4: Some of my experiences that have seemed very real may have been due to my imagination	-.74
BCIS (SR) 5: Some of the ideas I was certain were true turned out to be false	-.79
BCIS (SR) 6: Even though I feel strongly that I am right, I could be wrong	-.12
BCIS (SR) 7: If somebody points out that my beliefs are wrong, I am willing to consider it	-.06
BCIS (SR) 8: There is often more than one possible explanation for why people act the way they do	.09
BCIS (SR) 9: My unusual experiences may be due to my being extremely upset or stressed	-.41

Figure 2: Scree plot for EFA for BCIS-9

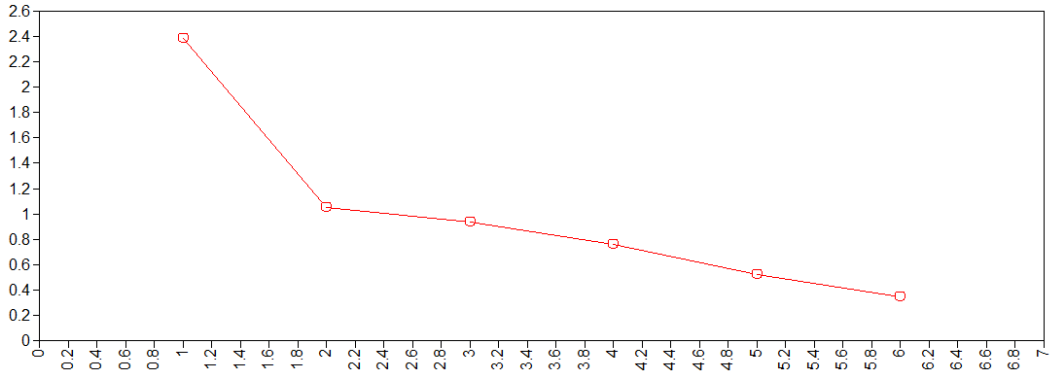


Supplement C

Table 3: Exploratory factor loadings for BCIS (SR-6) (one factor)

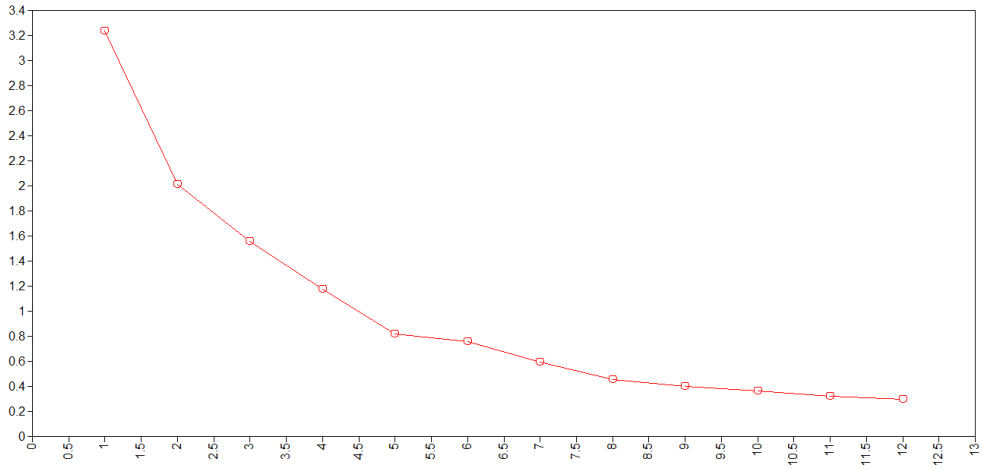
Item	BCIS (factor 1)
BCIS (SR-6) 1: At times, I have misunderstood other people's attitudes towards me	.39
BCIS (SR-6) 2: Other people can understand the cause of my unusual experiences better than I can	.33
BCIS (SR-6) 3: I have jumped to conclusions too fast	.37
BCIS (SR-6) 4: Some of my experiences that have seemed very real may have been due to my imagination	.74
BCIS (SR-6) 5: Some of the ideas I was certain were true turned out to be false	.79
BCIS (SR-6) 9: My unusual experiences may be due to my being extremely upset or stressed	.41

Figure 3: Scree plot for EFA for BCIS (SR-6) (6 items)



Supplement D

Figure 4: Scree plot for EFA for metacognitive variables.



11.2 Appendix B: Supplementary material from Chapter 4

Supplement A

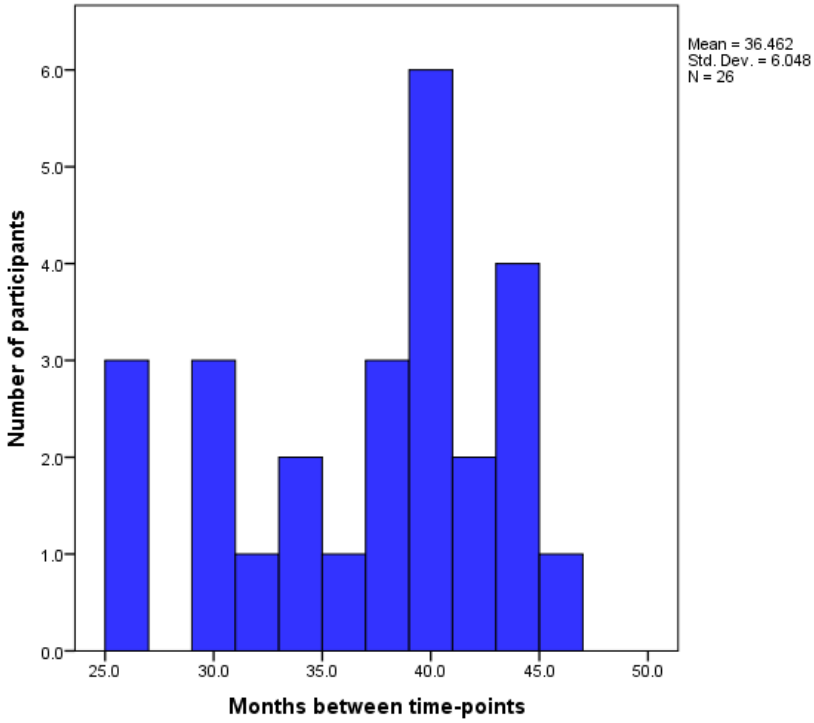
Table 1: Correlation matrix for neurocognition, metacognition, symptoms, functional capacity and functional outcome at baseline and follow-up.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Neurocognitive factor (baseline) 1	-												
Metacognition (baseline) 2	.61**	-											
Positive symptoms (baseline) 3	-.22	-.15	-										
Negative symptoms (baseline) 4	.43**	-.64**	.17	-									
General psychopathology symptoms (baseline) 5	-.22	-.39**	.59**	.52**	-								
UPSA (baseline) 6	.48**	.53**	-.09	-.44**	-.15	-							

Time-use (baseline)7	.48**	.84**	-.1	-.49**	-.27*	.39**	-						
Metacognition (follow-up) 8	.66**	.64**	-.33	-.56**	-.33	.66*	.4*	-					
Positive symptoms (follow-up) 9	-.32	-.36	-.39	.28	.17	-.31	-.29	-.59**	-				
Negative symptoms (follow-up) 10	-.54**	-.46*	.3	.51*	.13	-.46*	-.34	-.55**	.71**	-			
General psychopathology symptoms (follow-up) 11	-.28	-.44*	.38	.23	.26	-.34	-.47*	-.31	.75**	.67**	-		
UPSA (follow-up) 12	.71**	.63**	-.29	-.42*	-.31	.74**	.3	.49**	-.29	-.48*	-.24	-	
Time-use (follow-up) 13	.29	.82**	.02	-.41*	-.23	.54**	.74**	.42*	-.37*	-.46*	.47**	.5**	-

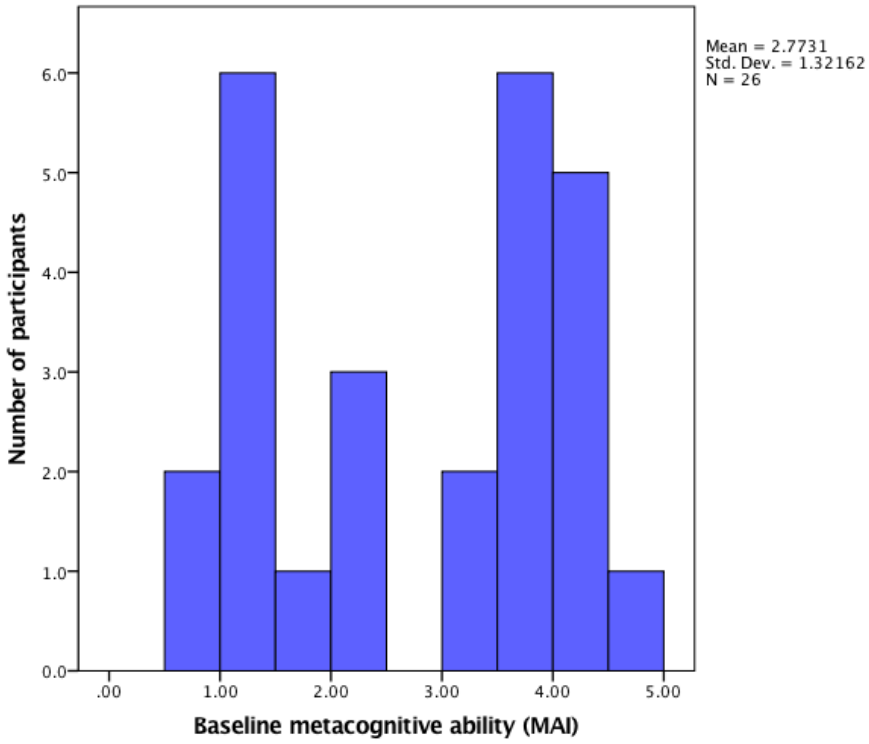
Supplement B

Figure 1: Bar chart for distribution of months between baseline and three years for full sample.



Supplement C

Figure 2: Bar chart for distribution of baseline metacognitive ability for the follow-up sample.



11.3 Appendix C: Supplementary material for Chapter 5

Supplement A

Details of coding self-defining memory: The first self-defining memory was additionally coded using the variables below:

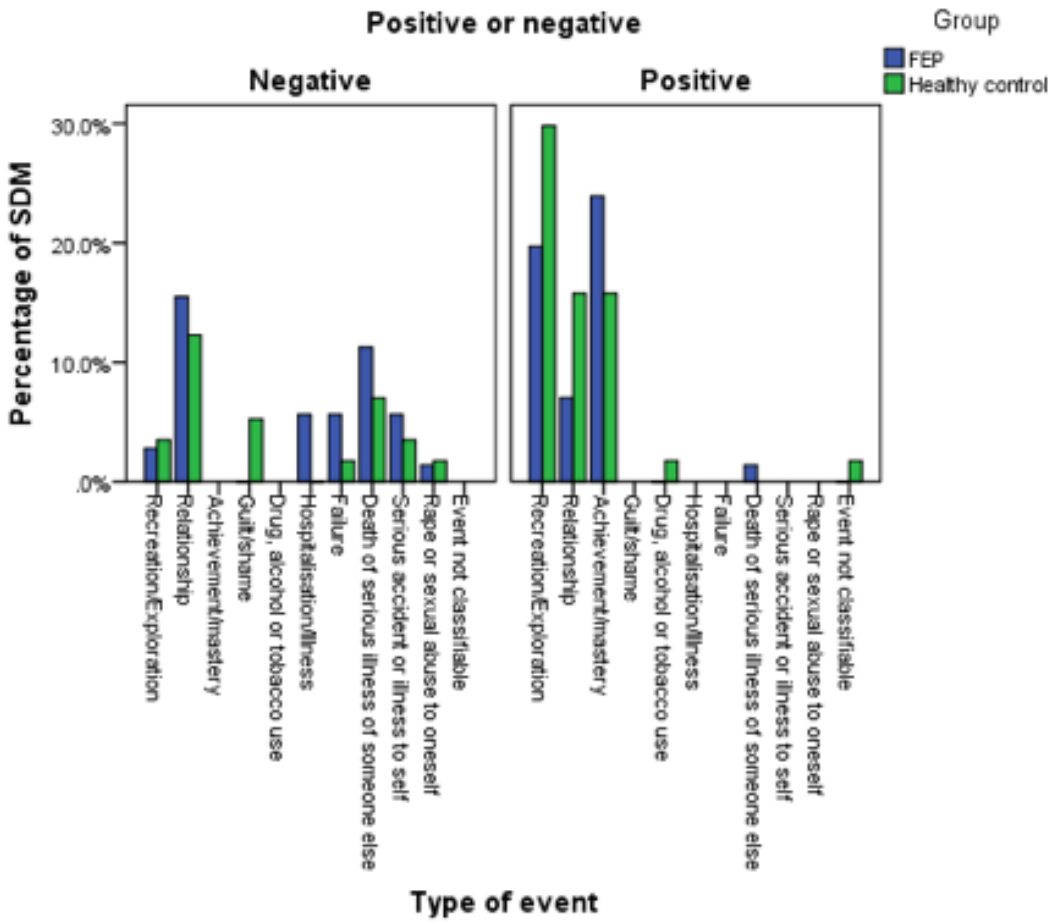
- Age during event
- Specificity: A binary variable coding non-specific (0) or specific (1)
- Integration: A binary variable coding not integrated (0) or integrated (1)
- Content type: We used the Manual for Coding Events in Self-Defining Memories[95]. This has been used in previous studies within schizophrenia research (Raffard et al., 2009) which scores the SDM into one of seven categories, but also including two additional categories: "hospitalization/stigmatization of illness" and "failure" relevant to people with psychosis. The categories included:
    - Recreation/Exploration (including spiritual moments);
    - Relationships (involving interpersonal investment, conflict or non-conflict);
    - Achievement/mastery (effort towards goals or skills);
    - Guilt/Shame (over doing something wrong);
    - Drug, alcohol, and tobacco use (for recreation or self-harm);
    - Life-threatening/ death (perceived as such to self or others at the time of the event);
    - Hospitalization/Stigma (specifically mental health illness experience and stigma);
    - Failure (and negative self-perception including in a social construct);
    - Event unclassifiable (rare, not fitting any of the above categories)

Content valence: A binary variable as negative (0) or positive (1)

Content valence was added as a measure specifically to identify the impact of a positive or negative content on an individual's real-world functioning. Positive or negative valence was decided using a similar decision making process as for content type within the Manual for Coding Events in Self-Defining Memories.

Supplement B

Figure 1: Clustered bar graph demonstrating percentage of type of events reported which are divided into positive or negative content of self-defining memories for First Episode Psychosis and healthy control sample.



11.4 Appendix D: Supplementary material for Chapter 6

Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies table (U.S. Department of Health & Human Services. n.d.)

Criteria	Yes	No	Other (NA/NR/CD)
Was the research question or objective in this paper clearly stated?			
Was the study population clearly specified and defined?			
Was the participation rate of eligible persons at least 50%?			
Were all the subjects selected or recruited from the same or similar populations? Were inclusions and exclusion criteria for being in the study prespecified and applied uniformly to all participants?			
Was a sample size justification, power description, or variance and effect estimates provided?			
For the analyses in this paper, were the exposures of interest measured prior to the outcomes being measured?			
Was the time frame sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?			
For exposures that can vary in amount of level, did the study examine different levels of the exposure as related to the outcome? (e.g. categories of exposure, or exposure measured as continuous variable)?			
Were the exposure measures (independent variables) clearly defined, valid, reliable and implemented consistently across all study participants?			
Was the exposure assess more than once over time?			
Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?			
Were the outcome assessors blinded to the exposure status of participants?			
Was loss to follow-up after baseline 20% or less?			
Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure and outcome(s)?			

11.5 Appendix E: Supplementary material for Chapter 8

Twenty-four people (9 FEP and 15 controls) had a perfect score on absent trials, implying an infinite d'. Following current research (Macmillan & Creelman, 2005) we converted proportions of 0 and 1 to 1/(2N) and 1-1/(2/N), respectively, where N is the number of trials on which the proportion is based. This strategy was used to correct the infinity scores for further calculation.

11.6 Appendix F: NHS HRA Research Ethics Committee (REC) approval for Chapters 3, 4, 5 & 8

NHS
Health Research Authority

Miss Abigail Christine Wright
PhD Student
University of Sussex and
Sussex Partnership NHS Foundation Trust
School of Psychology
University of Sussex
Falmer
BN1 9RH

Email: hra.approval@nhs.net

09 March 2017

Dear Miss Wright,

Letter of HRA Approval

Study title:	**Understanding unusual experiences and function in young people to develop a dynamic model of symptoms and function in young people with or without First Episode Psychosis**
IRAS project ID:	**208447**
REC reference:	**17/LO/0055**
Sponsor:	**University of Sussex**

I am pleased to confirm that **HRA Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications noted in this letter.

Participation of NHS Organisations in England

The sponsor should now provide a copy of this letter to all participating NHS organisations in England.

Appendix B provides important information for sponsors and participating NHS organisations in England for arranging and confirming capacity and capability. **Please read *Appendix B* carefully**, in particular the following sections:

- *Participating NHS organisations in England* – this clarifies the types of participating organisations in the study and whether or not all organisations will be undertaking the same activities
- *Confirmation of capacity and capability* - this confirms whether or not each type of participating NHS organisation in England is expected to give formal confirmation of capacity and capability. Where formal confirmation is not expected, the section also provides details on the time limit given to participating organisations to opt out of the study, or request additional time, before their participation is assumed.

- *Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* - this provides detail on the form of agreement to be used in the study to confirm capacity and capability, where applicable.

Further information on funding, HR processes, and compliance with HRA criteria and standards is also provided.

It is critical that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

Appendices

The HRA Approval letter contains the following appendices:

- A – List of documents reviewed during HRA assessment
- B – Summary of HRA assessment

After HRA Approval

The document *"After Ethical Review – guidance for sponsors and investigators"*, issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

In addition to the guidance in the above, please note the following:

- HRA Approval applies for the duration of your REC favourable opinion, unless otherwise notified in writing by the HRA.
- Substantial amendments should be submitted directly to the Research Ethics Committee, as detailed in the *After Ethical Review* document. Non-substantial amendments should be submitted for review by the HRA using the form provided on the HRA website, and emailed to hra.amendments@nhs.net.
- The HRA will categorise amendments (substantial and non-substantial) and issue confirmation of continued HRA Approval. Further details can be found on the HRA website.

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rd-review/.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

IRAS project ID	208447

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please email the HRA at hra.approval@nhs.net. Additionally, one of our staff would be happy to call and discuss your experience of HRA Approval.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

Your IRAS project ID is **208447**. Please quote this on all correspondence.

Yours sincerely,

Emma Stoica
Senior Assessor

Email: hra.approval@nhs.net

Copy to:

Dr Antony Walsh [sponsor contact]
Ms Taffy Bakasa [NHS R&D contact]
NIHR CRN Portfolio Applications Team

11.7 Appendix G: Sussex Partnership NHS Foundation Trust (SPFT) governance approval Chapters 3, 4, 5 & 8

Sussex Partnership NHS
NHS Foundation Trust

Research and Development
Sussex Education Centre
Mill View Hospital
Nevill Avenue
Hove BN3 7HZ

Tel: 0300 304 0088
Fax: 01273 242182

www.sussexpartnership.nhs.uk

10th March 2017

Miss Abigail Christine Wright
PhD Student
School of Psychology
University of Sussex
Falmer
BN1 9RH

Dear Miss Wright,

Study Title: Understanding unusual experiences and function in young people to develop a dynamic model of symptoms and function in young people with or without first episode psychosis (UNICOrN)
Trust Ref: IRAS 208447

Thank you for your application to Sussex Partnership Trust to conduct the above named study with in the Trust. I am pleased to inform you that Sussex Partnership has the capacity and capability to conduct this study at the following sites:

- Sussex Partnership Early Intervention Services

Our confirmation of capacity and capability to host this research study relates to the specific protocol and informed consent procedures described in your HRA application form approved by the HRA, and by the Statement of Activities agreed with SPFT. Any deviation from this will be deemed to invalidate this confirmation.

The documents reviewed for this approval were:

Document	Version	Date
Copies of advertisement materials for research participants [Control participant recruitment poster]	1	29 December 2016
Copies of advertisement materials for research participants [Clinical participant recruitment poster]	1	29 December 2016
Copies of advertisement materials for research participants [Blurb for online recruitment]	1	29 December 2016
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Sponsor Insurance]	1	01 August 2016
GP/consultant information sheets or letters [Letter to clinical participant's care team and GP]	1	02 February 2017

Interview schedules or topic guides for participants [Positive And Negative Symptom Scale Interview schedule and score sheet]	1	29 December 2016
Interview schedules or topic guides for participants [Time Use Survey interview schedule and score sheet]	1	29 December 2016
Interview schedules or topic guides for participants [Metacognitive Assessment Interview]	1	29 December 2016
Letter from funder [Letter from funder]	1	15 December 2016
Letter from sponsor [Sponsorship Approval]	1	15 December 2016
Letters of invitation to participant [Invitation letter]	1	29 December 2016
Non-validated questionnaire [Eligibility Questions]	1	29 December 2016
Non-validated questionnaire [Demographics questionnaire]	1	29 December 2016
Non-validated questionnaire [Example of visual detection task]	1	29 December 2016
Non-validated questionnaire [Auditory confidence ratings]	1	29 December 2016
Non-validated questionnaire [Visual confidence ratings]	1	29 December 2016
Non-validated questionnaire [Research Experience Questionnaire]	1	29 December 2016
Other [Participant debrief sheet]	1	03 December 2016
Other [Control participant debrief sheet]	1	03 December 2016
Other [Statement of Activities]	2	09 March 2017
Other [Schedule of Events]	1	09 March 2017
Participant consent form [Clinical]	3	09 March 2017
Participant consent form [Control]	3	09 March 2017

Sussex Partnership NHS
NHS Foundation Trust

Participant information sheet (PIS) [Clinical]	2	09 March 2017
Participant information sheet (PIS) [Control]	3	09 March 2017
Research protocol or project proposal [Research project protocol]	1	15 December 216
Summary CV for Chief Investigator (CI) [Abigail Wright CV]	1	29 November 2016
Summary CV for supervisor (student research) [Supervisor CV]	1	15 December 2016
Summary CV for supervisor (student research) [Second supervisor CV]	1	15 December 2016
Summary, synopsis or diagram (flowchart) of protocol in non technical language [Script for assessment procedure]	1	29 November 2016
Validated questionnaire [Beck's Cognitive Insight Scale]		
Validated questionnaire [Matrix Reasoning Task]		
Validated questionnaire [Schizotypal Symptom Inventory]		
Validated questionnaire [UCSD Performance-based skill task]		
Validated questionnaire [Multimodal Unusual Sensory Experience Questionnaire]		
Validated questionnaire [Vocabulary task]		
Validated questionnaire [Cambridge Depersonalisation Scale (Trait Version)]		
Validated questionnaire [Cambridge Depersonalisation Scale (state version)]		
Validated questionnaire [Trail making task]		
Validated questionnaire [Questionnaire of Process of Recovery]		

Sussex Partnership NHS
NHS Foundation Trust

Conditions of Approval

CI Responsibilities: As Chief Investigator of the study you agree to fully comply with the Department of Health Research Governance Framework, in particular that you are aware of and fully discharge your responsibilities in respect to Data Protection, Health and Safety, financial probity, ethics and scientific quality.

Recruitment: As the project has been adopted by the NIHR, you are responsible for ensuring accrual numbers are submitted to the co-ordinating centre for study on a monthly basis. If you need any support to manage this please contact me.

Conflict of Interest: You are responsible for insuring that any conflict of interest by any member of the research team will be disclosed. This includes any arising during the course of the research.

Honorary contracts: Members of the research team must have appropriate substantive or honorary contracts or letters of access (as appropriate) with the Trust prior to conducting any research on Trust premises. Any additional researchers who join the study at a later stage must also hold a suitable contract or must contact the R&D department to arrange an honorary contract/letter of access prior to commencing work on this research study.

Essential Documents: A project file or site file will be maintained for this study. Support from the R&D Office can be sought in creating and maintaining a site file.

Amendments: Project amendment details dated after the issue of this approval letter should be emailed to the Research and Development Office (research.governance@sussexpartnership.nhs.uk). Trust confirmation of capacity and capability must be issued prior to the implementation of any amendment.

Adverse Events: All adverse events and safety incidents will be reported to the study Sponsor as defined by the study protocol. In addition in line with SPFT Research Policy, you must report any adverse events and incidents to the R&D Office.

Monitoring: The Trust has a duty to ensure that all research is conducted in accordance with the Research Governance Framework and to ICH-GCP standards. In order to ensure compliance the Sponsor, Trust or Regulatory Body may undertake random audits and inspections. If your project is selected for a Trust inspection you will be given 4 weeks' notice to prepare all documentation for inspection. The trust undertakes annual monitoring of all research studies, please respond to any requests for information. Failure to do this may result in the Trust withdrawing its confirmation of capacity and capability. The information contained in this application, any supporting documentation and all correspondence with the R&D office may be

Sussex Partnership NHS
NHS Foundation Trust

subject to the provisions of the Freedom of Information Acts and may be disclosed in response to requests made under the Acts except where statutory exemptions apply.

Dissemination: Upon completion of the research the study team will be contacted to confirm arrangements for dissemination. Dissemination of findings is a condition of approval and will be monitored by the Research & Development Office. Failure to disseminate may result in the Trust being unable to support future studies.

I wish you luck with your project and would be grateful if you could inform me when the project is complete or due to be closed on this site.

Please sign below and return a copy to researchgovernance@sussexpartnership.nhs.uk

Yours sincerely,

Bakasa.

Taffy Bakasa
Lead Research Governance Officer

Please sign and date this letter and return one copy. Do not detach this lower section from the letter.

PLEASE SIGN AND DATE BELOW TO CONFIRM THAT YOU HAVE READ AND AGREED TO YOUR RESPONSIBILITIES AS PRINCIPAL INVESTIGATOR TO THE ABOVE STUDY

SIGNATURE ..Dwight.....

NAME (in block capitals) ...ABIGAIL WRIGHT.....

DATE ..10/03/17.....

11.8 Appendix H: Research Ethics Committee (REC) approval for Chapter 4 (baseline) and Chapter 5

NHS
Health Research Authority

NRES Committee London - Camden & Islington
North East REC Office
Room 002
TEDCO Business Centre
Rolling Mill Road
Jarrow
Tyne & Wear
NE32 3DT

Tel: 0191 428 3566
Fax: 0191 428 3432

25 July 2013

Dr Richard Whale
Consultant Psychiatrist / Senior Lecturer
Sussex Partnership Foundation NHS Trust / Brighton and Sussex Medical School
The White House
54 New Church Road
Hove
BN3 4FL

Dear Dr Whale

Study title:	**Sussex First Episode Psychosis Outcome Study**
REC reference:	**11/LO/1877**
Amendment number:	**2**
Amendment date:	**12 July 2013**
IRAS project ID:	**72141**

The above amendment was reviewed by the Sub-Committee in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	Version	Date
Summary of changes to protocol and REC form		01 July 2013
Participant Consent Form	2	01 July 2013
Participant Information Sheet	3	01 July 2013
Protocol		
Notice of Substantial Amendment (non-CTIMPs)	2	12 July 2013

UCSD Performance-Based Skills Assessment (UPSA-2)		
Metacognitive Interview Scale (MAI)		
Weschler Scales		
Cohort Data Pack		
Covering Letter		12 July 2013

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

11/LO/1877:	**Please quote this number on all correspondence**

Yours sincerely

J Brown

pp Mrs Rosie Glazebrook
Chair

E-mail: nrescommittee.london-camdenandislington@nhs.net

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Tanya Telling, Sussex Partnership NHS Foundation Trust*

11.9 Appendix I: Sussex Ethics for Chapter 7

University of Sussex

Certificate of Approval	
Reference Number	ER/AW395/7
Title Of Project	Pilot study: Understanding the association between anomalous experiences and metacognition
Principal Investigator (PI):	Kathy Greenwood
Student	Abigail Christine Wright
Collaborators	
Duration Of Approval	4 months
Expected Start Date	10-Jun-2016
Date Of Approval	15-Jun-2016
Approval Expiry Date	17-Oct-2016
Approved By	David Reby
Name of Authorised Signatory	
Date	15-Jun-2016

*NB. If the actual project start date is delayed beyond 12 months of the expected start date, this Certificate of Approval will lapse and the project will need to be reviewed again to take account of changed circumstances such as legislation, sponsor requirements and University procedures.

Please note and follow the requirements for approved submissions:

Amendments to protocol

* Any changes or amendments to approved protocols must be submitted to the C-REC for authorisation prior to implementation.

Feedback regarding the status and conduct of approved projects

* Any incidents with ethical implications that occur during the implementation of the project must be reported immediately to the Chair of the C-REC.

Feedback regarding any adverse and unexpected events

* Any adverse (undesirable and unintended) and unexpected events that occur during the implementation of the project must be reported to the Chair of the Social Sciences C-REC. In the event of a serious adverse event, research must be stopped immediately and the Chair alerted within 24 hours of the occurrence.

For Life Sciences and Psychology projects

* The principal investigator is required to provide a brief annual written statement to the committee, indicating the status and conduct of the approved project. These reports will be reviewed at the annual meeting of the committee. A statement by the PI to the C-REC indicating the status and conduct of the approved project will be required on the Approval Expiration Date as stated above.