THE COGNITIVE ANTECEDENTS OF PSYCHOSIS-LIKE (ANOMALOUS) EXPERIENCES: VARIANCE WITHIN A STRATIFIED QUOTA SAMPLE OF THE GENERAL POPULATION

BY

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"The terror began unobtrusively. Noises in Regan's room, an odd smell, misplaced furniture, an icy chill. Small annoyances for which Chris MacNeil, Regan's actress mother, easily found explanations. The changes in eleven-year-old Regan were so gradual, too, that Chris did not recognize for some time how much her daughter's behavior had altered. Even when she did, the medical tests which followed shed no light on Regan's symptoms, which grew more severe and frightening. It was almost as if a different personality had invaded the child. Desperate, Chris turned to Father Damien Karras, a Jesuit priest who was trained as a psychiatrist and had a deep knowledge of such phenomena as satanism and possession. If psychiatry could not help, might exorcism be the answer?"

(*The Exorcist*; Blatty, 1971, jacket)

Mission statement

The above quote, albeit over forty years old, highlights a variety of inexplicable (and frightening) phenomena that have captured the imagination for time immemorial (e.g., Irwin & Watt, 2007; Kermode, 2003; Nickell, 2001; Oesterreich, 1966; Roll, 1979, 2004). More specifically, the belief in paranormal and supernatural phenomena, such as poltergeists and demons, as being entities with which we can communicate—consciously, or not—strikes at the very heart of what it is to be human (Joseph, 2003). That is, to possess a self-defined consciousness, independence of thought, and a distinct personality: attributes for which discarnate entities (allegedly) pay scant credence. But how can such a large proportion of the populace entertain such ideology based on its apparent incredulity?

This research is borne from a lifelong inquisitiveness into the pervasive and perseverative nature of unusual beliefs and experiences in the face of mounting rational evidence to the contrary. Fuelling this inquiry are encounters with individuals engaging in paranormal (including occult) practices (e.g., Tarot, astrology, Wicca), those experiencing or who had previously experienced anomalous (psychosis-like) phenomena—both from a *clinical* perspective (e.g., encounters with non-hospitalised schizophrenic and bipolar disordered patients), plus *personal* experiences gained whilst under the influence of drugs (both recreational and medicinal).

Personal experiences gained whilst under the influence of recreational drugs were due to the respiratory and oral imbibing of cannabis from mid-teens through early-twenties; these anomalous experiences consisted mainly of time distortions (lapses, recurrences, plus slowing and acceleration), suspiciousness, grandiose imaginings (e.g., fantastical plans to harmonise humanity), and magical thinking (e.g., belief in ESP and PK). Notwithstanding, the fantastical content of those “recreational” drug-related experiences were at times extremely frightening, possibly due to the lack of conscious control. Conversely, those experiences gained whilst under the influence of medicinal drugs (i.e., oral as opposed to intravenous corticosteroids) although at times frightening (e.g., being “hunted” by demonically-glyphed orbs) were far less pertinent; that is, they had a lesser impact upon my psyche as the content and context within which they occurred allowed for rational, conscious evaluation.

From such experiences a mental springboard was forged from which academic pursuit could launch. Although not my initial line of postgraduate inquiry—that being the neurocognitive depletives associated with MS—this line of research, with its emphasis on the unusual and bizarre beliefs and experiences inherent to us all, and myriad combinations thereof, provides plentiful scope for investigation.

Dedications & acknowledgements

This research is dedicated to my family and friends, especially my parents; for without their unconditional love and unselfish support, I would not have been in the privileged position to investigate those things that fascinate me. To them I offer my heartfelt gratitude and the hope that this thesis goes some way to convincing them that their patience, kindness, and generosity was not misplaced.

I would also like to gratefully thank my supervisory team for their help and support, especially my original director of studies, Dr. John Stirling, for keeping me focused and grounded—reining me in during my preponderances to stray into the realms of fantasy. His knowledge regarding the scientific process, with regard to all aspects of my thesis, was invaluable. As were the contributions of my present director of studies, Mr. John Cavill—what that man does not know about Excel is not worth knowing—but, more seriously, his continued help in aiding me overcome numerous statistical obstacles was I'm sure, at times, provided through gritted teeth; and Dr. Andrew Parker, who's expertise regarding scientific methodology was pertinent and always welcome. Collectively, they kept reminding me, quite correctly, that reinventing the wheel was beyond my remit. Grateful thanks are also forwarded to Mr. Gareth Preston, who provided the technical expertise allowing for the generation of the computerised cognitive test battery.

I would also like to thank all participants (friends, family, and otherwise) for their willing involvement. Many had allocated specific time from their day-to-day duties, I could not have hoped for such unselfish engagement.

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Finally, many thanks to William Peter Blatty, author of *The Exorcist*, for corrupting the innocence of youth—my fault for picking up the darned book! Ah, the inquisitiveness of an eleven-year-old.

To all, a heartfelt: THANK YOU.

Abbreviations

General abbreviations:

α: Co-efficient alpha

AES: Apathy evaluation scale

ANCOVA: Analysis of covariance

ANOVA: Analysis of variance

APA: American psychiatric association

AUIE: Age-universal "intrinsic/extrinsic" (scale)

BA: Brodmann's area

BIMP: British inventory of mental pathology

CCS: Cybernetic coping scale

cf.: compare with

CFA: Confirmatory factor analysis

CNS: Central nervous system

CP: Cognitive-perceptual (positive dimension of the SPQ-B)

CPT: Continuous performance test

CPT-IP: CPT-independent pairs

d': d-prime

DES: Dissociative experiences scale

DRM: Deese-Roediger-McDermott

DSM: Diagnostic and statistical manual

DT: Disorganised thought (disorganised dimension of the SPQ-B)

DV: Dependent variable

e.g.: for example

EPI: Eysenck personality inventory

EPQ: Eysenck personality questionnaire

FFM: 5-factor model (of “normal” personality)

ICD: International classification of diseases

ID: Interpersonal dysfunction (negative dimension of the SPQ-B)

i.e.: that is to say

IQ: Intelligence quotient

IV: Independent variable

JTC: Jumping-to-conclusions

LSHS-R: Launay-Slade hallucinations scale-revised

LTA: Linear trend analysis

MI: Magical ideation scale

NART: National adult reading test (verbal IQ)

OCD: Obsessive-compulsive disorder

O-LIFE: Oxford-Liverpool inventory of feelings and experiences

PAS: Perceptual aberration scale

PCA: Principal components analysis

PDI: Peters et al. delusions inventory

PEN: Eysenck’s ‘psychoticism/extraversion/neuroticism’ model of personality

PLEs: Psychosis-like experiences

PTSD: Posttraumatic stress disorder

RPBS: Revised paranormal belief scale

RTS: Revised transliminality scale

s.c.: in this particular instance/specifically

SD: Standard deviation

SDT: Signal detection theory

SLESQ: Stressful life events screening questionnaire

SOC: Sense of coherence

SPD: Schizotypal personality disorder

SPQ: Schizotypal personality questionnaire

SPQ-B: Schizotypal personality questionnaire-Brief

STA: Schizotypal traits questionnaire, form A

UnEx: Unusual experiences (positive dimension of the O-LIFE)

VVIQ: Vividness of visual imagery questionnaire

WASI: Wechsler abbreviated scales of intelligence

WHO: World health organisation

Manuscript-specific abbreviations:

ANCOG: Anomalous cognitions

BT: Beads test

CCTB: Computerised cognitive test battery

CDA: Canonical discriminant analysis

Conf$_{\mathbf{50:50}}$: Confidence when uncertain

CSA: Childhood sexual abuse

DTC: Draws-to-conclusion

DUS: Drug use scale

ESNS: Emotional support network scale

EV: Eigenvalue

GCA: General cognitive ability (proxy IQ)

GE: Graded estimates

HOV: Homogeneity of variance

In*R*: Random errors

LVS: Lifeview system

MR: Matrix reasoning (fluid/visuoconstructive IQ)

NCRs: Number of correct responses

OR: Object recognition

PC: Perceptual closure

PE: Prediction error

PEC: Proportion of errors corrected

PIN: Participant identification number

RM: Reality monitoring

SAS: Social adaptation skills

SM: Self-monitoring

SOA: Sense of agency

SRM: Self-report measure

TRB: Traditional religious beliefs

WM: Working memory

XPG: Experimental group

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Abstract

In the general population, psychosis-like experiences have been extensively studied under the psychometric rubric of schizotypy (psychosis-proneness). As such, Phase 1 of this thesis aimed to assess the distribution of schizotypal traits and associated personality correlates displayed within a quota sample of the general population stratified by Gender and Ageband, the emphasis being upon anomalous experiences (positive schizotypy). Respondents (N = 130) completed a battery of established self-report measures assessing thirteen areas of personal experience. Correlational analysis revealed that eleven of the measures of ostensibly anomalous experiences possessed significant intercorrelations. Subsequent principal components analysis identified three factors accounting for 64.91% of the total variance; the factor accounting for the greatest proportion of variance (42.97%) was interpreted as representing a psychological disposition towards reporting 'Anomalous Cognitions'. The other two factors are named 'Lifeview System' (12.60% of total variance) and 'Social Adaptation Skills' (9.34% of total variance). From the principal factor inclusion criteria for Phase 2 of the research are explicated. No significant mean Gender differences were revealed for the six self-report measures that provided unique contributions toward anomalous cognitions, the two self-report measures that uniquely contributed toward a lifeview system, or for the single self-report measure that uniquely contributed toward social adaptation skills. Additionally, four of the nine self-report measures which provided unique factorial contributions generated significant mean differences between Agebands, with a further three providing trends toward significant mean differences. Implications for the role of anomalous cognitions, a framework for a lifeview system, and social adaptation skills with regard to psychosis-proneness are discussed. From the primary factor (anomalous cognitions), three experimental groups were identified for cognitive testing: respondents scoring 1) $\leq 20^{th}$ percentile; 2) 10% ± the mean; and 3) $\geq 80^{th}$ percentile. This procedure provided a total of 78 participants (three x 26) for Phase 2 testing.

Phase 2 of this thesis sought to identify some of the cognitive mechanisms underpinning subclinical anomalous cognitions with a view to deciphering which measures best predicted experimental group membership. A comprehensive literature review highlighted six domains of cognition, five accompanying self-report measures, and two measures of intelligence functioning (verbal and fluid/visuoconstructive), which, following previous research, were utilised as covariate measures. Based on prescribed delineation points, participants were allocated, according to scores on the primary factor from Phase 1, to one of three experimental groups (low-, mid, and high-anomalous cognitions). Of the six cognitive domains—1) sustained visual attention; 2) false (illusory) memory; 3) probability reasoning (decision making); 4) object recognition; 5) reality monitoring; and 6) self-monitoring—four succeeded in eliciting significant mean differences between experimental groups with the noted exceptions of sustained visual attention and self-monitoring. Subsequent canonical

discriminant analyses identified that the best predictors of XPG membership were the number of critical lures recognised on the false memory test, the number of correct responses and confidence when uncertain on the object recognition test, plus two self-report measures pertaining to comorbid psychopathology and the vividness of visual imagery. In light of previous research, the inclusion of fasle (illusory) memory biases, the comorbidity of mental pathology (especially, depressive and anxiety-related symptoms), and the vividness of visual imagery are unsurprising; however, the two object recognition variables (the ‘number of correct responses’ and ‘confidence when uncertain’) offer exciting avenues for future research into the continuum of psychosis. Moreover, the ‘confidence when uncertain’ data from the object recognition test (perceptual) and the probability reasoning (decision making) data from the Beads test suggest that cognitive underconfidence may well be an enduring personality disposition in those reporting elevated levels of anomalous cognitions, including positive and disorganised schizotypal personality traits. The results of Phase 2 add confirmatory evidence to previous research suggestive of memory and perceptual biases plus comorbid psychopathology and the vividness of visual imagery as being integral to the psychogenesis of psychosis-like (anomalous) symptomatology.

0. Prologue

0.1 Research statement

Despite being necessarily allied to the literature regarding the positive symptomatology of schizophrenia and schizophrenia spectrum disorders (i.e., hallucinatory experiences and delusional ideation); more specifically the personality (individual differences) correlate of schizotypy, this thesis's overarching remit is to assess anomalous cognitions in some of their various guises. To this end, first, the personality correlates of positive schizotypy will be investigated in a quota sample of the general population stratified by age and gender. Second, a necessarily restricted range of the cognitive antecedents of such personality dispositions will be empirically evaluated.

0.2 Anomalous experiences: A brief history

Anomalous experiences (e.g., near-death experiences) and their associated beliefs have potently existed since the ancient world (French, 2003; Spanos, 1994) where modern Westernised society has its roots (in Egypt, Mesopotamia, Palestine, Syria, Greece and Rome, and pre-Christian Northern and Western Europe). Our ancestors of not so many centuries ago regarded anomalous experiences as possessing supernatural agency; that is, perceptual (e.g., precognitive dreams) and behavioural aberrations (e.g., sleepwalking) were attributed to otherworldly origins. Moreover, all cases of severe psychopathology were regarded as possessing supernatural agency. For example, individuals with psychosis were said to be possessed by evil spirits, a contemporarily naïve explanation that was also applied to the neurotic [1] suffering from hysteria (Zusne & Jones, 1989). Supernatural beliefs (specifically, demonology and witchcraft) flourished during Europe's medieval period (Kemp & Williams, 1987), influencing and having influence upon Christianity. As such, the healing of mental illness in Western culture is embedded in the Christian "cure-of-souls" tradition (Favazza, 1982; Schoeneman, 1982; Trethowan, 1976). Such ideology, although far less widespread, remains firmly active today (French, 2001; Pfeifer, 1994), and has a far firmer grip on our psyches than the majority would care to accept (Cavendish, 1975) let alone attempt to understand (Bem & Honorton, 1994). Furthermore, concepts such as 'pure evil' and 'pure good' have wide-ranging ramifications for

[1] The term "neurotic" as used by Zusne and Jones (1989) most likely refers to "A personality or mental disturbance *not* due to any known neurological or organic dysfunction" (Reber & Reber, 2001, p. 465). More specifically, to a host of psychological disturbances including depression, anxiety, OCD, phobia, and panic disorder.

individuls' anti- and pro-social attitudes and behaviours (e.g. aggression and altruism; Webster & Saucier, *article in press*).

The first systematic inquiry into the varieties of anomalous experiences was conducted by the Society for Psychical Research in London in 1882. Numerous noted scientists and philosophers gathered "to investigate that large body of debatable phenomena … without prejudice or prepossession of any kind, and in the same spirit of exact and unimpassioned inquiry which has enabled Science to solve so many problems" (Society for Psychical Research, p. 2). Despite the Society for Psychical Research's goals being centred on testing claims of purported psi-related phenomena, such as telepathy and clairvoyance, the Society for Psychical Research was (still is) also interested in personality functioning, dissociative phenomena, hypnosis, preconscious cognition, and related topics (Gurney, Myers, & Podmore, 1886).

During the 19th-Century, European Romanticism involved a profound interest in supernatural and paranormal phenomena, many popular novelists of the time including such phenomena as core plot components. For example, Bram Stoker's *Dracula* (1897) included such concepts as mesmerism, eternal life, and ESP; George Eliot's *The Lifted Veil* (1859) incorporated ESP, fate, and life after death; and Robert Louis Stevenson's *The Strange Case of Dr Jekyll and Mr Hyde* (1886) dealt with split personality (now operationally defined as Dissociative Identity Disorder). In fact, *The Strange Case of Dr Jekyll and Mr Hyde*—such was its impact—coined the phrase "Jekyll and Hyde", which entered the common vernacular and has since been ubiquitously used to describe individuals who present opposites of personality. Even today, the sheer number of bestsellers from respected publishing houses that embrace anomalous phenomena is testament to the fact that at the dawn of the 21st-Century anomalous phenomena such as mystical events, parapsychological phenomena, and near-death experiences (Cardeña, Lynn, & Krippner, 2000b) plus the personality characteristics of those who report them hold an enduring fascination (Dewan, 2006).

To this end, Confucius's (551 to 479 BCE) quote "study the past if you would divine the future" is still relevant today as it reminds us that concepts and observations from different eras and cultural settings may be equally applicable amongst different cultures of heterogeneous origins and chronological placements (Cannon & Kramer, 2012; Fornaro, Clementi, & Fornaro, 2009). A more comprehensive review of research into anomalous phenomena is beyond this thesis's remit; however, interested readers can find helpful and informative reviews by the following authors: Cardeña, Lynn, and Krippner, (2000a); Farha (2007); Irwin (1993); Irwin and Watt (2007); Jinks (2011); Smith (2010a); Roberts and Groome (2001); Tart (2009); Wiseman (2011); and Zusne and Jones (1989).

0.3 Defining anomalous experiences

The English word *anomalous* derives from the ancient Greek ἀνωμαλία, (*anomalos*), which means uneven, irregular, abnormal, incongruous, of uncertain nature or classification, or unequal; as opposed to ὁμαλός (*omalos*), which means the same (unchanging), usual, standard, or common. Utilising this simple criterion, anomalous experiences can be said to be irregular because they differ in *content* from common experiences, and can also be said to be uncommon because they differ in *frequency* from normal experiences. However, beyond this basic 'irregular-uncommon' conceptualisation, encapsulating the gamut of anomalous experiences into a single all-encompassing description is a thankless task. Notwithstanding, anomalous experiences have been recently defined in the psychological literature, thus:

> "… an uncommon experience (e.g., synesthesia) or one that, although it may be experienced by a substantial amount of the population (e.g., experiences interpreted as telepathic), is believed to deviate from ordinary experience or from the usually accepted explanations of reality" (Cardeña, Lynn, & Krippner, 2000b, p. 4).

A more comprehensive description of anomalous experiences is that proposed in the preface to the recently published *Anomalous experiences: Essays from parapsychological and psychological perspectives*:

> 'An experience that might be described as "anomalous" is one that is in some way "out-of-the-ordinary". It can be anomalous in the sense that since that it may appear unusual to the person having the experience or in the sense that the processes involved in the experience appear to be "non-ordinary". Non-ordinary processes might either refer to glitches in what are otherwise relatively well understood processes (e.g., memory anomalies) or to processes that appear to fall beyond current scientific understanding (e.g., psychic experiences)' (Smith, 2010b, p. 1).

What is apparent from these two broad descriptions is that anomalous experiences in some way deviate from that which is ordinarily expected (to be experienced or believed) or indeed is scientifically understood. To this end, it has been postulated that attempts to understand anomalous experiences through the process of scientific abstractions is one of "absurdity" (Cardeña, 2010, p. 73). For the purposes of this research, anomalous *experiences* and *beliefs* (henceforth, anomalous cognitions) are grouped as an amalgam of personality correlates (including schizotypal, hallucinatory, and dissociative experiences). That is, this research is concerned with how anomalous (subjective) experiences relate to psychosis-like experiences (PLEs) and beliefs. Validating this line of investigation, previous research suggests that members of the general population scoring high for psychometric schizotypy, especially for the positive dimension, report experiencing and believing in a greater amount of anomalous and paranormal phenomena (Hergovich, Schott, & Arendasy, 2008; Lange, Irwin, & Houran, 2000; Simmonds & Roe, 2000; Williams & Irwin, 1991).

Chapter 1. General introduction

1.1 Introduction

Using cognitive (neuropsychological) models of the positive symptomatology of psychosis (sc., schizophrenia) (Fletcher & Frith, 2009; Frith, 1992; Garety, Bebbington, Fowler, et al., 2007; Garety, Kuipers, Fowler, et al., 2001; Morrison, 2001; O'Connor, 2009)—clinical disorders marked by, amongst other things, unusual experiences and beliefs, interpersonal dysfunction, and thought disorder (APA, 2000 pp. 299–301; Raine, Reynolds, Lencz, et al., 1994)—this two-Phase research will attempt to quantify the distribution (reporting) of such manifestations (Phase 1) and subsequently identify three XPGs in order to assess some of the cognitive mechanisms analogous with such seemingly irrational and perseverative percepts and ideation (cognitions) in non-psychotic normals (Phase 2). Henceforth, for brevity, when jointly alluding to anomalous (psychosis-like) *experiences* and *beliefs*, the umbrella phrase of "anomalous cognitions" shall be employed.

However, before we proceed a cautionary note must be observed: that is, with regard to the gamut of anomalous cognitions this research does not wish to trivialise such phenomena by claiming that the physical world is the only reality. Merely, to forward scientific understanding of such phenomena as they are evinced in psychometrically identified normals, and as such not reduce anomalous (psychosis-like) cognitions (McCreery & Claridge, 2002; cf., Brugger & Mohr, 2008) or religious, spiritual, and mystical cognitions (Beauregard & O'Leary, 2007; Cook, 2004; Douglas-Smith, 1971; Newberg & Waldman, 2007) to ones of obvious illusion. Put simply, the aim of this research is to further scientific understanding of those aspects of human experience and belief that, although at times seemingly nebulous in origin, e.g. the wide experience of and belief in paranormal/supernatural phenomena (Bering & Shackelford, 2004; Bobrow, 2003; Houran & Lange, 2008; Persinger, 1987, 2009), have been found to possess sufficient significance to become an essential thread in the tapestry of human evolution (Alcock, 2003; Horrobin, 1998). The acceptance and subsequent integration of such cognitions into individuals' conceptions of the meaning of human existence, i.e. the personal recognition and subsequent ownership of such cognitions as being integral to experiential interpretation (White, 1990, 1997a, 1998) provides individuals with a sense that such cognitions have in some way—and not always in a positive manner (e.g., Coelho, Tierney, & Lamont, 2008; Hartley & Daniels, 2008; Neppe, 1993; Persinger, 2001)—personally transformed them (Brown, 2000). Moreover, the wide acceptance of and belief in the paranormal/supernatural nature (agency) of anomalous (psychosis-like) cognitions, in the face of rational evidence to the contrary (Bering & Shackelford, 2004; Irwin, 1993; Kennedy, 2005; Vyse, 1997), forms the crux of this research.

Despite being necessarily allied to the literature regarding the positive symptomatology of schizophrenia; more specifically the personality (individual differences) correlate of *schizotypy*, this thesis's overarching remit is to assess anomalous cognitions in some of their various guises. Therefore, the next section of the thesis shall provide a brief background with regard to the symptomatology of schizophrenia, providing a framework within which anomalous (schizotypal) cognitions might be more readily interpreted (section 1.2). Next, the continuity of psychosis will be addressed (section 1.3) and then the topic of primary interest, i.e. schizotypy, will be introduced (section 1.4). Next, three theoretical models, which attempt to place the concept of psychosis-proneness (schizotypy) within personality- and illness-based frameworks (section 1.5) will be evaluated. Section 1.6 shall overview the psychometric assessment of schizotypy, and section 1.7 shall discuss any implications for disorder arising from such measurement. Section 1.8 looks at the multidimensionality of positive schizotypy, and section 1.9 attempts to ground schizotypal personality traits within the framework of "normal" personality. Finally, section 1.10 expounds a broad protocol for this two-Phase research.

1.2 Symptomatology of schizophrenia

Schizophrenic symptoms vary enormously between patients, creating diverse symptom profiles (Fujii & Ahmed, 2004; Williamson, 2006), which poses one of the most challenging aspects of the disorder (King, Laplante, & Joober, 2005). The symptoms include experiencing false (illusory) perceptions (hallucinations) and harbouring perseverative, irrational beliefs (delusions)—so-called *positive symptoms*; having impaired goal-directed behaviour (avolition), displaying blunted affect, being unable to experience pleasure in ordinarily enjoyable activities or in social situations (anhedonia/asociality), poverty of speech (alogia), and attentional depletives—so-called *negative symptoms*. Jackson (1931) was the first to use the terms "positive" and "negative" when describing the symptomatology of "insanity" (Berrios, 1985, 1991). A third cluster of symptoms was subsequently identified representing "disorganisation of thought" (Bilder, Mukherjee, Rieder, et al., 1985). Positive symptoms reflect an overabundance or exacerbation of normal functioning (hallucinations and delusions), whilst negative symptoms reflect a diminishment or absence of regular function (e.g., blunting of affect), and disorganised symptoms represent disorganised (erratic) thought and behaviour (Davison & Neale, 2001, pp. 283–287). Female gender has been associated with a greater presentation of positive symptoms (Mancevski, Keilp, Kurzon, et al., 2007; Maric, Krabbendam, Vollebergh, et al., 2003), whilst male gender has been routinely associated with a greater preponderance of negative (Køster, Lajer, Lindhardt, et al., 2008; Moriarty, Lieber, Bennett, et al., 2001) and disorganised symptoms (Ring, Tantam, Montague, et al., 1991). With regard to subjective quality of life, it has been revealed that the severity of negative symptoms at index hospitalisation may be an indicator of poor outcome, whereas an index presentation of mainly positive and/or disorganised symptoms does not appear to be predictive of subsequent quality of life (Leung & Chue, 2000).

Schizophrenia is characterised by a multiplicity of symptoms arising from almost all domains of mental function (e.g., language, emotion, reasoning, motor activity, and perception), which culminate in severe cognitive and social impairment (Ho, Nopoulos, Flaum, et al., 1998; Reichenberg & Harvey, 2007), morbidity, and mortality eventuating in reduced life expectancy (Andreasen, 1999). The impact of living with schizophrenia means that very few patients return to full-time work, get married, or raise a family (Tien & Eaton, 1992; Williamson, 2006), which has led the WHO (1992) to place it as one of the top ten most disabling medical illnesses (Murray & Lopez, 1996; see also, McGrath, Saha, Chant, et al., 2008).

1.3 The continuity of psychosis

Empirical evidence for the continuity of psychosis comes from studies into the genetics (Gottesman & Shields, 1972), psychophysiology (Raine, Venables, Mednick, et al., 2002), neurochemistry (Woodward, Cowan, Park, et al., 2011), and neuropsychology (Rosa, van Os, Fananas, et al., 2000) of schizophrenia spectrum disorders, supporting the idea that multiple genes contribute toward the inheritance of personality traits defining psychotic disposition (Claridge, 1985). Such a viewpoint acknowledges the potential interplay between the proposed genetic predisposition to schizophrenia (diathesis) and the combined effects of certain life experiences (e.g., stress and trauma) in accounting for decompensation to clinical schizophrenia (Tienari, Wynne, Sorri, et al., 2004).

On this account, certain individuals exhibit symptoms that resemble schizophrenia but are not actually symptomatic of the disorder. For example, they might experience unusual sensations (such as hearing voices), be subject to a deluge of perception and ideation, or feel that they have developed magical powers (positive psychosis-like symptoms). Such unusual cognitions (e.g., paranormal belief, pronounced religio-spiritual zealotry, delusional convictions, and hallucinatory experiences) are not solely the domain of those with a clinical diagnosis of a psychotic illness—they would appear to manifest themselves, to varying degrees, on a continuum throughout the entire population (Claridge, 1990, 1994, 1997; Compton & Chien, 2008; Hanssen, Bak, Bijl, et al., 2005; Johns & van Os, 2001; Kaczorowski, Barrantes-Vidal, & Kwapil, 2009; Myin-Germeys, Krabbendam, & van Os, 2003; Myin-Germeys, Spauwen, Lataster, et al., 2006; Shevlin, Murphy, Dorahy, et al., 2007; Stefanis, Hanssen, Smirnis, et al., 2002; Verdoux & van Os, 2002). From this perspective schizophrenia and related disorders represent but one end of the psychosis spectrum (Claridge, 1990, 1994, 1997; Cadenhead, 2002; Claridge & Beech, 1995; Kendler, Ochs, Gorman, et al., 1991; McGlashan & Johannessen, 1996; van Os, Hanssen, Bijl, et al., 2001; see also Figure 2).

Notwithstanding, some scholars assume that schizophrenia is a discrete disorder, which cannot be graded from negligible and low through to high (e.g., Cloninger, Martin, Guze, et al., 1985; see also, Loranger, 1999), and, most importantly, according to the diagnostic criteria of the DSM-IV-TR (APA, 2000) and ICD-10 (WHO, 1992). On this traditional (psychiatric) view, differences between schizophrenia and normal functioning are seen to be qualitative rather than quantitative in nature (van Os, 2003; van Os, Jones, Sham, et al., 1998). However, it has been recently proposed that a reorganisation and simplification of diagnostic categories and clinically relevant specifiers be implemented (Kingdon, Afghan, Arnold, et al., 2010), possibly resulting in major advantages for research, e.g. increasing concept validity (Kendell & Jablensky, 2003), standardising remission criteria (van Os, Burns, Cavallaro, et al., 2006), and the efficacy of primary care (Gask & Lester, 2008). Additionally, to conceptualise the multitude of signs and symptoms suggestive of a schizophrenia spectrum or psychotic disorder as single diagnostic entities "may be an error" (Crow, 1995, p. 135). To this end, certain authors propose a shift away from the categorical (all-or-nothing) classification of mental illness in clinical practice in favour of the utilisation of both categorical and dimensional representations (Peralta & Cuesta, 2005, 2007); including greater appreciations of clients' ethnicity (cultural background) and developmental (life) course (Dutta, Greene, Addington, et al., 2007). As such, following Kapur (2003), van Os (2009a,b; 2010) has proposed replacing terminology for all psychotic disorders with "Salience syndrome", which has the potential to reform, specifically destigmatise, public conceptions of psychotic illness promoting well documented research indicative that psychosis relates to "an aspect of human mentation and experience that is universal" (van Os, 2010, p. 363; see also, van Os, Linscott, Myin-Germeys, et al., 2009). Cicero, Kerns, and McCarthy (2010) have developed the first psychometric instrument for assessing "*aberrant salience*", i.e. the Aberrant Salience Inventory, which claims to address those aspects of human experience that involve "the unusual or incorrect assignment of salience, significance, or importance to otherwise innocuous stimuli" (Cicero et al., 2010, p. 688), that are hypothesised to be of importance for both psychosis research and schizophrenia, more specifically.

1.4 Introducing schizotypy

Schizotypy is a term derived from *schizophrenic genotype* (Claridge, 1997) and is a multidimensional construct referring to a broad range of biologically-determined personality factors, reflected in cognitive style and perceptual interpretations that manifest as subclinical levels of PLEs[2] and behaviours in otherwise psychologically healthy individuals (Chapman, Chapman, & Kwapil, 1994; Claridge, 1985). Epidemiological studies provide support for the continuity of psychotic

[2] Subclinical PLEs have alternatively been labelled as schizotypy, psychosis-proneness, or psychosis-like symptoms (Simons, Jacobs, Jolles, et al., 2007).

experience in the general population (e.g., Hanssen et al., 2005; Johns & van Os, 2001; van Os et al, 2001; van Os, Hanssen, Bijl, et al., 2000; Verdoux & van Os, 2002), manifesting as oddities of belief and behaviour, eccentricities, idiosyncratic speech, peculiar ideas, and social awkwardness or aversion (Siever, Kalus, & Keefe, 1993). Whilst these schizotypal personality features may represent a dimensional susceptibility to clinically psychotic behaviour, the precise relationship of schizotypy to clinical disorders such as schizophrenia and SPD is a matter of continuing debate (e.g., Laguerre, Leboyer, & Schürhoff, 2008; Mata, Gilvarry, Jones, et al., 2003; Tarbox & Pogue-Geile, 2011; Torgersen, 1985). Notwithstanding, schizotypy is said to represent an attenuated version of schizophrenia, involving milder yet similar cognitive and behavioural deficits (Claridge, 2008; Compton, Chien, & Bollini, 2007), and these anomalous cognitions are seen as being core components of such psychopathology in nonclinical schizotypy (Handest & Parnas, 2005; Torgersen, Edvardsen, Øien, et al., 2002). However, one must take care when employing terminology such as "pathology" as this by definition implies that there may be an underlying disease or disorder where none may be manifest (Magnavita, 2004).

1.5 Theoretical models of schizotypy (psychosis-proneness)

Ever since Kraepelin (1919) noted the abnormal personalities of some relatives of schizophrenia patients, investigators have sought to identify the fundamental features of this type of personality organisation (Calkins, Curtis, Grove, et al., 2004; Kendler, 1985). If schizophrenia is such a disabling and as yet relatively poorly understood disease how can one possibly attempt to identify individuals from the general population who may harbour the liability for developing schizophrenia and related disorders? In order to address this question various noted researchers have forwarded models of schizophrenic (psychotic) psychopathology. For brevity, this manuscript will focus on the contributions of Hans J. Eysenck, Paul E. Meehl (via Mark F. Lenzenweger), and Gordon Claridge.

Models of schizotypal personality have developed in recent decades in line with a conceptual shift in thinking about psychosis from a categorical (all-or-nothing) to a continuum (dimensional) perspective (Raine, 2006). Within this framework three major theoretical models of schizotypal (putatively psychosis-prone) personality have been proposed: 1) the *totally dimensional* view (Eysenck, 1947, 1960; Eysenck & Eysenck, 1976), based in personality theory, which makes no distinction between enduring personality traits and signs of abnormality; 2) the *quasi-dimensional* (or disease-based) model (Meehl, 1962, 1990; Rado, 1953), which places the schizotypy-schizophrenia continuum within the realm of illness; and 3) the *fully dimensional* model (e.g., Claridge, 1997), based also in personality theory, but which proposes that some discontinuity of function (e.g., social or cognitive) must demarcate the line between psychological health and abnormality or disease.

1.5.1 Eysenck's 'totally dimensional' model of personality

The totally dimensional view (Eysenck, 1947, 1960; Eysenck & Eysenck, 1976) is based in personality theory and makes no distinction between enduring personality traits and signs of psychopathology (abnormality). Eysenck's (1947) personality theory places psychotic illness at the extreme end of a continuous personality dimension, embedded within natural variation in CNS functioning. This proposed biological origin of personality dimensions has been derived from the Pavlovian concept of "nervous types", wherein variations in personality or 'temperament' are seen to reflect the underlying capacity of the CNS to withstand the action of excessive stimulation, reflecting a combination of weakness or strength in the excitatory and inhibitory capacity of the CNS (Pavlov, 1928; cf., Boyle, 1992) At the time, Eysenck's (1947) proposal of an inextricable connection between normal and abnormal personality along with the assumption of biological causation dissected many issues within the ongoing debate between psychiatry and the sociologically minded anti-psychiatry movement. The development of the biological personality paradigm heralded a new perspective on mental illness that neither accepted the orthodox organic view nor the exclusively sociological, non-biological view, but instead attempted an integration of both standings (Green, Boyle, & Raine, 2008).

Eysenck was one of the first psychologists to study personality with the method of factor analysis, a multivariate, data-reduction technique developed by Spearman (1904) "for the analysis of psychometric data" (Kline, 2000, p. 113). Eysenck's initial results suggested two predominant personality factors (extraversion [E] and neuroticism [N]). Subsequently, there were ongoing and vigorous debates regarding the number of dimensions (factors) that define personality (e.g., Costa & McCrae, 1992a,b,c; Eysenck, 1991, 1992b,c; Eysenck & Eysenck, 1985). In this respect, Eysenck now strongly advocates that there are only three major dimensions or superfactors in the description of personality: 1) E/introversion; 2) emotional stability versus instability, or N; and 3) psychoticism (P) versus impulse control (Eysenck, 1992a). In the PEN model, these dimensions or superfactors are based on "constitutional, genetic, or inborn factors, which are to be discovered in the physiological, neurological, and biochemical structure of the individual" (Eysenck, 1992a, pp. 42–43). With regard to psychometric schizotypy, after a re-analysis of Kendler and Hewitt's (1992) original data regarding the intercorrelations between schizotypy scales, Eysenck and Barrett (1993) concluded that after accounting for E, N, and P that "it is doubtful if there is a common element left over once these groups have been eliminated" (p. 59).

Researchers on the PEN model extol the dimensional aspect of personality, as opposed to categorisation (Eysenck, 1992a; Eysenck & Eysenck, 1985). That is, each person does not necessarily have 0% or 100% of P, E, or N; an individual may show some degree of these superfactors on the continuum. With relevance to this thesis, Eysenck (1992a) provided empirical evidence to support this "dimensional or continuity hypothesis" for P (p. 776). Below are three interesting points Eysenck (1992a) suggested after studying psychosis:

1. Psychotic symptoms and illnesses do not form completely separate diagnostic entities, unrelated to each other, but are genetically related and form a general cluster with *severity of illness* as the major distinguishing marker.
2. Psychosis is not a separate diagnostic entity which is categorically separated from normality; it is merely an extreme along a continuum of abnormality shading into schizoid personality, 'spectrum' disorders, psychopathy and personality disorder, criminality and alcoholism, and average types of behaviour right to the other extreme of empathy, altruism and selflessness.
3. This continuum is co-linear with the concept of psychoticism, embodied (however imperfectly) in the P scale of the EPQ (Eysenck & Eysenck, 1975), and also in a number of 'schizotypy' constructs and scales. All the elements of this theory are empirically testable, and have been so tested on numerous occasions (Eysenck, 1992a, pp. 776–777).

On this continuum, a person with high P is troublesome, uncooperative, hostile, and socially withdrawn, whereas a person with low P is altruistic, socialised, empathic, and conventional (Eysenck, 1992a). Furthermore, the superfactors of P, E, and N appear to be cross-culturally universal (e.g., Barrett, Petrides, Eysenck, et al., 1998; Eysenck, 1992a; Haraldsson & Eysenck, 1987; O'Gorman & Hattie, 1986); however, cross-cultural bias (by way of mean comparisons) may contribute to the similarity of such comparisons (Bijnen, 1988; Bijnen, Van Der Net, & Poortinga, 1986).

Despite the overall evidence supporting the PEN model fairly well, there remain many anomalies to be cleared up. For example, the trait of impulsivity was originally under the superfactor of E in the EPI (Eysenck & Eysenck, 1968), but later it was moved to P in the EPQ. The change was made because impulsivity correlated reasonably well with E, "but even better with psychoticism" (Eysenck, 1992a, p. 69). Some researchers, such as Gray (1981), disagree with this removal from E and strongly believe that impulsivity, as well as anxiety, should be treated as uniquely important. Moreover, Rocklin and Revelle (1981) argue that whilst the EPI measures E as a "reasonable mix of impulsivity and sociability" (p. 279), E as assessed by the EPQ is "almost purely a measure of sociability" (ibid). As such, experimental evidence (e.g., Loo, 1979; Revelle, Humphries, Simon, et al., 1980) has demonstrated that impulsivity is responsible for numerous findings previously attributed to E, casting doubt on the usefulness of E as measured by the EPQ in experimental research.

Notwithstanding, the major strength of Eysenck's model was to provide a comprehensive theory of the causes of personality "although not all aspects are equally well developed" (Maltby, Day, & Macaskill, 2007, p. 174). For example, the P scale, despite revision (Eysenck, 1992a), has proven to be problematic insofar as it has been found to possess much lower internal consistency than either E or N (Caruso, Witkiewitz, Belcourt-Dittloff, et al., 2001; Maltby et al., 2007); indeed, in a representative (i.e., non-undergraduate) survey of 97 members of the general population, Ray and Bozek (1981) found a α of 0.48, which is substantially lower than the 0.6 recommended by Nunnally

(1978). Problems with internal consistency are further compounded by mean inter-item correlations, which in the Ray and Bozek study were 0.04, suggesting that the P-scale items have little in common. In light of these and other findings, Ray and Pedersen (1986) concluded that Eysenck's P scale "is a failed experiment" (p. 636). Subsequently, Eysenck (1990) revised his 'inhibition' theory, proposing the cortical 'arousal' theory to explain the causal underpinnings of the three dimensions of personality. Analyses of the biological bases of personality—as specifically proposed by Hans Eysenck and Jeffrey A. Gray—are beyond this thesis's remit; however, interested readers are directed to an excellent review by Matthews and Gilliland (1999). However, one recent experiment revealed a positive relationship between participants' P scores and dopamine activity as indexed by eye-blink rates—these results did not hold for the two other components of the PEN model or indeed for a measure of social nonconformity (Colzato, Slagter, van den Wildenberg, et al., 2009). These results suggest that certain aspects of the P construct may be related to one endophenotypic measure of psychosis-proneness.

Criticism of Eysenck's P dimension acknowledges what most authors are now becoming agreed upon: that "the P scale relates to the antisocial aspects of personality and more generally to psychological disorder" (Mason & Claridge, 2006, p. 203). Moreover, it has been further argued that Eysenck's P scale can be replaced by three orthogonal factors relating to Insensitivity, Orderliness, and Absorption (van Kampen, 2009). Although the concept of absorption can readily be related to the reporting of anomalous cognitions and, as such, positive schizotypy (Glicksohn & Barrett, 2003; Parra, 2006), it is difficult to ascertain how insensitivity and orderliness are constituents of a personality disposition (framework) conducive to the reporting of (positive) schizotypal phenomena. If anything, such personality traits appear to be intuitively allied to the symptomatology of negative schizotpy (insensitivity) and OCD (orderliness), respectively.

1.5.2 Meehl's 'quasi-dimensional' "schizotaxia-schizotypy" model

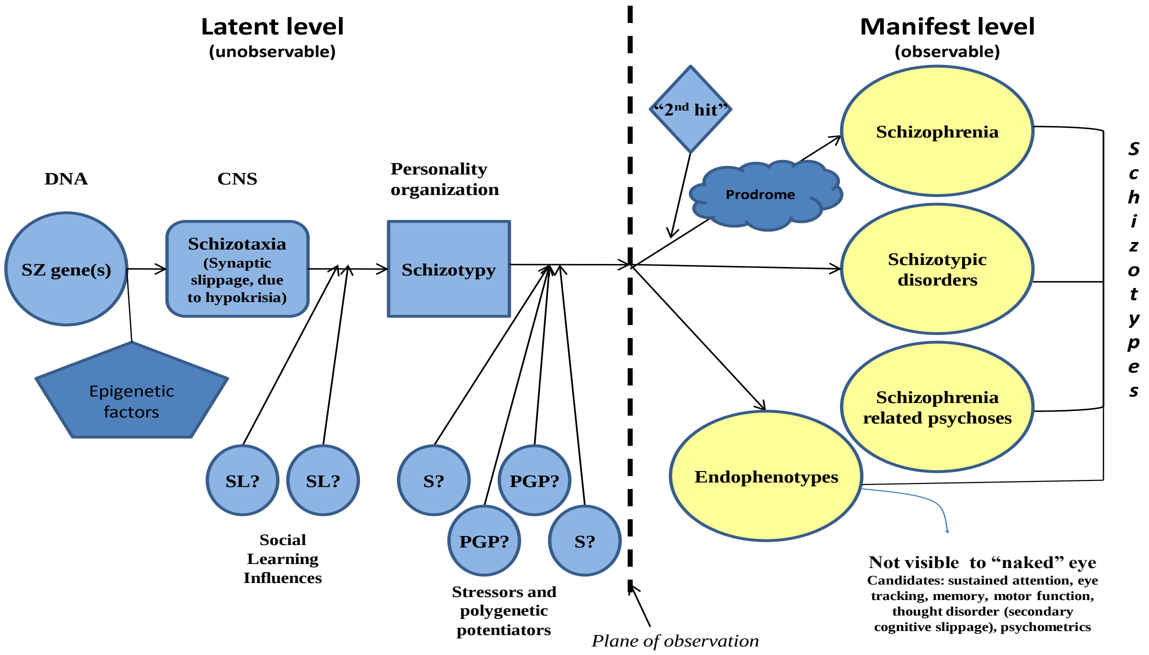
Following initial formulation by Rado (1953), Meehl (1962, 1990) has provided a conceptual model for the pathogenesis of schizophrenia; the model is widely accepted (e.g., Lenzenweger & Loranger, 1989; Tsuang, Stone, Gamma, et al., 2003; Tsuang, Stone, Tarbox, et al., 2002) and is known as the 'schizotaxia-schizotypy' model (see Figure 1). This model represents a categorical approach to schizophrenic ætiology by presupposing a qualitative distinction between indicators of health and those of disorder, in accord with orthodox psychiatry.

Within this neurodevelopmental model, schizotypy refers to a typology of behaviours expressed by a discrete class of individuals with a common defective genotype (Meehl, 1989, 1990; see also, Freedman, Adler, Olincy, et al., 2002; Raballo & Parnas, 2011). Schizotypal personality traits are hypothesised to emerge due to the presence of a genetically-determined, subtle, yet quantifiable, neurointegrative deficit at the neuronal level, which Meehl termed *hypokrisia*. The effects of hypokrisia on the brain are characterised by an “insufficiency of separation, differentiation, or discrimination” in neural transmission that amounts to a ubiquitous anomaly of synaptic control within the CNS, termed *schizotaxia*, and this brain organisation is theorised to represent the genetically determined predisposition to schizophrenia (Meehl, 1989, 1990). The essential element of the integrative neural defect that produces the schizotaxic nervous system (i.e., neuronal “slippage”) is thus conceived of as more than a simple inhibitory deficit or basic sensory abnormality, and can be seen to map directly onto schizophrenic symptomatology such as associative loosening and cognitive-affective dysregulation. Indeed, modern incarnations of these ideas are evident in contemporary models of schizophrenia such as those proposing aberrant neuronal connectivity under the guise of new terminology, such as *cognitive dysmetria* (Andreasen, Paradiso, & O’Leary, 1998; Dolan, Fletcher, McKenna, et al., 1999; Friston, 1999).

The schizotaxial deficit is a necessary condition, although not sufficient, for the development of schizophrenia (Ameen, Praharaj, & Sinha, 2004); with a normal upbringing in a stable (normal) environment most individuals with genetic schizotaxial vulnerability will develop schizophrenia under the influence of other personality traits and negative life experiences (Green et al., 2008). Schizotaxia is the neurophysiological predisposition to schizotypy, facilitated through social learning processes; schizotypy is the predisposition to schizophrenia at the level of the organisation of the personality (see Figure 1). The schizotype is characterised by four traits: 1) *Cognitive slippage*, which incorporates aberrant speech patterns brought about by categorical broadness, where words that on first inspection may be unrelated but become related via extraneous and tangential connections and is related to the positive symptoms of schizophrenia—“mild associative loosening” (Lenzenweger & Korfine, 1995, p. 138); 2) *Social aversiveness*, incorporating feelings of anxiety, even fear, especially in novel, social situations; 3) *Anhedonia*, which involves an inability to derive enjoyment for ordinarily pleasurable activities (e.g., exercise, eating, social and sexual intercourse); and 4) *Ambivalence*, which involves feelings of uncertainty and indecisiveness, especially in relation to emotional situations.

In review, while the schizotaxia-schizotypy model does not imply that all schizotypes will develop schizophrenia (Tsuang, Stone, & Faraone, 2000a)—a common misperception of Meehl’s theoretical views (see, Lenzenweger, 2006b)—Meehl did propose that most individuals with a schizotaxic brain would develop a schizotypal personality on the basis of social learning regimes (Ameen, et al., 2004; see also, Raine, 2006; Venables & Bailes, 1994); and further argued that schizotypal individuals evince aberrant schizotypal functioning at different levels of their psychological functioning. Regardless of the level of decompensation, the descriptors of dysfunction along the schizotaxia-schizotypy-schizophrenia continuum consist of overt signs of abnormality, ranging from subclinical levels of deviance detectable on laboratory measures (e.g., psychometric or neurocognitive) (e.g., Paíno-Piñeiro & Lemos Giráldez, 2003) to full-blown schizophrenia or other schizotypic psychopathology (e.g., schizotypal or paranoid personality disorders). As such, this quasi-dimensional model, with its demarcation between the healthy and schizotaxic brain, places the continuity of function within the schizophrenia spectrum completely in the abnormal (illness) domain. On this view, outstanding issues for debate include those of *ætiology*—for example, identifying the neurological insult or functional impairment that defines transition from normality to abnormality; and *nosology*—for example, differentiating factors contributing to the development of schizophrenia versus SPD. Further, Meehl's suggestion that the schizotaxial deficit is attributable to a single defective gene (Rado's, *schizogene*) is now very doubtful; however, in later adjustments to Meehl's theory (e.g., Lenzenweger, 2006a, 2010) it is acknowledged that the schizotaxial deficit most probably involves the interaction of multiple genes. Moreover, it has been suggested that schizotaxia may itself represent a distinct neurobehavioural syndrome; one which is diagnostically distinct from schizophrenia but nonetheless possessing sufficient similarity such that it may facilitate complementary research into diagnostic and therapeutic techniques aimed toward preventing the onset of schizophrenia (Faraone, Green, Seidman, et al., 2001; Raballo & Parnas, 2011; Tarbox, Almasy, Gur, et al., 2012; Tsuang, Stone, & Faraone, 1999).

Figure 1: Developmental model relating the genetic diathesis for schizophrenia, schizotaxia, and schizotypy and implied levels of analysis (inspired by Meehl, 1962, 1990) with modifications by Lenzenweger (2010); reproduced with the kind permission of The Guilford Press.



Those factors to the left of the vertical broken line (i.e., plane of observation) are "latent" and therefore unobservable with the unaided naked eye, whereas those factors to the right of the plane of observation are manifest (or observable). A DNA-based liability–primary synaptic slippage (or Meehl's hypokrisia)–creates impaired CNS-based neural circuitry (schizotaxia) that eventuates in a personality organization (schizotypy) that harbors the liability for schizophrenia. The liability could be one major gene, several genes of moderate effect, or numerous small-effect genes that have summed to pass a critical threshold. Social learning schedules interact with schizotaxia to yield schizotypy. Psychosocial stressors and polygenic potentiators interact with schizotypy to yield manifest outcomes across a range of clinical compensation. Various possible manifest developmental outcomes are schizophrenia (which may involve an *optional* "second hit," e.g., in utero exposure to maternal influenza), schizotypic psychopathology (e.g., schizotypal and/or paranoid personality disorders), or schizophrenia-related psychoses (e.g., delusional disorder). So-called prodromal features (withdrawal, reduced ideational richness, disorganized communication) may precede the onset of some (but *not* all) cases of schizophrenia.

Endophenotypes (e.g., sustained attention deficits, eye-tracking dysfunction, working memory impairments, motor dysfunction, thought disorder [secondary cognitive slippage], and/or psychometric deviance (see, Gottesman & Gould, 2003); which are invisible to the unaided, naked eye (but detectable with appropriate technologies), are found *below* the plane of observation. Epigenetic factors refer to nonmutational phenomena, such as DNA methylation and histone acetylation (modification), that alter the expression of schizophrenia gene (or genes) (Oh & Petronis, 2008). For example, there is the possibility that a hypermethylation process may serve to downregulate genes of relevance to schizophrenia (see, Tsankova, Renthal, Kumar, et al., 2007). Finally, all individuals represented across this range of manifest outcomes are considered "schizotypes," which does not necessarily imply an ICD or DSM diagnosis (Lenzenweger, 2010, p. 166).

1.5.3 Claridge's 'fully-dimensional' model

Claridge (1985, 1990, 1994, 1997) has explicated a fusion (hybrid, composite) of the above two models. Claridge's fully-dimensional model of schizotypy takes the normality of psychological health (i.e., normal variation in personality) as the starting point of the schizotypal spectrum (Goulding, 2005). Utilising the analogy of anxiety—wherein individuals are seen to be flowing from normality to abnormality, and vice versa, with little in the way of differentiation required to transform healthy into less healthy functioning—schizophrenia and related disorders may be viewed, although with more difficulty, "in a similar way" (Claridge, 1997, p. 11). In an earlier explication of his theory, Claridge (1985) draws parallels between mental illness and systemic diseases of the body using the analogy of hypertension. Upon this view, mental disease can be viewed similarly to a physiological condition: first, a breakdown of normal psychological functioning is seen to arise from aberrations within the biological system itself rather than as an exogenous affliction imposed upon the individual; secondly, arbitrary delineation (cut-off) points defining psychological health and ill health can be imposed; and thirdly, systemic and mental disorders may have multiple environmental causes—in the case of hypertension these can include diet, smoking, and lack of exercise—in the case of psychosis these can include social, environmental, and cognitive factors. Accordingly, "it is only at the extremes that the disease 'entities' of psychiatry become clearly definable" (Claridge, 1985, p. 11). On this view, schizotypal traits contain dual properties: firstly, they represent adaptive variation in personality organisation; and secondly, they include the potential for maladaptive psychological functioning. The fully-dimensional approach argues that high schizotypy does not necessarily denote full-blown psychosis, but that other factors—for example, loss of social (e.g., occupational) functioning—must be present before making such a diagnosis.

Concurring with Meehl (1990), Claridge proposed that the transition from schizotypy to clinically defined schizophrenia may occur for numerous reasons; for example, 1) the strength of the relevant predisposing personality factors; 2) the extent to which modifying life experiences afford protection against psychopathology; and 3) the presence (or absence) of external environmental triggers (Green et al., 2008; Lahti, Räikkönen, Sovio, et al., 2009; see also, Zubin, Magaziner, & Steinhauer, 1983). The fully-dimensional model of schizotypy can therefore be seen to encompass both the quasi- (see Figure 1) and totally-dimensional models.

In conclusion, Claridge's fully-dimensional model proposes that the continuity of schizotypal phenomena are inherent in normal personality variation and are, therefore, recognised as representing only a 'predisposition' to psychopathology, while the decompensation to disorder (sc., psychosis), as mentioned above, must involve a disintegration of functioning (e.g., cognitive) into the abnormal domain (see Figure 2).

Figure 2: Quasi and fully dimensional models of psychosis (adapted from Claridge, 1997, p. 12). Reproduced with the kind permissions of The Oxford University Press.

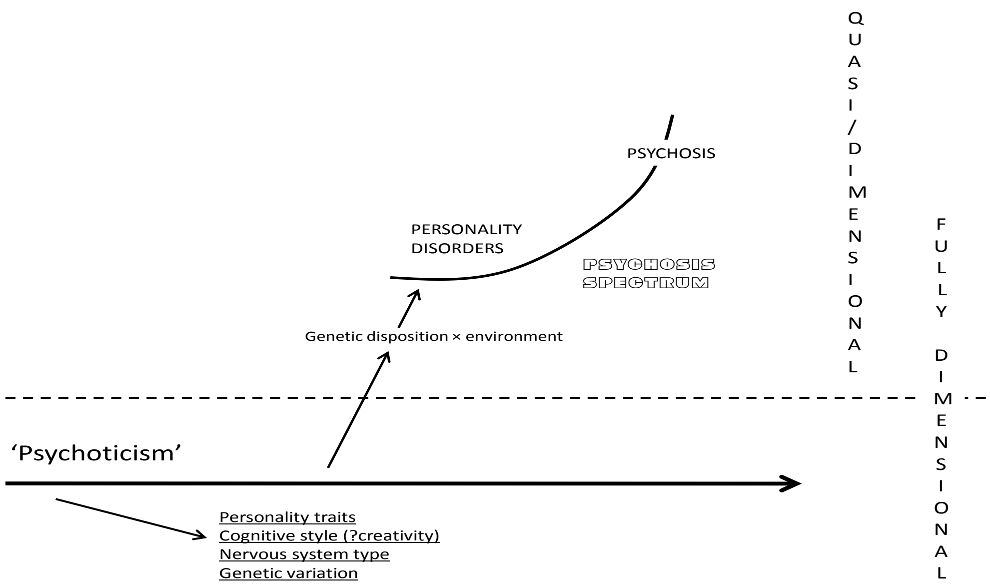


Figure 2 is a comparison of the quasi-dimensional (disease-based) and fully dimensional (personality-based) continuity models of psychosis. Note that, in the fully dimensional part of the model, the term 'psychoticism' has a more comprehensive meaning than Eysenck's usage. That is, it would be expected that different expressions of 'psychoticism' might generate their own versions of the model, e.g. SPD would substitute for 'personality disorders' along a 'schizophrenia spectrum' (Claridge, 1994).

Within the fully-dimensional model schizotypal traits are essentially benign in nature, sometimes associated with psychological health and sometimes with psychological ill-health (Goulding, 2005; Mason & Claridge, 2006). Agreeing with Irwin (2001), for the purposes of this thesis, schizotypy is contextualised not as a psychological disorder (e.g., SPD) but as a nonclinical personality domain that is clinically concomitant with schizophrenia. In this context, schizotypy is taken to signify a dimension of variability as opposed to a category, thus, incorporating a fuller appreciation of the numerous variables (e.g., cognitive, social, genetic) inherent to the onset of a psychotic disorder (see Figure 2). With regard to psychiatric diagnosis, it has been proposed that a combination of dimensional and categorical systems would enhance the reliability (categorical) and validity (dimensional) of psychiatric diagnosis (Esterberg & Compton, 2009). As such, in accordance with Figures 1 and 2, several authors have demonstrated a symptomatic continuum of PLEs (i.e., delusions and hallucinations) ranging from self-reported subclinical symptoms in the general population (e.g., Johns & van Os, 2001; Peters, Joseph, & Garety, 1999) to clinically diagnosed psychotic individuals in psychiatric care settings (Nettle & Clegg, 2006). Although variation in the extent and distribution of PLEs, which is most likely attributable to heterogeneous sampling, measurement differences, and operational definitions, the notion is upheld that PLEs occur within a far broader range of the population than just individuals with a clinically diagnosed psychotic disorder (Esterberg & Compton, 2009; Rössler, Riecher- Rössler, Angst, et al., 2007).

1.5.4 Models of psychosis-proneness (schizotypy): Conclusion

Schizotypy includes some of the features of schizophrenia and schizoaffective disorder and is primarily manifest by early adulthood; however, schizotypal personality traits are also found in children and adolescents (Ericson, Tuvblad, Raine, et al., 2011; Davies, 2007). Although the Eysenckian model, by postulating no demarcation between psychological health and ill health differs from the other two models, one common thread running through all three models is that of a genetic (biological) predisposition, centring on the relative strength of the physiological response system to adaptively integrate potentially harmful environmental stimulation. Claridge's fully-dimensional model, with its appreciation of the numerous variables inherent to the onset of a psychotic disorder, would appear to be the most appropriate with reference to this thesis; which has within its remit the requirement to embrace the gamut of PLEs within a normal, specifically non-psychotic, quota sample of the general population.

1.6 Schizotypy as a multidimensional personality construct: Psychometric assessment

A multi-factorial threshold model of schizophrenia development (see, McGue, Gottesman, & Rao, 1983) is based on the assumption that the majority of individuals harbouring increased liability for schizophrenia will not decompensate into schizophrenia-related psychosis (Chapman, Chapman, & Kwapil, 1994; Kwapil, 1998), although such individuals may experience schizotypal symptoms (Lenzenweger, 2006a) or neurobehavioural deficits (Cornblatt, Obuchowski, Roberts, et al., 1999). This model also suggests that as risk factors accumulate so too does psychological deviance (Bolinskey & Gottesman, 2010). As such, numerous researchers consider the presence of endophenotypes, including psychometric deviance (see Figure 1), as evidence of increased risk for schizophrenia (e.g., Braff, Freedman, Schork, et al., 2007; Cannon & Keller, 2006).

The importance of detecting emerging psychotic disorder has led to renewed interest in the construct of schizotypy (e.g., Cohen, Matthews, Najoli, et al., 2010; Horan, Reise, Subotnik, et al., 2008; van Kampen, 2006), and there is now an extensive literature attesting to the value of psychometric SRMs of psychosis-proneness (Raine & Lencz, 2007). Unfortunately, much of this research has relied on data collected from undergraduate students (Rawlings, Williams, Haslam, et al., 2008; Roth & Baribeau, 1997). Although an easily accessible sample group, undergraduate students cannot be regarded as representative of the adult population as a whole (Balogh & Merritt, 1990) given their enhanced educational status, limited age range, and possible increased propensity for, or at least access to, recreational drug use (Bradbury, Stirling, Cavill, et al., 2009).

Notwithstanding, since Meehl's (1964) manuscript many SRMs have been developed to assess schizotypal personality traits (Stefanis, Vitoratou, Ntzoufras, et al., 2006); as such, attempts to measure schizotypy by questionnaire (i.e., psychometrically) are not new (Golden & Meehl, 1979). Such scales are commonly employed to identify normal but potentially 'psychosis-prone' subjects for research aimed at furthering our understanding of the functioning (e.g., cognitive) and ætiology of schizophrenia (Lenzenweger, 1999, 2010; Raine, Lencz, & Mednick, 2007). The impetus for such work harks from the requirement to identify 'harder' indicators of the genetic influence in psychotic disorders (endophenotypes) rather than 'softer' diagnostic and clinical signs (Gottesman & Gould, 2003; Gottesman & Shields, 1972).

1.6.1 Psychometric measurement: Theoretical viewpoint

The style and content of SRMs assessing schizotypal personality traits varies according to the researchers' aims and theoretical standing. The earliest schizotypy scales focused on the measurement of vulnerability for specific symptoms of schizophrenia, including perceptual aberration (PerAb; Chapman, Chapman, & Raulin, 1978), magical ideation (MI; Eckblad & Chapman, 1983), physical and social anhedonia (PhA; Chapman, Chapman, & Raulin, 1976), hypomanic personality traits (Eckblad & Chapman, 1986), predisposition to hallucination (Launay & Slade, 1981), and more recently for delusions (Peters, et al., 1999). Other SRMs have been formulated on the basis of psychiatric classification systems for SPD (SPQ; Raine, 1991)—as a point of interest, the positive dimension of the SPQ has been suggested to reflect the genetic vulnerability to schizophrenia (Vollema, Sitskoorn, Appels, et al., 2002)—and/or 'borderline personality' disorders (Claridge & Broks, 1984), or by assuming the existence of fundamental personality aspects such as the asocial element of psychoticism (Eysenck, 1992a; Eysenck & Eysenck, 1976; see section 1.5.1). In contrast, the development of SRMs tapping the general schizotypy construct has concentrated on the empirically observed factor structure of schizotypal traits (e.g., Bentall, Claridge, & Slade, 1989; Hewitt & Claridge, 1989; Lipp, Arnold, & Siddle, 1994; Mason & Claridge, 2006; Mason, Claridge, & Jackson, 1995; Mason, Claridge, & Williams, 1997; Mason, Linney, & Claridge, 2006; Rawlings & MacFarlane, 1994).

Despite subtle theoretical distinctions in approach, considerable effort has been directed towards the development of psychometric indices of schizotypy and the investigation of psychophysiological (including, cognitive) correlates of schizotypal personality organisation (Green et al., 2008). Heterogeneity in the expression of psychometric schizotypy may reflect the severity of decompensation for psychosis, and/or additional personality traits including potentially protective, e.g. paranormal beliefs (Schofield & Claridge, 2007) and adaptive factors such as creativity (see, Nelson & Rawlings, 2010; Schuldberg, 1990) and spirituality (Jackson, 1997) present within the endophenotype, especially when related to the positive and disorganised dimensions. As such, schizotypy may manifest as mild thought disorder, elevated social anxiety, or in aberrant perceptual experiences, which may not be objectively observable. Alternatively, manifestations of schizotypy may only be detectable via laboratory measures of psychophysiological and cognitive responding (such as eye-tracking dysfunction, sustained attention deficits, and psychomotor impairment) (see also Figure 1).

1.6.2 Dimensionality of schizotypal personality traits: Factor analysis

In accordance with the assumption that psychotic traits exist on a continuum (e.g., Chapman & Chapman, 1980; Claridge, 1997; Claridge & Hewitt, 1987; Rawlings et al., 2008) and that schizotypy might be viewed as an analogue of schizophrenia, evidence also suggests that schizotypy is a multidimensional construct (Compton et al., 2007; Kelley & Coursey, 1992; Kendler, McGuire, Gruenberg, et al., 1995; Venables & Rector, 2000; review: Linscott & van Os, 2010) probably consisting of at least three factors: including, 1) *Cognitive-perceptual* deficits (positive dimension—incorporating ideas of reference, odd beliefs, magical thinking, unusual perceptual experiences, and paranoid ideation); 2) *Interpersonal dysfunction* (negative dimension—incorporating blunted affect, no close friends, and social anxiety); and 3) *Cognitive disorganisation* (odd speech and behaviour) (Raine et al., 1994). Indeed, Mason et al. (1995) conducted a factor analytic study of the Combined Schizotypal Trait Questionnaire (CSTQ; Bentall, Claridge, & Slade, 1989), a large measure which amalgamated several established schizotypy measures, and derived a four-factor solution: 1) Unusual Experiences (UnEx; positive schizotypy), Introvertive Anhedonia (negative schizotypy), Cognitive Disorganisation (disorganised and social anxiety aspects of schizotypy), and Impulsive Nonconformity (subclinical hypomanic and anti-social behaviour). Mason et al. hypothesised that the fourth factor, Impulsive Nonconformity, may reflect the continuity between schizophrenia and disorders of emotion regulation such as affective psychosis, bipolar affective disorder, and borderline personality disorder. With the exception of Introvertive Anhedonia, which was associated only with Cognitive Disorganisation, the dimensions of schizotypy were correlated with each other, suggesting that features of schizotypy are likely to co-occur to some degree within individuals.

The heterogeneity of schizotypal psychopathology (including positive, negative, and disorganised dimensions) is apparent, to varying extent, in all individuals from all cultures: for example—Hong Kong (Chen, Hsiao, & Lin, 1997), the United States (Compton, Goulding, Bakeman, et al., 2009), France (Dumas, Bouafia, Gutknecht, et al., 2000), South Korea (Moon, Yang, Lee, et al., 1997), Italy (Fossati, Raine, Carretta, et al., 2003), China (Ma, Sun, Yao, et al., 2007), Spain (Mata, Mataix-Cols,

& Peralta, 2005), Mauritius (Reynolds, Raine, Mellingen, et al., 2000), Turkey (Aycicegi, Dinn, & Harris, 2005), Iran (Mohammadzadeh, Najafi, & Ashuri, 2009), Japan (Ito, Okumura, & Sakamoto, 2010), Greece (Stefanis et al., 2006), and the United Kingdom (Tiliopoulos & Crawford., 2007). This three-factor schizotypal typology represents one of the predominant findings in the extensive literature on the nature of subclinical psychosis-like phenomena. Furthermore, this factor structure appears to be invariant to gender, ethnicity, religion, and social background (e.g., Reynolds et al., 2000), and may be seen to support the fully-dimensional model of schizotypy (Claridge, 1997; see also Figure 2).

Although extensively utilised in personality and psychopathological research three-factor models of schizotypy have now been joined by four- (Mason et al., 1995) and five-factor models (Chmielewski & Watson, 2008; Edmundson, Lynam, Miller, et al., 2011) incorporating additional areas of assessment such as impulsivity, nonconformity, mistrust, and eccentricity or oddity. Notwithstanding, a general consensus is now becoming agreed upon that schizotypy reduces to three core components (positive, negative, and cognitive disorganisation) (Lin, Wigman, Nelson, et al., 2013), which correspond well with the three-factor model of schizophrenic symptomatology (Brunelin, Dumas, Saoud et al., 2011; Vollema & Hoijtinkm, 2000), although the negative dimension of schizotypy has been alternatively described as 'social impairment' (Venables & Rector, 2000). Notwithstanding, the trisyndromic features of schizophrenia as explicated by Liddle and others (e.g., Liddle, 1987; Liddle & Barnes, 1990; Liddle, Barnes, Morris, et al., 1989; Liddle & Morris, 1991; see also, Brown & White, 1992) have been routinely identified via factor analytic investigation (e.g., Andreasen, Arndt, Alliger, et al., 1995; Arndt, Andreasen, Flaum, et al., 1995; Cuesta & Peralta, 1995; Daban, Amado, Bayle, et al., 2003; Peralta, de Leon, & Cuesta, 1992); and a similar trisyndromic expression has also been routinely reported in the schizotypy literature (e.g., Hewitt & Claridge, 1989; McCreery & Claridge, 2002; Montag & Levin, 1992; Raine et al., 1994; Vollema & van den Bosch, 1995).

Because of the shadowing of schizophrenic symptomatology, such instruments can be utilised in research exploring the underlying and causal mechanisms of schizophrenia (Lenzenweger, 2010); moreover, schizotypy scales, because of their dimensional composition, can be utilised as effective measures in clinical practice and experimental research (Chapman, Chapman, & Kwapil, 2007; Cohen et al., 2010). Such scales are useful tools for identifying individuals who have a high risk for developing psychosis (Raine & Lencz, 2007; van den Bosch & Luteijn, 1990) and who may benefit from preventive intervention (Bentall et al., 1989; Grove, 1982; Verdoux & van Os, 2002). Psychometric identification tools possess a distinct advantage over other risk-identification measures, e.g. genetic identification (Addington, 2004; Moldin, Rice, Gottesman, et al., 1990) inasmuch as they can be administered to large samples in a cost effective manner; additional benefits of such scales include that they can be administered quickly, they are objective, and standardised (Raine & Allbutt, 1989). Furthermore, continuous as opposed to categorical measures of psychopathology (review:

Trull, Tragesser, Solhan, et al., 2007) may provide greater statistical power to detect susceptibility facets (loci) for psychotic disorders, including schizophrenia (Fanous, Gardner, Walsh, et al., 2001).

What is apparent from the literature regarding the psychometric measurement of schizotypy is that it can be said to be a factor-specific construct; moreover, one that closely mirrors the multidimensionality of schizophrenia symptoms (Vollema & van den Bosch, 1995).

1.7 Schizotypy measures: Implications for disorder

Evidence of distinct schizotypal trait dimensions comes from the biological relatives of schizophrenic patients (Bora & Veznedaroglu, 2007; Calkins et al., 2004; Schürhoff, Laguerre, Szöke, et al., 2005), clinical patients with schizophrenia (Arndt, Alliger, & Andreasen, 1991; Bentall et al., 1989; Bergman, Silverman, Harvey, et al., 2000; Mason, 1995; Peralta, Cuesta, & Farre, 1997; Thompson & Meltzer, 1993), and patients with SPD (Axelrod, Grilo, Sanislow, et al., 2001; Battaglia, Cavallini, Macciardi, et al., 1997). In further confirmation of these findings, schizotypal individuals display anatomical markers (e.g., Modinos, Mechelli, Ormel, et al., 2010; Tsuang et al., 2003), soft neurological signs (e.g., Kaczorowski et al., 2009), psychophysiological signs (e.g., Raine et al., 2002; Takahashi, Iwase, Canuet, et al., 2010), electrophysiological signs (Kiang, Pugh, & Kutas, 2010; Tcheslavski & Beex, 2010), perceptual-cognitive signs (e.g., Mohr, Blanke, & Brugger, 2006; Tsakanikos & Reed, 2005a; Yaralian, Raine, Lencz, et al., 2000), abnormal brain connectivity signs (e.g., Nelson, Seal, Phillips, et al., 2011; Nakamura, McCarley, Kubicki, et al., 2005), and language and thought signs (McConaghy, 1989; Romney, 1990; review: Kiang, 2010) all of which are also observed in schizophrenia.

As such, it follows that the description and classification of schizotypal disorders should be a multidisciplinary matter. To this end, the study of schizotypy is of great interest to schizophrenia researchers (Lenzenweger, 1999, 2010; Miller, Byrne, Hodges, et al., 2002; Nuechterlein & Dawson, 1984) given evidence that schizotypy and SPD are phenotypically (Catts, Fox, Ward, et al., 2000; Kendler, Gruenberg, & Kinney, 1994; Siever et al., 1993) and genetically (Clementz, Grove, Katsanis, et al., 1991; Kendler et al., 1995; Silverman, Siever, Horvath, et al., 1993) related. Continued research into schizotypy in population samples will help further our understanding of this complex personality construct not only as a vulnerability marker but also as a genetic marker (Compton et al., 2009).

If schizotypy reflects the phenotypic expression of a genetic predisposition to schizophrenia a significant proportion of individuals exhibiting schizotypal personality traits would be expected to develop schizophrenia spectrum disorders (e.g., Hay, Martin, Foley, et al., 2001; Kendler, Neale, & Walsh, 1995). However, evidence is mixed as to whether the cognitive-perceptual (positive) or interpersonal (negative) factor of schizotypy is better at predicting such a breakdown. One study suggests that PhA (negative dimension) is not predictive (Chapman, Chapman, Kwapil, et al., 1994), whilst another (Gooding, Tallent, & Matts, 2005) reports a significantly higher rate of schizophrenia-spectrum disorders in those with high social anhedonia scores (15.6%), but failed to observe any breakdown in a high-scoring PerAb/MI (positive schizotypy) group (3.4%). Also utilising the Chapman indices (Wisconsin schizotypy scales), Meyer and Hautzinger (2002) in a dimensional and categorical study sampled 404 non-student adults and focused on two schizotypal risk groups (PhA [negative schizotypy] N = 14 and combined PerAb/MI [positive schizotypy] N = 36) alongside 19 controls. In a two year follow-up the SCID-II (Spitzer, Williams, Gibbon, et al., 1990) was used to assess for clinically relevant personality disorders. MI was found to account for most of the clinically-relevant variance in SPD; PhA and PerAb were associated with the number of diagnostic criteria met for other personality disorders, whilst both risk groups exceeded controls in clinically relevant borderline traits. Additionally, only PerAb/MI individuals differed in fulfilling diagnostic criteria for SPD. Another recent large-scale study, again using the Chapman scales (N = 6,137), found that schizotypal dimensions were differentially associated with psychopathology, personality, and social impairment. The researchers found that both the positive and negative dimensions were related to schizotypal and paranoid symptoms; the positive dimension was uniquely related to PLEs, substance abuse, and mood disorders, whereas the negative dimension was related to negative and schizoid symptoms (Kwapil, Barrantes-Vidal, & Silva, 2008). Despite research consistently reporting excellent psychometric properties for the Chapman scales (e.g., Cannon, Cadenhead, Cornblatt, et al., 2008; Chapman et al., 2007), the above findings highlight the difficulty in predicting specific psychiatric (sc., schizotypal) dimensions (Horan, Blanchard, Gangestad, et al., 2004) and any subsequent decompensation.

Compounding the difficulty in isolating specific schizotypic profiles is the fact that schizotypal dimensions are not necessarily mutually exclusive. For example, individuals reporting high positive schizotypy can also report high levels of negative and/or disordered schizotypy (e.g., Barrantes-Vidal, Lewandowski, & Kwapil, 2010a,b; Suhr & Spitznagel, 2001). In fact, data regarding the diagnostic validity of schizotypy scales is currently limited (Mass, Girndt, Matouschek, et al., 2007). This is a perturbing situation as the core symptoms of schizotypy are ambiguous (i.e., they can occur in other disorders). For example, 'social anxiety' (component of negative schizotypy) is also a component of avoidant personality disorder; 'ideas of reference' (component of positive schizotypy) could occur as part of a social phobia; 'lack of close friends' (component of negative schizotypy) could be as a consequence of depression; and 'odd and eccentric behaviour' (component of positive schizotypy) can also occur in OCD (see also Chapter 3, section *3.1.3.1*). As such, an individual identified as being schizotypic via self rating, e.g. scoring ≥ 90th percentile; may in fact not be schizotypic (Mass et al., 2007). For example, Rossi and Daneluzzo (2002) reported that the SPQ (Raine, 1991) differentiated schizophrenic from unipolar depressive patients but not from OCD patients; and the research of Spitznagel and Suhr (2004) revealed that respondents reporting high schizotypy (SPQ) and depression (BDI-II; Beck, Steer, & Brown, 1996) endorsed a higher number of paranoid/suspiciousness items than a control group (low schizotypy and depression) suggesting that the comorbidity of depressive symptomatology influences the affirmation of positive schizotypal items.

1.8 Multidimensionality of positive schizotypy

Converging evidence, including research from the schizophrenia domain (e.g., Kitamura, Okazaki, Fujinawa, et al., 1998), is now appearing suggesting that the positive dimension of schizotypy, rather than being investigated as a discrete entity, is itself multidimensional. For example, Wolfradt and Straube (1998) found that after subjecting the STA to PCA, three factors representing perceptual experiences, ideas of reference/social anxiety, and suspiciousness were revealed. In a more recent study, Cicero and Kerns (2010) utilising the SPQ found that positive schizotypy when subjected to factor analysis also generated three distinct factors (paranoia, referential thinking, and cognitive-perceptual anomalies), and that these three factors fitted the data better than models with either one or two factors. This finding may not be surprising considering the number of items comprising the positive dimension of schizotypy as measured by the SPQ (total across five subscales = 41). Of greater import to this thesis are the results of a recent study which factor analysed the SPQ-B (Raine & Benishay, 1995); which contains only eight positive schizotypy items (total items = 22). Using American undergraduate students (N = 825) Compton et al. (2009) revealed a four-factor structure incorporating *cognitive-perceptual* and *paranoid* (positive factors), negative, and disorganised factors; again, these results are further suggestive of the multidimensionality of psychometric schizotypy. Moreover, a factor analytic study by Cohen et al. (2010), which aimed to produce a new and expanded version of the SPQ-B, generated a 32-item measure that incorporated subordinate seven- and superordinate three- (positive, negative, and disorganised) and four-factor (positive, negative, social anxiety, and disorganised) solutions. What is interesting from this latter study is the fact that whereas in previous studies positive and negative (sc., social anxiety) schizotypal dimensions had been found to possess significant overlap (e.g., Brown, Silvia, Myin-Germeys, et al., 2008; Lewandowski, Barrantes-Vidal, Nelson-Gray, et al., 2006), the positive dimension remained relatively independent; moreover, the positive dimension incorporated items pertaining to four of the nine criteria for a clinical diagnosis of SPD (i.e., ideas of reference, suspiciousness, eccentric behaviour, and magical thinking). The issue of factor (dimension) retention is of great importance considering impending changes to the operational definition of SPD in the forthcoming DSM-V and ICD-11 (David, 2010; Linscott & van Os, 2010; Möller, 2008; Sommer, 2010; see also, Wright, Pincus, Hopwood, et al., 2012).

1.9 Psychometric schizotypy and "normal" personality

The fully dimensional model holds that psychometric schizotypy is concomitant with both psychological health and ill-health (see section 1.5.3); therefore, is it possible to entrench schizotypal personality traits within a framework of ostensibly "normal" personality? In order to answer this question, findings from research utilising the most widely accepted measure of normal personality (Goldberg, 1993; John & Srivastava, 1999; Widiger, 2009), i.e. the 5-factor model (FFM) as forwarded by Costa and McCrae (1992a) shall be briefly reviewed. Previous research suggests that the personality trait structure as assessed by the FFM is a human universal (McCrae & Costa, 1997).

The FFM posits that a multitude of personality aspects can be broken down into five broad traits (factors): 1) Conscientiousness; 2) Agreeableness; 3) Neuroticism; 4) Openness (to experience)[3]; and 5) Extraversion. Because the experimental prerogative of this thesis involves investigating anomalous cognitions, this section shall concentrate on recent research that has specifically investigated the relationship between Openness and the positive dimension of schizotypy. For example, a study utilising the SPQ and conducted over two time periods with a delay of fourteen days (Chmielewski & Watson, 2008) found that when related to the Big-5 Inventory (BFI; John & Srivastava, 1999) social anxiety (negative dimension) was inversely related to Extraversion (time 1, r = -0.60; time 2, r = -0.62) and positively related to Neuroticism (time 1, r = 0.46; time 2, r = 0.46); otherwise, the five dimensions of normal personality were only modestly related to schizotypal personality. All of the scales were positively related to measures of dissociation, but these correlations were lower for social anhedonia and social anxiety. More importantly, the schizotypy dimensions were only weakly correlated with each other (time 1, mean r = 0.26; time 2, mean r = 0.25), highlighting the multifaceted nature of schizotypy. The results of Chmielewski and Watson are given further credence through similar findings in a study which utilised the Chapman scales of schizotypy—positive schizotypy (MI and PAS); negative schizotypy (PhA and Revised Social Anhedonia Scale [Eckblad, Chapman, Chapman, et al., 1982; Mishlove & Chapman, 1985]), which have been suggested to reliably measure the symptoms of both schizotypal and schizoid personality disorders (Bailey, West, Widiger, et al., 1993)—and the Revised NEO Personality Inventory (Costa & McCrae, 1992a). Results from this study identified that positive schizotypal symptoms were significantly predicted by Neuroticism (+), Openness (+), and Agreeableness (–); whereas negative schizotypal symptoms were best predicted by Neuroticism (+), Extraversion (–), Openness (–), and Agreeableness (–) (Ross, Lutz, & Bailley, 2002). The findings point to a predisposition for those with elevated Openness to also

[3] Openness is a high-order trait, associated with personality attributes such as imagination, creativity, intellectual curiosity, unconventional attitudes, and divergent thinking (Costa & McCrae, 1992a). Moreover, it is related to the 'permeability of consciousness' (McCrae, 1994) and a softening of the rigidity of mental categories (McCrae & John, 1992; see also *Transliminality*, Chapter 2, section *2.1.2.6*).

exhibit positive schizotypal traits (see also, Miller & Tal, 2007; Swarmi, Pletschnig, Stieger, et al., 2011).

In conclusion, the relationship between Openness (to experience) and positive schizotypy would appear to be consistent with a nonpathological personality type (e.g., McCreery & Claridge, 2002); that is, possessing high Openness is an experiential predisposition distinct from the potentially maladaptive cognitions associated with psychosis proneness (e.g., hallucinations), and one that may vary as a function of age (Larøi, DeFruyt, van Os, et al., 2005). As such, it may be the factor of Extraversion that increases the risk for developing certain psychotic symptoms (e.g., delusions) (Larøi, Van der Linden, DeFruyt, et al., 2006). In support of this line of reasoning, the Big-5 does not specifically include a dimension related to abnormal cognition (Costa & McCrae, 1992d; cf., Asai, Sugimori, Bando, et al., 2011). In further confirmation, studies of the static 5-factor model of personality in relation to schizotypy, SPD, and schizophrenia have produced inconsistent results, potentially because of the previously noted concern (Green et al., 2008). Moreover, an attempt to represent personality disorders (sc., schizotypal, borderline, avoidant, and OCD) via application of the Big-5 has been found to be difficult as the four disorders in question share diverse interactions amongst the five normal personality dimensions rather than being uniquely differentiated on a single dimension (Morey, Gunderson, Quigley et al., 2002). Notwithstanding, in a study looking into the relationship between aspects of normal personality, cognitive functioning and schizophrenia spectrum personality traits, Tien, Costa, and Eaton (1992) found that Openness and Neuroticism were strongly associated with schizophrenia spectrum personality traits, including paranoid personality traits. As such, increasing evidence suggests that normal and abnormal personality can be treated within a single structural framework (e.g., Markson, Krueger, & Watson, 2005).

The Big-5 is now thought to be premised on a relatively out-dated and restrictive (static) conceptualisation of personality structure, which does not take into account recent empirical findings (e.g., Cattell, Boyle, & Chant, 2002; Roberts, Walton, & Viechtbauer, 2006b) suggesting that personality is a dynamic psychological attribute subject to numerous learning and developmental changes throughout the lifespan (Fraley & Roberts, 2005; Roberts, Walton, & Viechtbauer, 2006a). As such, personality traits may not be the enduring and stable factors as historically assumed (Green et al., 2008). What can be said of the relationship between psychometric schizotypy and normal personality in normal populations is that schizotypal traits are not discordant with rather they are variations on, an underlying personality profile, further supporting the fully dimensional model of schizotypy (Asai et al., 2011; Claridge, 1997; see also Figure 2). That said, despite being functional members of society, individuals presenting schizotypal traits often appear odd and eccentric (Eysenck, 1994; Fisher, Mohanty, Herrington, et al., 2004; Parnas & Jorgensen, 1989).

1.10 Research protocol

Recent research indicates that persistent psychometrically-identifiable subclinical psychotic symptoms are paramount in the subsequent development of clinical psychosis (Dominguez, Wichers, Lieb, et al., 2011). As such, the accurate psychometric assessment of schizotypy (psychosis-proneness) is of great importance and is an assessment methodology that carries relatively low risk, e.g. stigmatisation and/or the implementation of inappropriate treatment and/or preventive measures (Heckers, 2009). The identification of individuals who are potentially at high-risk for developing a psychotic disorder is of equal importance, as the duration of untreated psychosis has deleterious effects with regard to prognosis (de Haan, Linszen, Lenior, et al., 2003; Drake, Haley, Akhtar, et al., 2000; Larsen, Johannessen, & Opjordsmoen, 1998; Marshall, Lewis, Lockwood, et al., 2005; Perkins, Gu, Boteva, et al., 2005). As such, this research is split into two distinct Phases: Phase 1 will involve the psychometric assessment of the distribution (reporting) of a variety of anomalous cognitions within a stratified quota sample of the general (non-undergraduate) population (cf., Pechey & Halligan, 2012). The psychometric SRMs will be primarily based around the known correlates of positive schizotypy (e.g., delusional ideation, dissociative experiences)[4]. With regard to Phase 2 of the research, "It is crucial to understand the psychological mechanisms that mediate transition from having one or two psychotic symptoms to becoming a patient with a psychotic disorder" (Krabbendam, Myin-Germeys, Bak, et al., 2005, p. 180), and because such abnormal subjective cognitions in schizophrenic and SPD patients are associated with cognitive (neuropsychological) disturbance (e.g., Brekke, Kohrt, & Green, 2001; Cuesta et al., 1996; Freedman, 1974; Parnas et al., 2003; Frith, 1992; Garety et al., 2001; Morrison, 2001; O'Connor, 2009), Phase 2 will involve the assessment of some of the cognitive processes that may underpin the reporting of anomalous cognitions (e.g., deficits in RM, memory aberrations). The assessment of cognitive impairment associated with schizotypal characteristics (including the reporting of anomalous phenomena) can facilitate more focused intervention strategies (Meyer & Shean, 2006; Garety et al., 2007, 2001; Murphy, Shevlin, Houston, et al., 2012a).

[4] Note: It is worth bearing in mind that the endorsement of personality traits that are *not* truly indicative of an individual's personality profile—the so-called "Barnum effect"—has been previously verified (Mason & Budge, 2011).

Chapter 2. Phase 1: The reporting of psychosis-like (anomalous) experiences in the general population: A factor analytic investigation to identify three XPGs

2.1 Introduction

Brief or attenuated psychotic symptoms are reported by individuals in the prodromal phase of schizophrenia and other psychotic disorders, and can give rise to considerable personal and/or social distress (Henry, Bailey, & Rendell, 2008; Loewy, Johnson, & Cannon, 2007). Population-based studies have revealed that self-reported positive symptoms of psychosis strongly predict the development of a psychotic disorder in both the short- and long-term (Chapman & Chapman, 1987; Chapman et al., 1994; Hanssen, Bak, Bijl, et al., 2005; Mason, Startup, Halpin, et al., 2004; Poulton, Caspi, Moffitt, et al., 2000); however, a relatively small proportion of such individuals actually go on to develop a psychotic disorder in the ensuing time period (Bentall, 2006; Gooding, Tallent, & Matts, 2005; van Os, Hanssen, Bijl, et al., 2000; Yung, Nelson, Baker, et al., 2009), and it is presently difficult to predict those that will convert to full psychosis (Bolinskey, Gottesman, Nichols, et al., 2001; Yung et al., 2009) from those that will remain well (Goulding & Ödéhn, 2009; Yung, Yuen, Berger, et al., 2007). Although nothing new, the concept of early intervention in psychosis[5], especially for those identified as being at ultra-high-risk, has witnessed an explosion of research attempting to identify vulnerability markers (e.g., Amminger, Leicester, Yung, et al., 2006; Morrison, French, Lewis, et al., 2006; Yung & McGorry, 1996; Yung, Phillips, & McGorry, 2004; review: Mason & Beavan-Pearson, 2005).

It has been suggested that "low-level anomalous experiences form an important foundation for later psychotic symptoms to be built upon" (Hodgekins, Fowler, Freeman, et al., 2006, p. S88). Furthermore, the positive symptoms of schizotypy (sc., magical ideation and perceptual aberrations) have been identified by certain researchers as being non-genetically transmitted (e.g., MacDonald III, Pogue-Geile, Debski, et al., 2001); as such, it may be the influence of environmental factors (e.g., trauma) on personality functioning that facilitates transmission to psychosis (Jang, Woodward, Lang, et al., 2005; Moutoussis, Williams, Dayan, et al., 2007; van Os et al., 2009). To this end, in line with ætiological research it has been suggested that phenotypic differences in psychotic symptoms may be quantitative rather than qualitative (Myin-Germeys, Spauwen, Jacobs, et al., 2004; van Os, Verdoux, Maurice-Tison, et al., 1999). Therefore, the psychometric identification of those individuals from the general population reporting elevated levels of anomalous (including positive schizotypal) experiences is an invaluable tool for furthering our understanding of the heterogeneity and trajectory

[5] "What is needed is not the early diagnosis of schizophrenia, but the diagnosis of pre-psychotic schizophrenia" (Meares, 1959, p. 55).

of such psychopathology (Malla & Payne, 2005; Olsen & Rosenbaum, 2009; Tsuang, Stone, & Faraone, 2000b; cf., White, Anjum, & Schulz, 2006). It is however acknowledged that applying differing methodological, ontological, and epistemological perspectives (e.g., adopting a pluralist interpretative [qualitative] perspective) may provide additional benefits (e.g., Coyne, 2010; McLeod, Corbisier, & Mack, 1996); for example, theoretical development and the revision of theory in light of empirical observation (McClenon, 1991). Notwithstanding, agreeing with Cardeña (2010), both quantitative and qualitative approaches to the investigation of anomalous experiences (cognitions) have much to offer.

A significant proportion of individuals from the general population report experiencing PLEs (Pechey & Halligan, 2012)—or psychometrically defined schizotypal phenomena—without attaining the clinical threshold for psychosis (Yung, Nelson, Stanford, et al., 2008; Verdoux & van Os, 2002), leaving them generally free from the experimental confounds inherent to clinical subjects, e.g. psychotropic medication, institutionalisation, chronicity, stigmatisation, etc. (Bradbury et al., 2009; Laws, Patel, & Tyson, 2008; Pickup, 2006; Savina & Beninger, 2007; Tirupati, Padmavati, Thara, et al., 2006). As such, this research is interested in those individuals from the general population reporting psychosis-like (anomalous) experiences without attaining the clinical threshold of being defined as a 'case in need of treatment' (Meehl, 1962, 1990; Venables, Wilkins, Mitchell, et al., 1990).

2.1.1 Literature search

It is acknowledged that there are numerous analogues of anomalous cognitions, many of which will be assessing similar constructs (e.g., positive schizotypy and the absorption element of dissociative experiences). Notwithstanding, the areas of interest were distilled from those occurring with the greatest prevalence from the following literature search. Utilising 'positive schizotypy', 'anomalous experiences', and 'anomalous cognitions' as primary search terms articles were electronically sourced from the years 1980–2005 via PubMed and PsycINFO; the literature review revealed eleven domains of personal experience with appropriate and psychometrically verified SRMs: (1) hallucinatory experiences; (2) delusional ideation; (3) coping style; (4) religiosity; (5) stressful life events; (6) transliminality; (7) schizotypy—for the purposes of Phase 1, the three core dimensions of schizotypy (positive, negative, and disorganised) will be analysed separately; (8) sense of coherence (subjective psychological wellbeing); (9) paranormal beliefs; (10) traditional religious beliefs; and (11) dissociative experiences. The eleven areas of interest extracted from the database searches were subsequently cross-referenced and further distilled by conducting a full internet search via Google to account for any database-specific occurrences. That is, the database search only accounted for articles within a necessarily restricted range. Applying a full internet search via Google incorporated a more diverse literature search. The areas of stressful life events, transliminality, and sense of coherence, although not occurring with any great regularity within the literature search were included because they have been found to be associated with schizophrenia symptomatology and, more recently, psychometric schizotypy. More specifically, it is acknowledged that the inclusion of transliminality—although being a known correlate of positive schizotypy and anomalous cognitions, per se—was included because of the author's personal interest in the link between anomalous and religio-spiritual phenomena. Such inclusion criteria (i.e., a restricted range of direct correlates plus personal preferences) may have unwittingly omitted pertinent areas of interest, e.g. hypersensitivity (e.g., Raine, 2006) and sleep-related disturbances (e.g., Koffel & Watson, 2009) (see also, section 2.6.2). Notwithstanding, the areas of interest will now be further explicated.

2.1.2 Areas of interest

2.1.2.1 Hallucinatory experiences

Since Fischer's (1969) identification of a 'perception–hallucination' continuum, there now exists a massive literature suggesting that hallucinations are not merely characteristics of organic deficits and therefore are not necessarily psychopathological in nature (e.g., Asaad & Shapiro, 1986; Bentall, 1990a,b, 2000; Chaudhury, 2010; Johns, 2005; Johns & van Os, 2001). Hallucinatory experiences as assessed in the general population include the propensity to experience anomalous auditory and visual phenomena (Langer, Cangas, & Serper, 2011) and engagement in vivid daydreaming (Ohayon, Priest, Caulet, et al., 1996). Hallucinatory experiences are documented by a large sub-proportion of the normal population (Aleman, Nieuwenstein, Böcker, et al., 2001; Ohayon, 2000; Posey & Losch, 1983; Tien, 1991; Verdoux & van Os, 2002; Young, Bentall, Slade, et al., 1986). In fact, a recent review of hallucinatory experiences in the general population found a median lifetime prevalence of 4% (van Os et al., 2009). More specifically, the reporting of auditory verbal hallucinations in ostensibly healthy populations may be viewed as part of a general vulnerability for schizophrenia (Sommer, Daalman, Rietkerk, et al., 2010).

Subclinical hallucinatory experiences are commonly equated with the positive dimension of schizotypy (van de Ven & Merckelbach, 2003) and are viewed by many researchers involved with schizotypy research to be cardinal personality traits indicative of positive schizotypal functioning (e.g., Debanné, Van der Linden, Gex-Fabry, et al., 2009; McCreery & Claridge, 1996; Tsakanikos & Reed, 2005a). As such, and in accordance with the dimensional model of psychosis (Claridge, 1997; Figure 2), hallucinatory experiences are thought to lie on a continuum with normal psychological functioning (Waters, Badcock, & Maybery, 2003), and when experienced at a subclinical level in healthy normals, as opposed to clinical patients who report such experiences as being predominantly distressing and maladaptive (Morrison, 1998), hallucinatory experiences may be emotionally neutral and even pleasurable (Jackson, 2007; McCreery, 1997).

However, a more recent study (Preti, Bonventre, Ledda, et al., 2007) utilised respondents (N = 250) from the general Italian population and found that the LSHS-R (Bentall & Slade, 1985a; Launay & Slade, 1981) fully mediated the links between delusional ideation as measured by the PDI (see section *2.1.2.2*) and "psychic distress of a clinically relevant nature" (p. 484) as measured by the General Health Questionnaire (GHQ; Goldberg, 1972; Goldberg et al., 1978)—the authors concluded that it could be argued that hallucination- and psychosis-proneness do not overlap but that both, however, can independently cause distress. Such distress has been found to include negative beliefs about the self and others, which further suggests an association between re-experiencing symptoms (of trauma) and hallucinations (Gracie, Freeman, Green, et al., 2007).

For the purposes of Phase 1, the LSHS-R was employed. The LSHS-R has been widely used to examine the prevalence of hallucinatory experiences within the general population (e.g., Bentall & Slade, 1985a,b; Feelgood & Rantzen, 1994; Jakes & Hemsley, 1986; Larøi & Van der Linden, 2005a; Rankin & O'Carroll, 1995; Waters et al., 2003) and was developed on the assumption that hallucinatory experiences occur on a continuum with normal psychological functioning.

Additionally, abnormalities of perceptual processing in patients with schizophrenia may explain their proclivity to delusional misidentifications (Fleminger, 1992). To this end, it has been proposed that hallucinations also play a causative role in the development of delusional ideation (Maher, 2006).

Caveat: "Hallucinations may be a normal part of religious experience in certain … contexts" (APA, 2000, p. 300).

2.1.2.2 Delusional ideation

Delusional ideation involves the tendency to hold irrational beliefs contrary to an individual's religious, social, and cultural norms (Fletcher & Frith, 2009; Kiran & Chaudhury, 2009; Mujica-Parodi & Sackeim, 2001; Pechey & Halligan, 2011); more specifically, to hold "erroneous beliefs that usually involve a misinterpretation of perceptions or experiences" (APA, 2000, p. 299). One possible mechanism by which such ideology is rooted in individuals is through *fear* (see, Houran & Lange, 1996; Lange & Houran, 1999, for work relating to the fear of the paranormal). Approximately 1–3% of the general population experience delusions at a clinically-significant level with a further 5–6%, experiencing delusions of a lesser severity (Freeman, 2006), especially paranoid and suspicious thoughts, which have been reported to frequently occur in 10–15% of the general population (Freeman & Garety, 2006). For the purposes of Phase 1, the PDI (Peters, Joseph, Day, et al., 2004) was adopted. The PDI has been widely used in the assessment of subclinical delusional ideation within the general population (e.g., Cella, Cooper, Dymond, et al., 2008; Jung, Chang, Yi, et al., 2008; Peters et al., 1999, 2004).

Similar to hallucinatory experiences, delusional ideation is suggested to lie on a dimensional continuum (Eaton, Romanoski, Anthony, et al., 1991) and is deemed to be a cardinal source of individual differences indicative of positive schizotypy (Boyle, 1998b; Brod, 1997; Debanné et al., 2009; Tsakanikos & Reed, 2005b); more specifically, magical ideation (including paranormal beliefs) is registered as one of the nine personality facets suggestive of a diagnosis of SPD[6]. Moreover, it has been proposed that susceptibility to magical ideation (an integral component of positive schizotypy) involves “belief and reported experiences in form and causation that by conventional standards are invalid” (Eckblad & Chapman, 1983, p. 215). Delusional ideation (in normal cognition) may be subserved by a confirmation bias; that is, the validity of an individual’s delusion/s may be impervious to contradictory evidence only registering evidence that confirms pre-existing beliefs, which culminates in perseveration and (perceptual) data distortion (Mercier & Sperber, 2011; see also Figure 8, Chapter 3). To this end, Maher (1974, 1988, 1992, 2003) has suggested that the confirmation of delusions (and hallucinations) may be operationalised when an individual attempts to explain their anomalous experiences. On this *anomalous experience hypothesis*, any pathology lies in the experience itself (see, Startup, Owen, Parsonage, et al., 2003) and not in the associated cognitions (e.g., probability reasoning). Although Maher developed his hypothesis based on observations with individuals with schizophrenia, there must be a second factor explaining why, if the delusion becomes manifest after exposure to an anomalous experience/s, does the individual not simply reject the belief (Coltheart, 2007). Questions to which cognitive science has attempted to provide answers (see Chapter 4).

Delusional ideation has been found to mediate psychosis onset in those also disposed to hallucinations, i.e. the clinical outcome of psychosis-like (anomalous) experiences is related to the development of secondary beliefs and appraisals (Meyer & Shean, 2006; see also, Krabbendam, Myin-Germeys, Hanssen, et al., 2004; Larøi & Van der Linden, 2005b), suggesting that attributional processes may serve adaptive functions by reducing the fear associated with ambiguous stimuli and delusional ideation (Houran & Lange, 2004; Lovatt, Mason, Brett, et al., 2010). Furthermore, such mediation may be operationalised by personal distress (Hanssen, Krabbendam, de Graaf, et al., 2005).

2.1.2.3 Coping strategies

Work-related (occupational) stress is an endemic feature of most occupations (Johnson, Cooper, Cartwright, et al., 2005). Occupational involvement is central to an individual’s notions regarding self

[6] SPD is defined as “[A] pervasive pattern of social and interpersonal deficits marked by acute discomfort with, and reduced capacity for, close relationships as well as by cognitive or perceptual distortions and eccentricities of behavior, beginning by early adulthood” (APA, 2000, p. 701).

and identity (Sutin & Costa, 2010) and subjective wellbeing (review: Erdogan, Bauer, Truxillo, et al., 2012). Additionally, according to Belongingness Theory (Baumeister & Leary, 1995) people possess an innate requirement to feel connected to something greater-than-themselves. With the above two proposals in mind, research indicates that occupational exclusion (ostracism) is "psychologically aversive to victims" (Hitlan & Noel, 2009, p. 479) leading to a host of maladaptive interpersonal behaviours, e.g. negative emotionality, loneliness, jealousy, guilt, and social anxiety (Leary, Koch, & Hochenbleikner, 2001), and dishonesty (Poon, Chen, & DeWall, 2013) potentially resulting in mental ill health (Stoetzer, Ahlberg, Bergman, et al., 2009). When deprived of belonging people seek to reassure their sense of self-worth and meaningfulness (Williams, 2007); as such, involvement in occupational decision making and problem solving, increased support and feedback, plus increased communication have been identified as key contributors to an individual's psychological wellbeing (Michie & Williams, 2003; Williams, 2007; Wood, Van Veldhoven, Croon, et al., 2013; cf., Nowack, 1989). Moreover, occupational mental health problems at the subclinical level are prevalent (Larsen, Bøggild, Mortensen, et al., 2010). As all Phase 1 respondents are (or have been) in part- or full-time employment, and because of its origin in occupational and management psychology (e.g., Edwards, 1992), the CCS (Edwards & Baglioni, 1993; Guppy, Edwards, Brough, et al., 2004) was employed.

Cybernetics is concerned with the use of information for and feedback to control purposeful behaviour. The basic premise of this theory is that behaviour is directed toward reducing deviations from a specific goal-state: "it is the deviations from the goal-state itself that direct the behavior of the system, rather than some predetermined internal mechanism that aims blindly" (Buckley, 1967, p. 53). This approach has been widely used in the scientific study of how organisms adapt to deviations from their goal-states (Cummings & Cooper, 1998). Cybernetic theory's concentration on 'information' highlights the central precept—that information and its subsequent feedback mediate the person-environment relationship (Edwards, Caplan, & Van Harrison, 1998); and, as a result, stress perception. Such an approach to stress management emphasises that the integration and subsequent utilisation of environmental information, based on such factors as prior experiences, expectations, etc., is crucial to an individual's understanding of potential stressors (Edwards et al., 1998). That is, the management of stress is an information-feedback-motivated drive toward psychophysiological homeostasis. The cybernetic model goes beyond the traditional models of stress and stress management by introducing factors that are not immediately in the work situation (e.g., threat; see, Fletcher, Gardner, & McGowan, 2006). An individual experiencing stress is theorised to go through several stages of stress perception, mediation, and resolution (coping) before reaching their personal (homeostatic, or as near to) goal-state (Lazarus, 1966; Lazarus & Folkman, 1984); and this process requires the individual's cognitive appraisal of all relevant factors (Brough, O'Driscoll, & Kalliath, 2005a). As such, the cybernetic theory of stress acknowledges the cyclical ongoing comparison between an individual's current state and their goal state (Buckley, 1967; Cummings & Cooper, 1998; Edwards et al., 1998).

An individual's coping style is proven to be one of the factors mitigating life stress and psychological health (Lazarus, 1999). How much of a direct influence life stress (trauma) has on psychological health is still an unresolved matter (Daniels & Guppy, 1994); some report only a small effect (e.g., Clements & Turpin, 1996), whilst other researchers report a significant direct effect (e.g., Ellison & Levin, 1998; Sarason, Johnson, & Siegel, 1978). Ultimately one's coping style to adverse events is essentially subjective in nature (Shiloh & Orgler-Shoob, 2006). To this end, as advocated by Wilkinson, Walford, and Espnes (2000), Phase 1's questionnaire battery also includes a measure of subjective wellbing (see section *2.1.2.8*; SOC) and as such the concept of traumatic events can be assessed on opposite ends of a single continuum—distress, may be operationalised (manifest itself) as depression, anxiety, and negative affect whilst wellbeing may be manifested as happiness, life satisfaction, and positive affect (Headey & Wearing, 1992). Further, Lazarus and Folkman (1984) advocate that coping styles can affect how traumatic (stressful) events are perceived. Within this framework coping is described as "all efforts to manage taxing demands, without regard to their efficacy or inherent value" (Lazarus & Folkman, 1984, p. 134); consequently, coping is not necessarily concomitant with a positive outcome. Furthermore, poor coping skills/maladaptive responses to trauma have been demonstrated to supersede eccentric belief systems, e.g. New Age beliefs [7] (incl., paranormal and religious ideology) (e.g., Sjöberg & af Wåhlberg, 2002). Notwithstanding, a religiously-oriented coping style has been shown in some cases to be highly effective at mediating life trauma, including occupational stress (Park, 2005; Southwick, Vythilingham, & Charney, 2005).

2.1.2.4 Religiosity

In the opinion of Weber (1965), religion is a prime source of meaning and significance in human existence, i.e. religion furnishes people with the feeling that they are not merely reacting to situations in a circumscribed manner, but rather their activities are part of a greater order of things, and their fates are connected to some greater purpose. For example, religion can ascribe meaning to otherwise seemingly futile situations (e.g., chronic illness), providing those who are suffering with the idea that it is not for nothing, and that there may be reward for their suffering in another life. To this end, it has been posited that humankind must believe in *something*, and in the absence of good grounds for belief we have little recourse but to choose bad ones (Russell, 1950).

[7] New Age beliefs including practices such as yoga, meditation, astrology, and aromatherapy are generally described as being a personally-oriented value system offering an alternative to organised religion (review: Heelas, 1996).

Religion, and by association religious involvement[8], has been "one of the major formative influences on human thought and behaviour throughout the centuries" (Fontana, 2003, p. 1; see also, Miller & Thoresen, 2003). Religiosity is defined as an "interest, involvement, or participation in religion … properly [referring to] a continuum of degree of participation in religious ritual or practice" (Reber & Reber, 2001, p. 622). An extensive literature has demonstrated a relationship between religious (and spiritual) involvement and improved health outcomes (Ellison & Levin, 1998; review: Coruh, Ayele, Pugh, et al., 2005), including psychological wellbeing (e.g., Kashdan & Nezlek, 2012; Martin, Kirkcaldy, & Siefen, 2003). For example, religious involvement, especially religious certainty (i.e., increased faith conviction) has been reported to provide elevated levels of life satisfaction, greater personal happiness, and fewer negative psychosocial consequences as a result of stressful (traumatic) life events (Ellison, 1991). These effects are proposed to be "direct and substantial" (Ellison, 1991, p. 80) as opposed to practices such as Church attendance and private prayer/devotion, which have been identified as indirect facilitators of religious faith and not directly related to an individual's wellbeing. Notwithstanding, religiosity highlights the importance of belief in God/gods to all human cultures, which is a perplexing conundrum that science has yet to resolve (Laubach, 2004; Tam & Shiah, 2004).

Psychotic and religious experiences have been associated since the earliest recorded history (Lukoff, 2005; Lukoff & Lu, 2005; Wootton & Allen, 1983); however, pronounced religio-spiritual problems may not be indicative of a psychotic disorder based on DSM-IV (APA, 2000) criteria, but may merely be manifestations of nonpathological religio-spiritual experiences (Johnson & Freidman, 2008; Koenig, 2007; Lukoff, 2007; Menezes & Moreira-Almeida, 2010; Sanderson, Vandenberg, & Paese, 1999). Within the psychology of religion, the relationship between mental health and religiosity occupies much of the literature (Koenig, McCullough, & Larson, 2001; Maltby & Day, 2004; Thoresen, Harris, & Oman, 2001). As far as schizotypy is concerned, religious and New Age beliefs and practices may attract individuals seeking an outlet for their magical beliefs and ideation therefore possibly facilitating a loose cognitive style and emotional sensitivity (Day & Peters, 1999; Farias, Claridge, & Lalljee, 2005; Smith, Riley, & Peters, 2009). Notwithstanding, the relationships between religiosity and schizotypy, and susceptibility to schizophrenia more generally are complex, involving for example, distinct patterns of intercorrelations between both schizotypal and religiosity subcomponents (e.g., Joseph & Diduca, 2001). Utilising multiple regression analysis, Thalbourne (2007) found that religiosity as measured by Haraldsson's (1981) eight-item non-sectarian religiosity scale was not significantly predictive of psychopathology, at least not in his sample of psychology undergraduates.

Transliminality (see section *2.1.2.6*), which contains, amongst other constructs, elements of magical ideation and mystical experience, has been suggested to be an alternative measure of positive

[8] Religious involvement is said to incorporate religious beliefs, experiences, and practices (Previc, 2006).

schizotypy (Thalbourne, Keogh, & Witt, 2005; Thalbourne & Maltby, 2008); however, transliminality also contains an implicit element of religiosity (Thalbourne & Houran, 2000) and previous research has found significant statistical relationships between transliminality and various measures of religiosity (Thalbourne & Delin, 1999), highlighting the knotty problem of dissociating pathological from nonpathological experiences (e.g., visions), which are often religious in meaning (Loewenthal, 2007; Lukoff, 2007). Additionally, it has been suggested that religious attachment (sc., Christian) may be a potential source of positive therapy for schizophrenic (Genia, 1992) and schizotypal individuals (Hancock & Tiliopoulos, 2010).

For the purposes of Phase 1, the AUIE (Gorsuch & McPherson, 1989; Gorsuch & Venable, 1983) was utilised. The Intrinsic-Extrinsic distinction addresses the relations between religion, personality, and behaviour (Donahue, 1985). The AUIE scale is based on the classic work of Allport and Ross (1967) further refined by Hood (1970), and addresses religion in respect of prejudice (summary: Hunsberger & Jackson, 2005). In this context, an *Intrinsic* motivation toward religious involvement (i.e., individually-oriented), involves a complete commitment to religious beliefs insofar as the influence of such beliefs is evident in everyday life (Allport, 1966). Such an approach to religious involvement is theorised to be less prejudiced than an *Extrinsic* involvement (i.e., socially motivated), which involves, for example, participation within socially-powerful in-groups (Genia & Shaw, 1991). In support of this duality in religious motivations, it has been suggested that possessing a socially-motivated reason for religious involvement "reflect[s] an extrinsic, means orientation because it would presumably be motivated by a desire to gain the self-serving, extrinsic end of social approval" (Batson, Schoenrade, & Ventis, 1993, p. 169) and as such is "non-normative" (Cohen, Pierce, Chambers, et al., 2005, p. 310). However, the simplicity of this dualism has been challenged (e.g., Hunsberger, 1995; Laythe, Finkel, & Kirkpatrick, 2001), with, for example, extrinsic motivation being split into two separate constructs: 1) extrinsic-personal ("religion as a source of comfort"); and 2) extrinsic-social ("religion as a source of social gain") (Maltby & Lewis, 1996, p. 938). Notwithstanding, the I-E concept has become firmly embedded within the psychology of religion (Gorsuch, 1988).

2.1.2.5 Stressful (traumatic) life events

Many authors report that traumatic life events precipitate psychological ill health and dysfunction (e.g., Berenbaum, Valera, & Kerns, 2003; Spataro, Mullen, Burgess, et al., 2004; Watts-English, Fortson, Gibler, et al., 2006) particularly in relation to PTSD symptomatology (e.g., Bernat, Ronfeldt, Calhoun, et al., 1998; Yoshizumi & Murase, 2007). To this end, it has been argued that traumatic events are recalled more reliably than adverse life events as they function as 'flashbulb' memories containing unusual vividness and clarity (Vrana & Lauterbach, 1994). Furthermore, individuals with diagnosed clinical psychoses (especially schizophrenia) possess excess victimising experiences (Read, Perry, Moskowitz, et al., 2001; review: Read & Ross, 2003), especially sexual- or violence-related abuse identified as occurring during childhood (e.g., Bebbington, Bhugra, Brugha, et al., 2004; Cohen, 2011; Costello, Erkanli, Fairbank, et al., 2002; Kessler, Davis, & Kendler, 1997; Mason, Brett, Collinge, et al., 2009; Read, Agar, Argyle, et al., 2003; Singer, Anglin, Song, et al., 1995; Turner & Lloyd, 1995). This point is important as many adult disorders are seen as having roots in childhood vulnerabilities (Maughan & Kim-Cohen, 2005), trauma exposure being one pertinent example (Lataster, van Os, Drukker, et al., 2006; Lawrence, Edwards, Barraclough, et al., 1995; Mackie, Castellanos-Ryan, & Conrod, 2011; Merckelbach & Muris, 2001). This association is suggested by some authors to indicate a causal relationship (Larkin & Morrison, 2006; Read, van Os, Morrison, et al., 2005) though this suggestion remains contentious (Corcoran, Walker, Huot, et al., 2003; Mason et al., 2009). Notwithstanding, this relationship is of ætiological importance (Spence, Mulholland, Lynch, et al., 2006).

Previous research has shown stress to be commonly implicated in the onset and maintenance of psychotic disorders (Lardinois, Lataster, Mengelers, et al., 2011; Lysaker, Outcalt, & Ringer, 2010; Phillips, Francey, Edwards, et al., 2007; Read et al., 2001; Spauwen, Krabbendam, Lieb, et al., 2006), personality disorders (Yen, Shea, Battle, et al., 2002) including schizotypy (Cohen & Davis III, 2009; Horan, Brown, & Blanchard, 2007; Schürhoff, Laguerre, Fisher, et al., 2009), transliminality (Thalbourne, Houran, & Crawley, 2003), and psychopathology in general (e.g., Gros, Price, Strachan, et al., 2012; Lange, De Beurs, Dolan, et al., 1999; Zuckerman, 1999). The frequency of magical thinking and superstitious behaviour becomes elevated when individuals are subjected to stress (both physical and psychological), possibly through the sense of 'loss of control' and/or coping with uncertainty (Keinan, 1994, 2002). Furthermore, an individual's personality type may be linked to stress adaptivity (Flaa, Ekeberg, Kjeldsen, et al., 2007). Cognitive models (e.g., Garety et al., 2007, 2001; see Chapter 3) propose that psychosis may develop via the emergence of intrusive threat beliefs after trauma. This line of reasoning has been recently confirmed in a study investigating the mediating effect of paranoid ideation on experiences of sexual abuse and psychosis (Murphy, Shevlin, Houston, et al., 2012b). Using mediation analysis, the authors obtained significant results for the mediating effect of paranoid ideation on sexual abuse (path a; $ß = 0.69$, SE = 0.09, $P < 0.05$), psychosis on paranoid ideation (path b; $ß = 0.21$, SE = 0.01, $P < 0.05$), and psychosis on sexual abuse (path c; $ß = 0.27$, SE = 0.07, $P < 0.05$). The mediated effect of sexual abuse on psychosis via paranoid ideation was also significant (path ab; $ß = 0.14$, SE = 0.07, $P < 0.05$). The authors concluded that posttraumatic paranoid ideation may be a viable hypothesis for exploring trauma-related psychosis (Murphy et al., 2012b).

One criticism of trauma and stress research is that it focuses almost exclusively on female subjects (Mezey & King, 1992); as such, gender differences need to be ascertained before formulating any comprehensive conclusions (Krajewski & Goffin, 2005; see also, Myin-Germeys & van Os, 2007).

However, this study has as one of its aims as identifying potential Gender differences: therefore, in this sample 50% are males and 50% females (see Table 1).

In order to assess stressful (traumatic) life events the SLESQ (Goodman, Corcoran, Turner, et al., 1998) was utilised. The SLESQ was designed to identify Criterion A events associated with PTSD—as outlined in DSM-IV (APA, 1994)—and to minimise sub-threshold events. PTSD is a syndrome with debilitating symptoms, such as intrusive distressing memories, nightmares, loss of interest in previously pleasurable activities, insomnia, and loss of concentration (APA, 2000). For a trauma experience to qualify as a traumatic stressor, Criterion A1 stipulates that "the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others" (APA, 2000, p. 463). Criterion A2 stipulates that the person's subjective response to the A1 event must involve "intense fear, helplessness, or horror" (APA, 2000, p. 463). However, one criticism of the SLESQ is that it does not directly assess Criterion A2 events (Norris & Hamblen, 2004). Notwithstanding, previous research has suggested that Criterion A experiences are significantly associated with schizotypal symptoms (Berenbaum, Thompson, Milanak, et al., 2008).

Traumatic events such as sexual assault, warfare, disasters, serious accidents, etc. are unfortunately commonplace (Kubany, Haynes, Leisen, et al., 2000), and there is a well-established link between adverse (traumatic) life events and psychological ill health (Barker-Collo & Read, 2003; Beasley, Thompson, & Davidson, 2003; Molnar, Buka, & Kessler, 2001). Furthermore, it has been suggested that traumatic stress in response to intra-psychic phenomena (e.g., delusions) can be understood in similar ways to trauma derived from physical phenomena such as disasters (Chisholm, Freeman, & Cooke, 2006; see also, Scott & Weems, 2012).

Seemingly counterintuitive, it has been argued that the "normal outcome of traumatic stress is growth, rather than pathology" (Christopher, 2004, p. 75), including increased psychological wellbeing, spiritual involvement, altruism, and intensified perception (Taylor, 2012; sc., Lelorain, Tessier, Florin, et al., 2012). As such, including an assessment of trauma exposure may provide insights into the shared ætiological mechanisms underpinning both psychotic and PTSD symptomatology (Neria, Bromet, Sievers, et al., 2002; Scott, Chant, Andrews, et al., 2007). Moreover, and confirming the need to assess respondents' trauma exposure is that such assessment provides a common antecedent linking all areas of Phase 1 interest, namely that of childhood trauma and stress (Diseth, 2005).

2.1.2.6 Transliminality

Transliminality is a hypothetical construct designed to assess individual differences in "a hypersensitivity to psychological material originating in (a) the unconscious, and/or (b) the environment" (Thalbourne & Maltby, 2008, p. 1,618). More specifically, the RTS (Lange, Thalbourne, Houran, et al., 2000) was designed to address a probabilistic hierarchy of items incorporating Magical Ideation, Mystical Experience, Absorption, Hyperaesthesia (extreme sensitivity to touch; reviews: Aron, Aron, & Jagiellowicz, 2012; see also, Jawer, 2005, 2006), Manic Experience, Dream Interpretation, and Fantasy Proneness. At the core of transliminality is the idea of "a hypothesised tendency for psychological material to cross *(trans)* thresholds *(limines)* into or out of consciousness" (Thalbourne & Houran, 2000, p. 853). With increasing transliminality the gating mechanism between subliminal (unconscious) and supraliminal (conscious) awareness is theorised to become less able to potentiate the flow of psychological information (Thalbourne, 2000a), allowing for the assessment of individual differences in the extent to which "different areas of the brain/mind are separated" (Sherwood & Milner, 2004/2005, p. 369). Additionally, transliminality, due to the aforementioned porosity between thresholds (layers) of awareness (consciousness), could be viewed as "an underlying dimension … involving enhanced connections between the unconscious and conscious aspects of the mind … allowing greater access to subconscious material via anomalous perceptions" (Winkelman, 2004, p. 211). In support of this, Soffer-Dudek and Shahar (2009) in a study of sleep-related disturbances concluded that transliminality is a general altered state of consciousness trait. For example, information from an individual's 'dream state' can infiltrate and have influence upon that individual's 'waking state', a flourishing idea in psychosis (Mahowald, 2003; Mason & Wakerley, 2012; McCreery, 2008) and psychosis-proneness research (Claridge, Clark, & Davis, 1997; McCreery, 1997; Watson, 2001, 2003).

Empirical evidence for transliminality is mixed (Goulding & Parker, 2001). For example, in a study of precognition, the core transliminality variables failed to predict precognition performance (Thalbourne, 1996). Conversely, in support of transliminality, Storm and Thalbourne (1998/1999) in a study using *I Ching* (an ancient form of Chinese divination) revealed that elevated performance levels—hexagram-descriptor pair 'hitting' (40%; mean chance estimate = 25%)—significantly correlated, albeit weakly, with transliminality ($r = 0.27$, $P < 0.010$, 2-tailed). Additionally, in a study utilising a subliminal card-guessing task Crawley, French, and Yesson (2002) provided contributory evidence for transliminality. In their study participants were delineated (mean split) for transliminality scores and subsequently compared on their task performance. Those scoring higher for transliminality performed significantly better only when subliminal primes were present ($r = 0.26$, $P = 0.009$, 1-tailed), furthermore an overall advantage was observed for high scoring transliminals when the same data were subjected to SDT (d'; $r = 0.253$, $P = 0.011$, 1-tailed). The authors concluded that the concept of transliminality possibly allows for an alternative explanation of seemingly psychic phenomena if subliminally acquired perceptual material is erroneously attributed to psychic origins. With this in mind, it has been suggested that certain individuals may ascribe a paranormal origin to an anomalous experience "without due critical testing of the logical plausibility of this belief" (Irwin, 2004, p. 149; see also, Hergovich & Arendasy, 2005). In further confirmation of this position, individuals with schizophrenia and manic depression (bipolar disorder) have been reported to score significantly higher than normal controls for one of the core components of transliminality—paranormal belief and experience (Thalbourne, 1998; Thalbourne & Delin, 1994). Additionally, Thalbourne (2010) suggests that transliminality may be informative in the study of psychosis.

In a study involving 40 undergraduate students (Thalbourne, 2000b), transliminality was found to possess a significant, albeit weak, positive relationship (r = 0.27, P < 0.05, 2-tailed) with the "normal" personality dimension of 'Openness' to experience as assessed by Brebner's Quick Scales (Brebner & Stough, 1995). This finding corresponds well with results reported in Chapter 1 (section 1.9) inasmuch as 'Openness' to experience is also significantly correlated with positive schizotypy. Notwithstanding, transliminality was identified, from a battery of personality measures (e.g., STA), via regression path analysis as the strongest predictor of anomalous experiences as measured by the anomalous experiences inventory (AEI; Kumar, Pekala, & Gallagher, 1994) (Simmonds-Moore, 2009-2010).

Numerous schizotypy measures have been found to possess significant associations with paranormal beliefs and transliminality (Kelley, 2010); and as such, it has been recently suggested that transliminality may be seen as an alternative measure of positive schizotypy, (e.g., Thalbourne et al., 2005; Thalbourne & Maltby, 2008) and by association, anomalous cognitions more broadly (see, Simmonds-Moore, 2009-2010). Thalbourne and Maltby (2008) provide evidence for this claim. They administered the RTS, the positive dimension of schizotypy as indexed by the O-LIFE (Mason et al., 1995), Hartmann's Boundary Questionnaire (Hartmann, 1991), and the Temporal Lobe Scale (TLS; Persinger, 1984) to a large sample (N = 1,368); the data was subsequently subjected to PCA. The results suggested a single factor solution accounting for 74.6% of the total variance, although the authors posit the proviso that all four variables are not necessarily "interchangeable with each other" (Thalbourne & Maltby, 2008, p. 1,622]. Notwithstanding, due to its brevity and superior psychometric properties the authors suggest the RTS to be an appropriate instrument for assessing any of the four constructs in question. The RTS was utilised in this study.

2.1.2.7 Schizotypy

The proclivity for members of the general population to report anomalous experiences (e.g., hallucinatory experiences) is the subject of burgeoning investigation primarily conducted under the psychometric rubric of *schizotypy* (Bradbury et al., 2009)—which is usually referred to as a non-specific psychosis-proneness (Claridge, McCreery, Mason, et al., 1996; Rossi & Daneluzzo, 2002). Analogous with transliminality, the notion of schizophrenia spectrum disorders involving disruptions in consciousness is well documented (e.g., Frith, 1979; Gruzelier, 2003; Nelson & Yung, 2009); which in the case of schizotypy may lead to cognitive fragmentation and sensory overload (Evans, Gray, & Snowden, 2007a), possibly resulting in the erroneous verification of perceptual anomalies (e.g., Crawley et al., 2002; Croft, Lee, Bertolot, et al., 2001; Gruzelier, 2002). It is evident that disruptions to the ordinarily integrated stream of conscious material are manifest in both high-scoring transliminals (Fleck, Green, Stevenson, et al., 2008) and high-scoring schizotypals (Evans, 1997; Koffel & Watson, 2009; see also, Pekala & Kumar, 2007).

Adrian Raine developed the 74-item SPQ (Raine, 1991) to characterise the extent to which individuals manifest features of schizotypal personality traits. The SPQ comprises nine subscales, one corresponding to each of the nine criteria for SPD as defined by the DSM-III-R (APA, 1987). The nine subscales can be combined to form three broader scales: the 1) Reality distortion; 2) Disorganisation; and 3) Negative symptom components of schizophrenia (Lenzenweger & Dworkin, 1996; Raine, Reynolds, Lencz, et al., 1994): respondents specify (Yes/No) as to whether or not they feel or believe they exhibit these features. The SPQ is the most prevalent measure of schizotypy in the research domain (Wuthrich & Bates, 2006). However, for the purposes of this study, due to its brevity and specific function for “dimensional research on the correlates of schizotypal features in the normal population” (Raine & Benishay, 1995, p. 346), schizotypal personality traits were assessed with the SPQ-B, which was developed from the SPQ. The SPQ-B comprises three subscales containing a total of 22 items, which were derived from the most reliable items from the aforementioned SPQ: 1) cognitive-perceptual deficits (CP; positive dimension [eight items]—incorporating ideas of reference, odd beliefs, magical thinking, unusual perceptual experiences, and paranoid ideation); 2) interpersonal dysfunction (ID; negative dimension [eight items]—incorporating blunted affect, no close friends, and social anxiety); and 3) disorganised thought [six items] (DT; odd speech and behaviour) (Gruzelier, 1996; Raine et al., 1994). The three subscales are seen to relate directly to the factor structure of schizophrenia and schizophrenia spectrum disorders (Battaglia, Fossati, Torgersen, et al., 1999; Rossi & Daneluzzo, 2002; Vollema & Hoijtinkm, 2000; Vollema & van den Bosch, 1995) and as such, when assessed in the general population, can be viewed as a liability (propensity) for developing a schizophrenia spectrum disorder (e.g., Meyer & Hautzinger, 2002; Miller, Byrne, Hodges, et al., 2002; Tyrka, Cannon, Haslam, et al., 1995).

2.1.2.8 SOC (subjective psychological wellbeing)

The SOC scale (Antonovsky, 1993) was employed in this study. The SOC scale was derived from the Orientation to Life Scale (OLS; Antonovsky, 1987). SOC is purported to assess the disposition toward viewing the world as comprehensible, manageable, and meaningful: perceptions that individuals within the schizophrenia spectrum have been shown to have problems with (e.g., Hemsley, 2005; van den Bosch, 1995; Waters, Maybery, Badcock, et al., 2004) due to difficulties in cognitive and emotional processing (Bengtsson-Tops & Hansson, 2001). The SOC construct is flexible, not fixed around a core set of mastering strategies (e.g. coping styles). As such, SOC is concerned with how individuals understand their lives and the lives of others, perceptions toward life management, and, most importantly, individuals' perceptions of the meaningfulness this imbues subsequent motivations to continue (Lindström & Eriksson, 2006). The SOC scale appears to reliably measure how people, especially females (Kivimäki, Feldt, Vahtera, et al., 2000), manage stressful situations and stay healthy (Eriksson & Lindström, 2005). As such, increased scores for SOC have been linked to greater stress adaptation and improved psychological and physical health functioning (Amirkhan & Greaves, 2003; Antonovsky, 1993; Ebert, Tucker, & Roth, 2002; Kennedy, Lude, Elfström, et al., 2010; Larsson & Kallenberg, 1999; Pallant & Lae, 2002). To this end, the SOC construct has been likened to "a protective personality factor" (Kivimäki, et al., 2000, p. 583). For the purposes of thesis, as increased SOC (sc., subjective wellbeing) has been found to be strongly allied with the reduced risk of developing a psychiatric disorder (Kouvonen, Väänänen, Vahtera, et al., 2010), SOC is to be equated with 'subjective psychological wellbeing' (review: Diener, Oishi, & Lucas, 2003). More generally, psychological wellbeing has been shown to be associated with reduced psychopathology (Urry, Nitschke, Dolski, et al., 2004).

It is worthwhile pointing out at this juncture that within the realms of positive psychology subjective and psychological wellbeing, although related, are considered to be two independent constructs (Linley, Maltby, Wood, et al., 2009). Subjective wellbeing is thought to possess an affective (emotional) component concerned with the balance between positive and negative affect plus a cognitive component involving judgments regarding one's life satisfaction (Diener, Lucas, & Oishi, 2002; Keyes, Shmotkin, & Ryff, 2002); whereas psychological wellbeing is defined as "engagement with existential challenges in life" (Keyes et al., 2002, p. 1,007).

With regard to dimensional schizotypy (including paranormal beliefs and experiences), utilising agglomerative hierarchical cluster analysis, SOC has been investigated by Goulding (2004, 2005). These two studies display a pattern of results consistent with the idea of healthy schizotypy and provide further evidence for the fully dimensional model of schizotypy (Claridge, 1997). That is, the cluster of respondents (in both studies) reporting above average scores on the unusual experiences (UnEx; positive) dimension as indexed by the O-LIFE coupled with increased paranormal beliefs/experiences as indexed by the Australian Sheep-Goat Scale (ASGS; Thalbourne & Delin, 1993) (i.e., Low Schizotypy cluster) were found to report SOC scores that were significantly increased as compared to the other two clusters ('Cognitive Disorganisation' and 'Introvertive Anhedonia').

2.1.2.9 Paranormal beliefs

Paranormal beliefs, including ESP, clairvoyance, spirit contact, and extraordinary lifeforms (e.g., Bigfoot) are commonly held even in modern times (Moore, 2005; Newport & Strausberg, 2001; Rhine-Feather & Schmicker, 2005; Ross & Joshi, 1992; Soh, Lee, Ng, et al., 2011). Continued fascination with the paranormal is promoted through the constant stream of supposedly "paranormal" media (Sparks & Miller, 2001), and the personality attributes of those who report such beliefs hold an enduring fascination (Dewan, 2006). One section of the general public that one might intuitively assume to be immune from such fantastical involvement, given their enhanced knowledge regarding the physical laws governing our existence, i.e. natural scientists (e.g., physicists), have themselves been shown to be 12-times more likely than psychologists to believe in ESP (Wagner & Monnet, 1979). Reasons for this are not clear, but Child (1985) suggested that a greater knowledge of human judgment and its associated errors may be partly responsible. See, Kelemen, Rottman, and Seston (*article in press*) for an interesting teleological explanation couched in terms of latent quasi-religious beliefs as possibly accounting for this disparity.

For parapsychologists (and psychologists, per se), paranormal phenomena such as those identified above are annoyingly non-replicable in nature (Kennedy, 2001, 2003; Krippner, Braud, Child, et al., 1993; Kurtz, 2000; Parker, 2003; Utts, 1991, 1995, 1996; cf., Keen, 2003), defying precise conceptualisation and thus comprehensive analysis[9]; a situation which has led some authors to question the validity of the 'paranormal' as a research topic (e.g., Scheibe & Sarbin, 1965; cf., Lau, Howard, Maxwell, et al., 2009; Mousseau, 2003). The ontology of paranormal (including magical, superstitious, and religio-spiritual) beliefs and experiences (henceforth, paranormalcy) nonetheless requires thorough empirical investigation (Lindeman & Aarnio, 2007; Tart, 2001, 2003). Numerous paranormalcy correlates have been identified such as personality traits, demographics, and social influences (reviews: Vyse, 1997; Zusne & Jones, 1989; see also, Auton, Pope, & Seeger, 2003). However, a major research avenue is to conceptualise paranormalcy as false cognitions: e.g., limitations in processing capacity (Shweder, 1977); beliefs that are barely articulated (Campbell, 1996); limitations in GCA (Musch & Ehrenberg, 2002); misperceptions of internal experience to external (paranormal) sources, a process analogous with mechanisms underpinning hallucinations and delusions (Houran & Williams, 1998); beliefs founded on ignorance (Padgett & Jorgenson, 1982); errors in probability judgment (Dawes & Mulford, 1993); the misrepresentation of chance/perception of randomness (Blackmore & Troscianko, 1985; Dagnall, Parker, & Munley, 2007); biases in emotion-based reasoning (Irwin, Dagnall, & Drinkwater, 2012); causal beliefs that by conventional standards are nonviable (Brugger & Graves, 1997; Eckblad & Chapman, 1983); and rapid,

[9] Considering the conceptual difficulties in its definition, the *paranormal* has been described as "a label for a residual category – a garbage bin filled with various odds and ends that we do not otherwise know what to do with" (Nemeroff & Rozin, 2000, p. 1).

subconscious, intuitions—a non-verbal reasoning style (Irwin & Young, 2002). Notwithstanding, individuals espousing little or no paranormalcy are generally in the minority, with females (and those expressing a feminine gender role) demonstrating elevated levels of paranormalcy (e.g., Blackmore, 1997; Rice, 2003; review: Irwin, 2009).

The dual-process account of paranormalcy (Evans, 2003; Pacini & Epstein, 1999; Sloman, 1996; Stanovich & West, 2000; Sun, 2004) suggests duality in human cognition (information processing). One type of processing is rational and critical (e.g., "Death is final"), whilst the other is intuitive, operating more automatically and being resistant to logical argument (e.g., "The soul continues to exist even though the body may die"). These two modes of cognition are not mutually exclusive: for example, the same magical beliefs typical of children (e.g., belief in witches, the Devil, and the Loch Ness monster) may be implicitly preserved and activated in adulthood despite their representations having been devalued in the face of rational knowledge (Subbotsky, 2000, 2001).

Such beliefs have been routinely linked with schizotypy (e.g., Chequers, Joseph, & Diduca, 1997; Goulding, 2004, 2005; Genovese, 2005; Hergovich, Schott, & Arendasy, 2008; Irwin & Green, 1998-1999; Peltzer, 2003; Pizzagalli, Lehmann, & Brugger, 2001; Schofield & Claridge, 2007), especially the positive dimension as indexed by the MI (Eckblad & Chapman, 1983) (e.g., Thalbourne, 1985; Williams, 1995; Williams & Irwin, 1991). However, this relationship is not all-encompassing because findings, in general, report correlations of around 0.6 suggesting that paranormal beliefs cannot account for the majority of variance in positive schizotypy scores (Irwin, 2009; see also, Dagnall, Munley, Parker, et al., 2010). To this end, it has been proposed that caution should be employed when interpreting data suggestive of a link between the ostensibly "maladaptive" personality traits associated with schizotypy as having roots in paranormal beliefs (Irwin & Green, 1998-1999; Parra, 2006). Notwithstanding, Irwin (2009) further points out that "there is … a clear association between proneness to schizophrenia and a wide range of paranormal beliefs (with TRB being a possible exception to this trend)" (p. 98). To this end, the relationship between TRB and paranormal beliefs are complex and generally inconclusive (e.g., Buhrmann & Zaugg, 1983; Ellis, 1988; Orenstein, 2002; Thalbourne & Hensley, 2001). As such, for the purpose of Phase 1, paranormal beliefs and TRB (see section *2.1.2.10*) will be analysed separately.

For the purposes of Phase 1, the 26-item RPBS (Tobacyk, 2004) was employed. The RPBS was designed to assess belief in phenomena that appear to defy/contradict our current understanding of the physical world (Bobrow, 2003; Broad, 1953a,b). It is the most widely utilised measure of paranormal beliefs in parapsychological research (Goulding & Parker, 2001) and has "made an unparalleled contribution to empirical research into paranormal belief" (Irwin, 2009, p. 45); Paranormal beliefs have been associated with psychological dysfunction (Dudley & Whisnand, 2000; Persinger, 2001), whilst other studies suggest that paranormal beliefs may be analogous with psychological health (Greeley, 1975; Pollner, 1989; reviews: Irwin, 1993; Irwin & Watt, 2007). Additionally, paranormal experiences may occur as a consequence of negative life events (Perkins & Allen, 2006; Rabeyron &

Watt, 2010). To this end, one possible mechanism by which paranormal beliefs may promote psychological wellbeing is by providing ‘emotional refuge’ for those who have experienced, for example, childhood abuse (Lawrence et al., 1995), possibly by providing an ‘illusion of control’ over uncontrollable life events (Irwin, 1992; cf., Bak, Krabbendam, Janssen, et al., 2005).

2.1.2.10 TRB

TRB and paranormal beliefs, although not mutually exclusive (Aarnio & Lindeman, 2007; Evans, 2003; Irwin & Watt, 2007), for the purposes of Phase 1 have been segregated in order to analyse paranormal beliefs as distinct from religious beliefs. Notwithstanding, Rojcewicz (1986) has noted that the Betty Andreasson abduction case of 1967 provides a fascinating perspective on the blurring of distinctions between religious and abduction (paranormal) experiences. Betty Andreasson interpreted her abduction experiences as visitations from angelic beings: "We can clearly see here the fusion between experience and belief, description and interpretation. Betty's Christian beliefs color her interpretation of the appearance of her abductors, calling them "angels," despite her verbal and pictorial descriptions to the contrary" (Rojcewicz, 1986, p. 138). Rojcewicz sees this as the intersection of "two or more belief traditions ... in one experience" (ibid.)—we might even consider the possibility that two or more belief traditions developed from a single experience (see, Partridge, 2004, for an opposite interpretation, i.e. aliens as demons). See Appendix I for a theoretical model of the potential interplay between paranormal and religious, experiences and beliefs.

Various authors report a negative relationship between paranormal and religious beliefs. (e.g., Beck & Miller, 2001; Emmons & Sobal, 1981; Persinger & Makarec, 1990); however, this negative relationship might alternatively be interpreted as a manifestation of the rejection of certain aspects of paranormal belief (e.g., ‘precognition’ and ‘superstition’) by the Catholic Church (Goode, 2000; Sparks, 2001). That is, the expression of paranormal beliefs may be defined by an individual’s religious affiliation. To this end, previous research suggests that a worldview which is open to the possibility of phenomena lying beyond the physical-materialistic realm (i.e., supernatural agents) may promote health and wellbeing (Abdel-Khalek & Lester, 2012; Gartner, Larson, & Allen, 1991; George, Ellison, & Larson, 2002). Inasmuch as mental health is concerned, the importance of supernatural beliefs (e.g., ghosts and demons) should not be dismissed as pure fantasy as those individuals espousing such beliefs may be coding and subsequently communicating important information in supernatural terms (Smith, 2008). Traditional religious (and spiritual) beliefs by their very nature possess an intuitive relationship with the magical ideation and odd experiences analogous with positive schizotypy (Farias et al., 2005; Jackson, 1997; Wolfradt, Oubaid, Straube, et al., 1999; see also, Moreira-Almeida & Cardeña, 2011).

2.1.2.11 Dissociative experiences

For the purposes of Phase 1, the DES (Bernstein & Putnam, 1986; Carlson & Putnam, 1993) was utilised. In the words of Bernstein and Putnam (1986) "dissociation is the lack of normal integration of thoughts, feelings, and experiences into the stream of consciousness and memory" (p. 727). In clinical terms, dissociation is similarly conceptualised as those occasions when one might experience "a disruption in the usually integrated functions of consciousness, memory, identity, or perception" (APA, 2000, p. 519). In their subclinical form dissociative experiences include subjective phenomena such as derealisation/depersonalisation, absorption, and memory complaints (Ross, Joshi, & Currie, 1990); additionally, dissociative experiences can include trance states (e.g., meditation, hypnosis) (Pekala, Maurer, Kumar, et al., 2010; Pintar & Lynn, 2008), possession states (e.g., demonic) (Paris, 1996), plus spiritual and healing practices (Seligman & Kirmayer, 2008).

Such experiences are not only to be found in psychiatric populations but lie on a continuum throughout the general population (Bernstein & Putnam, 1986; Hilgard, 1977; Ross et al., 1990), with an estimated prevalence rate of 3.3% (Kihlstrom, 2005). Furthermore, such experiences may underpin the complex relationship between the continuity of personality and psychopathology (Kihlstrom, Glisky, & Angiulo, 1994). Dissociative experiences are conceptually linked to other areas of interest within Phase 1 of the study, including: paranormal phenomena (Alvarado, 1998a,b; Beyerstein, 1995; te Wildt & Schultz-Venrath, 2004), schizotypy/psychosis-proneness (Allen & Coyne, 1995; Lipsanen, Lauerma, Peltola, et al., 1999; Merckelbach, Rassin, & Muris, 2000; Simeon, Guralnik, Knutelska, et al., 2004), transliminality (Thalbourne, 1998; Thalbourne, Bartemucci, Delin, et al., 1997), trauma (Merckelbach & Muris, 2001; Stein, Koenen, Friedman, et al., 2013; Spiegel, Hunt, & Dondershine, 1988), plus religiosity (Binks & Ferguson, 2013; Kennedy & Drebing, 2002).

Phenomenological research suggests that disturbances of basic self experience (including a variety of dissociative symptoms and experiences) constitute a phenotypic marker of psychotic vulnerability (Nelson & Yung, 2010). To this end, a gamut of research utilising different measures of schizotypy attests to the robust relationship between positive schizotypy and dissociative experiences—for example, 'unusual beliefs and experiences' [UBE] subscale of the SPQ (Chmielewski & Watson, 2008); PAS[10] and MIS (Pope & Kwapil, 2000). See Giesbrecht and Merckelbach (2008) for a recent discussion of this robust relationship. These correlational relationships range from 0.35 (SPQ 'UBE') to 0.43 (PAS) to 0.44 (MIS). Furthermore, aspects of dissociative experiences as identified through factor analysis (Stockdale, Gridley, Balogh, et al., 2002) revealed that the 'absorption' factor of the DES significantly predicted 3.8% of the variations in SPQ-B 'CP' scores and that the 'depersonalisation/derealisation' factor significantly predicted 4.8% of variations in RTS scores

[10] The PAS (Chapman, Chapman, & Raulin, 1978) was designed to assess positive schizotypy, more specifically, following Rado (1953, 1960) and Meehl (1962)—bodily image distortions and perceptual anomalies (Lenzenweger, 1994).

(Bradbury, Cavill, & Dagnall, *manuscript in preparation*); the authors concluding that despite the highly significant correlational relationship between positive schizotypy and transliminality ($r = 0.69$, $P \leq 0.0005$) this relationship may be more complex and multifaceted than face value suggests. That is, analysis of DES subscale (factor) scores allowed for a more indepth assessment of the interrelationships between transliminality, positive schizotypy, and aspects of dissociative experiences.

2.2 Synopsis of areas of interest

It will hopefully be evident that the literature search (section 2.1.2), which resulted in eleven areas of personal experience (increasing to thirteen once the three SPQ-B subscales were included), provided personality constructs that possess large areas of common overlap, whether that be statistically (e.g., transliminality and positive schizotypy sharing a large amount of common variance), theoretically (e.g., transliminal experiences facilitating a paranormal validation of perceptual anomalies), or conceptually (e.g., stressful life events superseding dissociative experiences and/or paranormal beliefs). Notwithstanding, the eleven core areas of interest, given that they each possess psychometrically verified SRMs, provide a strong theoretical base from which to statistically analyse potential Gender and Ageband differences in the reporting of ostensibly psychosis-like (anomalous) experiences.

2.3 Phase 1 study aims

Based on investigations into the phenomenology of anomalous self-experiences (Kennedy & Kanthamani, 1995; Parnas & Handest, 2003; Parnas, Handest, Jansson, et al., 2005; see also, Mundt, 2005; Nelson, Yung, Bechdolf, et al., 2008) the first hypothesis (hypothesis 1) is that the eleven SRMs—increasing to thirteen when SPQ-B subscales are incorporated—will display significant intercorrelations in a stratified quota sample. More specifically (hypothesis 2), that, following previous research (Thalbourne et al., 2005; Thalbourne & Maltby, 2008), despite utilising a different measure of psychometric schizotypy, positive schizotypal and transliminal experiences will remain strongly correlated.

Thirdly, it is hypothesised (hypothesis 3) that when subjecting all thirteen SRMs to PCA the resultant data will provide a limited number of factor solutions, and that the majority of SRMs will provide unique contributions toward the principal factor, hypothesised as a bias toward reporting anomalous cognitions. A further aim is to provide contributory evidence concerning the distributions of factor and uniquely contributing SRM scores with regard to Gender and Ageband (see, Badcock & Dragović, 2006; Maric, Krabbendam, Vollebergh, et al., 2003; Raine, 1992).

Finally, three XPGs will be identified from the factor (component) explaining the greatest proportion of variance in the data set.

2.4 Methods

2.4.1 Respondents

Initial recruitment was undertaken via means of a formal letter, which was sent to prospective companies asking for their permission to approach staff (via email). The letter outlined study aims and respondent's rights. If any members of staff were willing to take part, a preferred postal address was requested and SRM packs were duly posted. Using this recruitment methodology, one hundred and thirty respondents were recruited from the general (non-undergraduate) population and enrolled into the study utilising a stratified quota sampling technique, with delineations derived from National Statistics Online (2005). All respondents reported no history of, or treatment for, psychopathology[11], were white-Caucasian (due to non-response), in full- or part-time employment, and spoke English as their first language. Although psychotic symptoms (sc., hallucinations and delusions) have been reported in British children aged as young as twelve (Polanczyk, Moffitt, Arsenault, et al., 2010), for ethical simplicity all respondents for Phase 1 were aged $\geq$ 18. Following Badcock and Dragović (2006), age was treated as a non-continuous (banded) variable (see Table 1), the stratified quota sampling technique affording highly significant mean differences between Agebands: $F(2,127) = 355.879$, $P \leq 0.0005$.

[11] No respondents reported seeking help for any form of psychological distress, e.g. attenuated PLEs, depression, anxiety, etc (see, Kobayashi, Nemoto, Murakami, et al., 2011).

Table 1: Demographic characteristics of the total sample, including subgroups

Ageband	*N*	Mean age	Age range	Male/female (%)
18–34	54	27.81 (5.54)	–	27/27 (50.0/50.0)
35–54	50	41.44 (5.38)	–	25/25 (50.0/50.0)
55–85	26	63.69 (6.36)	–	13/13 (50.0/50.0)
Males	65	39.85 (13.93)	18–74	
Females	65	40.62 (14.96)	18–83	
Religious	22	47.09 (18.27)	22–83	10/12 (41.7/58.3)
Non-religious	108	38.83 (13.15)	18–72	55/53 (50.9/49.1)
Total	130	40.98 (14.61)	18–83	65/65 (50.0/50.0)

*SD in parentheses

2.4.2 Materials

Cronbach's α (Cronbach, 1951) for this sample are indicated within each SRM description. For those SRMs with a dichotomous response format (SLESQ, RTS, and SPQ-B) Kuder-Richardson (KR20) coefficients were computed. It is acknowledged that although α is the most commonly utilised criterion for measuring internal consistency, scales incorporating differential scoring systems (e.g., SPQ-B [dichotomous] and DES [polytomous]) potentially present different estimates of reliability (Almehrizi, 2013) and may potentially distort any data reduction techniques (e.g., PCA).

2.4.2.1 Demographic information

Although the variables of primary interest are respondents' Gender and Ageband, additional data was collected with regard to Ethnicity, Socioeconomic status, and Religious affiliation. A final section asked for contact details (landline, mobile, email) should they be selected for Phase 2 of the research (see Appendix II).

2.4.2.2 LSHS-R

Twelve-item Likert scale SRM ($\alpha = 0.87$). Respondents rate their level of agreement with each statement (e.g., "Sometimes a passing thought seems so real that it frightens me") on a five-point scale ranging from "Certainly does not apply" (score = 1) through "Certainly applies" (score = 5). The psychometric properties of the LSHS-R are well established (e.g., Aleman et al., 2001; Bentall & Slade, 1985a; Levitan, Ward, Catts, et al., 1996). Internal reliabilities are generally reported as > 0.80 (Bentall & Slade, 1985b). However, the multidimensionality (e.g., Aleman et al., 2001; Morrison, Wells, & Nothard, 2002; Paulik, Badcock, & Maybery, 2006) and temporal stability (e.g., Aleman, Nieuwenstein, Böcker, et al., 1999) of the scale are continually debated. Notwithstanding, the LSHS-R was scored as a unidimensional scale.

2.4.2.3 PDI

Twenty one-item Yes/No SRM ($\alpha = 0.86$). If one answers Yes to any of the questions, then one has to complete three further subscales regarding the amount of *distress*, *preoccupation* and *conviction* of said belief (scored 1–5 each). The 21 items are derived from items utilised in the Present State Examination (PSE; Wing, Cooper, & Sartorius, 1974) to assess delusional symptoms, but are mitigated and aim at exploring a lifetime experience using the introductory sentence "**Do you ever feel as if**…" For example, "Do you ever feel as if you are especially close to God?" (Preti, Rocchi, Sisti, et al., 2007). The doubting nature of the items was deemed necessary for assessing delusional ideation that may not ordinarily be within the realm of psychopathology (Peters et al., 2004).

The psychometric properties of the PDI are well established (e.g., Peters et al., 2004; Preti et al., 2007). However, the multidimensionality of the scale has been debated (e.g., Verdoux, van Os, Maurice-Tison, et al., 1998); although a more recent study suggests that, at present, the unidimensional scoring system is optimal for utilisation with normal populations (Jones & Fernyhough, 2007b). Recent research has suggested that scores on the PDI in normal populations may not be normally distributed (Varghese, Scott, & McGrath, 2008); as such, PDI scores were tested for normality. Kolmogorov-Smirnov statistic = 0.124, df = 130, $P \leq 0.0005$ and Shapiro-Wilk statistic = 0.885, df = 130, $P \leq 0.0005$. The two tests of normality indicate that the data are significantly skewed. As such, PDI raw scores were subjected to a square root transformation[12], which reduced the levels of significance to those of nonsignificance and a trend, respectively: Kolmogorov-Smirnov statistic = 0.058, df = 130, $P = 0.200$ and Shapiro-Wilk statistic = 0.981, df = 130, $P = 0.073$. PDI and PDI-transformed (henceforth, PDI-trans) scores were subsequently checked for HOV between Genders and Ageband. For PDI raw scores (Gender, Levene statistic = 3.117, $P = 0.080$; Ageband, Levene statistic = 1.864, $P = 0.159$). However, PDI-trans reduced the trend toward significant Gender difference to that of nonsignificance (Levene statistic = 1.365, $P = 0.245$); with regard to the Ageband result, PDI-trans scores remained nonsignificant (Levene statistic = 0.012, $P = 0.988$). As such, it was decided to utilise the unidimensional PDI-trans scores in future analyses.

[12] A square root transformation was performed as the DES is scored on linear scale from 0–100 percentage points and as such incorporated values of zero.

2.4.2.4 CCS

Fifteen-item Likert scale SRM ($\alpha = 0.68$)[13] designed to assess the ability to implement effective coping strategies when involved in problematic and stressful situations. Items are endorsed on a seven-point Likert scale. In response to an emboldened leading sentence, respondents rate their level of agreement with each statement (e.g., **When needing to change a difficult situation** … "I focus my efforts on changing the situation") on a seven-point scale ranging from "Do not use at all" (score = 1) through "Use very much" (score = 7). Items 7 through 12 are reverse scored.

The CCS comprises five subscales: 1. Change the situation (three items); 2. Accommodation (three items); 3. Devaluation (three items); 4. Avoidance (three items); and 5. Symptom reduction (three items). Multigroup confirmatory factor analysis confirmed a well-fitting model with a stable factor structure and partial measurement invariance compared to previous CCS versions. Moreover, a fourteen-item version of the CCS provided superior goodness-of-fit and item properties as compared to the Ways of Coping Questionnaire (WCQ; Folkman & Lazarus, 1988) (Brough et al., 2005a,b). A recent study employing the CCS reported that in a sample of 129 persons with early psychosis, that personality factors, such as coping, are linked to behavioural changes (Beauchamp, Lecomte, Lecomte, et al., 2011). This finding provides evidence for the inclusion of the CCS within this questionnaire battery. The five-factor composition and item associations were mirrored in this study. Notwithstanding, the CCS was scored as a unidimensional scale.

2.4.2.5 " AUIE

Fourteen-item Likert scale SRM ($\alpha = 0.76$). Respondents rate their level of agreement with each statement (e.g., "What religion offers me most is comfort in times of trouble and sorrow") on a five-point scale ranging from "Strongly disagree" (score = 0) through "Strongly agree" (score = 4). Items 3, 10, and 14 are reverse scored. The psychometric properties of the original AUIE have been verified (e.g., Gorsuch & McPherson, 1989), although the item response format has been challenged (Maltby, 2002). Additionally, a twelve-item version of the scale has been suggested to be parsimonious for use with "a number of Western samples, among adults and school children, and among religious and non-religious individuals" (Maltby, 1999, p. 407; see also, Maltby & Lewis, 1996). As far as Phase 1 is concerned, α's for the three subscales are as follows: 1) Intrinsic (eight items; $\alpha = 0.90$); Extrinsic-social (three items; $\alpha = 0.62$); 3) and Extrinsic-personal (three items; 0.92). Notwithstanding, the AUIE was scored as a unidimensional scale.

[13] Although Nunnally (1978) suggests that coefficients of ≥ 0.7 are ideal, he describes coefficients of ≥ 0.6 as acceptable for the social/psychological sciences.

2.4.2.6 *SLESQ*

Thirteen-item YES/NO SRM (α = 0.62). Example item: "Have you ever had/do you currently have a life-threatening illness?" Although meant to be a basis for indepth interview-based screening, the SLESQ, without qualification, provides a rudimentary measure of previous and/or ongoing life trauma; i.e. the scale was trimmed to discount further investigation into the extent (i.e., frequency and duration) of any reported trauma; a simple YES or NO answer was required. Questions concerning sexual assault are behaviourally specific, and avoid the use of broad terms such as rape. The psychometric properties of the SLESQ have been established. The SLESQ possesses good discrimination between Criterion A and non-Criterion A events. The SLESQ has good test–retest reliability (0.89) with a median kappa of 0.73 (Costello et al., 2002) and good convergent reliability (0.77) (Beasley et al., 2003). Cross-cultural validity has been partially confirmed (Green, Chung, Daroowalla, et al., 2006) in a small sample of African-American women (N = 16), with only minor rewording required. Utilisation of the SLESQ, unsurprisingly, allows for a more sensitive evaluation of trauma exposure than the (single-item) trauma screen of the Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, et al., 1994), facilitating a more comprehensive screening (Elhai, Franklin, & Gray, 2008). A total of YES responses were summated to calculate respondents' scores. The SLESQ was scored as a unidimensional scale.

2.4.2.7 *RTS*

Twenty nine-item True/False SRM, for which only the seventeen Rasch-scaled (Rasch, 1980) items are scored (α = 0.86). The psychometric properties of the RTS have been demonstrated (Lange et al., 2000). Houran, Thalbourne, and Lange (2003) in an erratum and comment on the RTS stated that the Rasch reliability of the scale is 0.82, relating to a KR-20 reliability of 0.85. Thalbourne (2000c) found the full twenty nine-item version to have a test-retest reliability of 0.88 ($N = 51$, $P < 0.001$) over an average of fifty days, and further analysis on this same data set showed that the seventeen items that are scored for the RTS have a test-retest reliability of 0.82 ($P < 0.001$).

2.4.2.8 *SPQ-B*

Twenty two-item Yes/No SRM (α = 0.86). The psychometric properties of the SPQ-B have been verified (e.g., Raine & Benishay, 1995; Compton et al., 2007); furthermore, the three-factor (trisyndromic) structure has been recently confirmed (e.g., Fransesca-Pedrero, Lemos-Giráldez, Paino, et al., 2009c; Mata, Mataix-Cols, & Peralta, 2005). Recent research with a sample of American undergraduates (N = 825) confirmed satisfactory fit indices for the three factor model (CFI = 0.82;

Compton et al., 2009). The three subscales are seen to relate directly to the factor structure of schizophrenia and schizophrenia spectrum disorders (Gruzelier, 1996; Reynolds, Raine, Mellingen, et al., 2000; Rossi & Daneluzzo, 2002; Vollema & Hoijtinkm, 2000), more specifically to Liddle's (1987) three-factor model of schizophrenic symptomatology, incorporating positive, negative, and disorganised factors.

The α's for the three subscales are as follows: CP = 0.75; ID = 0.76; and DT = 0.75, and compare favourably with results found in the above-cited studies. Notwithstanding, the Yes/No item response format of the lengthier SPQ has been questioned, Likert scale response formats provide superior internal reliabilities and discriminatory power for identifying high scorers (Wuthrich & Bates, 2005). However, the authors posit the proviso that such discriminations may only be of relevance when dealing with schizophrenic patients. Cross-cultural validity of the distribution of SPQ-B scores, its factor structure, and the intercorrelations between populations of Turkish and U.S. respondents have been found to be similar (Aycicegi, Dinn, & Harris, 2005). The utility for the SPQ-B to evaluate, especially the CP and ID features of schizotypal disorder, has been verified in a population of psychiatrically-hospitalised adolescents (Axelrod, Grilo, Sanislow, et al., 2001) suggesting convergent validity.

Although it is acknowledged that a fourth factor representing 'paranoid' symptoms has been identified (e.g., Compton et al., 2009; Fonseca-Pedrero, Paíno-Piñeiro, Lemos-Giráldez, et al., 2009), for simplicity, the SPQ-B was scored as a tri-dimensional scale. The total of YES responses are summated for each subscale (CP, range = 0–8; ID, range = 0–8; DT, range = 0–6).

2.4.2.9 SOC-13

Thirteen-item Likert scale SRM (α = 0.85). Respondents rate their level of agreement with each statement (e.g., "Has it happened that people whom you counted on disappointed you?") on a seven-point scale ranging from "Happens all the time" (score = 1) through "Never happened" (score = 7). Items 1, 2, 3, 7, and 10 are reverse scored. The psychometric properties of the SOC are well established (see, Antonovsky, 1993). For example, the average α, unweighted for sample size, for the lengthier SOC-29 over eight published studies is 0.91—range = 0.86–0.95 (Antonovsky, 1993)—and more recent studies utilising the SOC-13 have reported good internal reliability (e.g., Pallant & Lae, 2002; α = 0.84). Studies have, amongst other things, linked the SOC-13 with greater psychological wellbeing, adaptive coping strategies, and personality measures, (including psychometric schizotypy (O-LIFE; Goulding, 2004, 2005). Test-retest reliability has been found to range from 0.41 to 0.97 (Antonovsky, 1993).

Criticism of the SOC construct comes from the fact that its three components (comprehension, management, and meaning) do not appear when the scale is subjected to multivariate statistical techniques (Antonovsky, 1993); nonetheless SOC seems to co-vary strongly with measures of health (Ebert et al., 2002; Kivimäki et al., 2000; Pallant & Lae, 2002). Because of the uncertainty as to the factor structure and the intercorrelations between SOC components (Antonovsky, 1993; Larsson & Kallenberg, 1999; Sandell, Blomberg, & Lazar, 1998), Antonovsky (1993) suggested that the scale be used in its entirety with no analyses of subcomponents—this approach (i.e., unidimensional scoring) was adopted in this study.

2.4.2.10 RPBS

Twenty two-item Likert scale SRM (α = 0.91). Respondents rate their level of agreement with each statement (e.g., "Some psychics can accurately predict the future") on a seven-point scale ranging from "Strongly disagree" (score = 1) through "Strongly agree" (score = 7). From the full 26-item scale, items 3, 19, and 24 are reverse scored. Much evidence supports the reliability and validity of the RPBS and its subscales (e.g., Tobacyk, 2004; Tobacyk & Milford, 1983). The RPBS provides factorially derived subscales for seven dimensions of paranormal belief although one has been segregated—TRB (see also, Lange et al., 2000; Williams, Francis, & Lewis, 2009)—for independent analysis (see section *2.4.2.11*). Reliability statistics for the remaining six subscales are as follows: 1) Psi (α = 0.71); 2) Witchcraft (α = 0.76); 3) Superstition (α = 0.80); 4) Spiritualism (α = 0.71); 5) Extraordinary lifeforms (α = 0.71); and 6) Extrasensory perception (α = 0.83). Although the multidimensionality of the RPBS is now well established (e.g., Tobacyk, 2004; Tobacyk & Mitchell, 1987; Tobacyk, Nagot, & Miller, 1988), the exact number of factors (subscales) and their method of extraction has been a topic of fierce debate (e.g., Lawrence, 1995; Lawrence & de Cicco, 1995; Lawrence, Roe, & Williams, 1997). Notwithstanding, the RPBS total score (i.e., the sum of all six subscales) will be utilised to provide an index of global paranormal beliefs.

The revised version of the scale offers superior psychometric properties due to its increased scoring range, i.e. seven-point as opposed to five-point (cf., Tobacyk & Milford, 1983) and item changes to three of the seven subscales (witchcraft, extraordinary lifeforms, and precognition). This imbues the RPBS with "greater reliability and validity, less restriction of range, and greater cross-cultural validity" (Tobacyk, 2004, p. 94). The RPBS was scored as a unidimensional scale.

2.4.2.11 TRB subscale of the RPBS

Four-item seven-point Likert scale SRM (α = 0.79). The psychometric properties of the TRB subscale are subsumed above. The TRB subscale was scored as a unidimensional scale.

2.4.2.12 DES

Twenty eight-item scale SRM (α = 0.96). Respondents rate their level of agreement with each statement (e.g., "Sometimes people have the experience of driving or riding in a car or bus and suddenly realising that they don't remember what has happened during all or part of the trip") on an eleven-point linear scale (0–100, multiples of ten). The psychometric properties of the DES are well established (Bernstein & Putnam, 1986; Carlson & Putnam, 1993; Holtgraves & Stockdale, 1997; van Ijzendoorn & Schuengel, 1996). For example, the test-retest reliability coefficients range from 0.79 (Pitblado & Sanders, 1991; six to eight weeks) to 0.84 (Frischholz, Braun, Sachs, et al., 1991; four to eight weeks) to 0.96 (Spitzer, Freyberger, Stieglitz, et al., 1998; four weeks). The internal reliability found in the current sample compares favourably with that found in other studies: 0.95 (Farrington, Waller, Smerden, et al., 2001); 0.94 (Ruiz, Poythress, Lilienfeld, et al., 2008). Furthermore, an ongoing topic of debate relates to the number of factors subserving the DES. Despite the majority of studies utilising the DES as a unidimensional scale (e.g., Zingrone & Alvarado, 2001/2002), several researchers suggest that multiple-factor models may be more appropriate, especially when screening for elevated levels of dissociation in clinical and nonclinical groups (e.g., Bernstein, Ellason, Ross, et al., 2001; Ross, Ellason, & Anderson, 1995; Stockdale et al., 2002).

Additionally, previous research has indicated that in normal populations DES scores may be skewed toward lower scoring respondents—a floor effect (e.g., Startup, 1999; Wright & Loftus, 1999). As such, raw DES scores were tested for normality. Kolmogorov-Smirnov statistic = 0.167, df = 130, $P \leq 0.0005$ and Shapiro-Wilk statistic = 0.771, df = 130, $P \leq 0.0005$. The two tests of normality indicate that the data are significantly skewed. As such, DES raw scores were subjected to a cube root transformation, which reduced the significant normality statistics to ones of nonsignificance: Kolmogorov-Smirnov statistic = 0.056, df = 130, $P = 0.200$ and Shapiro-Wilk statistic = 0.993, df = 130, $P = 0.756$. Following transformation, the DES transformed (henceforth, DES-trans) scores were utilised for future analyses.

2.4.3 Procedure

SRM 'packs' were distributed for completion at home or at work; all respondents completed the SRM battery in a fixed order. Although it is acknowledged that such a method of questionnaire administration may have potentially introduced a *context effect* (Council, 1993), because of the relaxed completion criteria the effect of such a confound was hopefully limited (see, Roig, Bridges, Hackett Renner, et al., 1998).

A covering information sheet made it clear that respondents were not to report experiences gained whilst under the influence of drugs (recreational and/or medicinal). The questionnaire test battery (minimum 200 items/maximum 263 items, dependent on responses) took approximately 45-minutes +/- 15-minutes to complete. As no remuneration was offered for Phase 1, respondents were allocated a period of one month within which to complete SRM packs at their leisure. SRM packs were returned to the researcher via pre-paid envelopes, a strategy that has been shown to increase response rates (Newton, Stein, & Lucey, 1998); this allowed for a gratifying return rate of 66.5% (133/200) (cf., Lawrence & Peters, 2004). However, three SRM packs had to be discarded due to missing information (e.g., contact details, age, sex, etc). Due to the interesting nature of the subject matter—many respondents claiming that it made them address certain areas that they had a personal interest in (e.g., paranormal phenomena) (see, Subbotsky, 2004) but hardly ever discussed (e.g., for fear of ridicule)—most were keen to see a completed copy of the final Phase 1 results, to compare themselves with friends, family, males vs. females, etc.

2.4.4 Ethical considerations

Because of previous literature suggesting that certain individuals may be reticent to endorse schizotypy questionnaire items (Jones, Cardno, Murphy, et al., 2000; Peltier & Walsh, 1990), adopting, dependent on the context of presentation, a defensive response style (Mohr & Leonards, 2005) the wording for all SRMs, where appropriate, was left as neutral as possible avoiding terminology such as "schizophrenia", "psychosis", "disorder", "psychopathology", "psychiatry", "dysfunction", or "maladaptive" (see also, Linscott & Cross, 2009). In the field of anomalistic psychology it is generally assumed that, as a general rule, barring psychopathology or a clear intention to deceive, respondents are providing veridical affirmations of their experiences (Beyerstein, 2007). All participants were assigned a PIN so that responses would remain anonymous. These PINs were also carried through to Phase 2 of the research for cross-referencing purposes..

The study was approved by the Ethics Committee of the Department of Psychology & Speech Pathology, Manchester Metropolitan University. The study was introduced as an inquiry into the patterns and prevalence of unusual thought and ideation within the general population. All respondents provided informed written consent.

2.5 Results

2.5.1 Data analysis

Pearson's Product Moment (bivariate) correlations were utilised to assess statistical relationships between SRMs and revealed factors (components).

Although SRMs were chosen on the basis of theoretical interconnectedness (see section 2.1), due to the exploratory nature of Phase 1, PCA will be employed to reduce the complete data set (Costello & Osborne, 2005).

Independent samples *t*-tests and ANOVAs were utilised to assess mean differences between groups (Gender and Ageband).

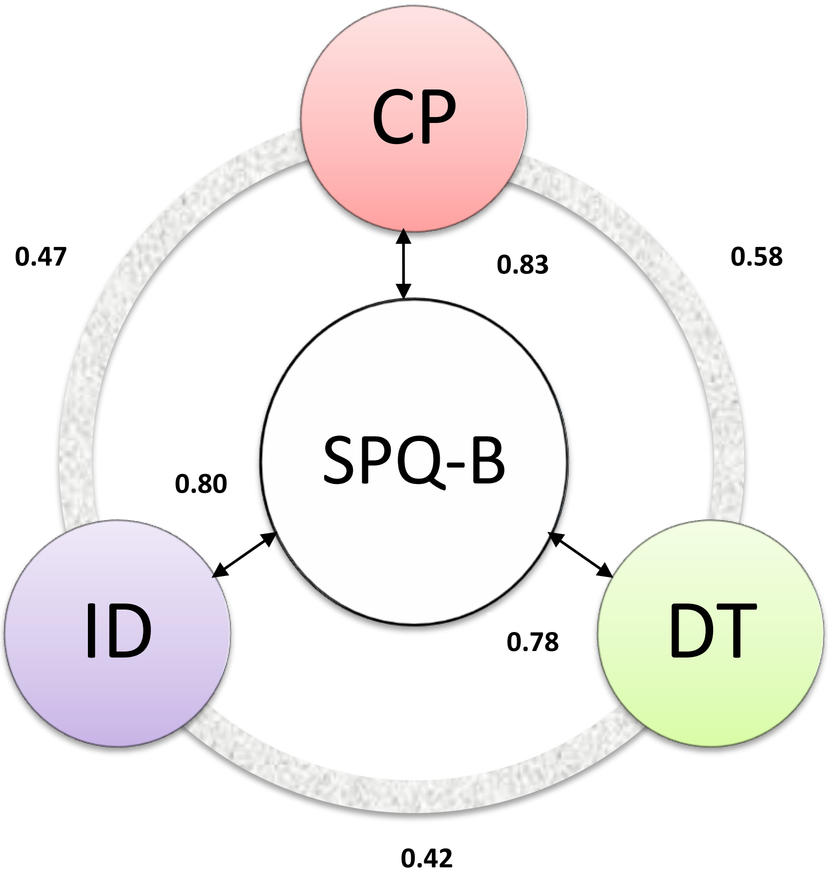
Table 2: SRM descriptives

SRM (total range)	Minimum	Maximum	Actual range	Mean	SD
LSHS-R (12–60)	12	51	39	23.9	9.35
PDI-trans (0–315)	0	14.35	17.7	5.6	2.93
CCS (15–95)	37	95	58	66.1	10.58
AUIE (0–56)	0	46	46	15.9	8.30
SLESQ (0–13)	0	10	10	2.2	2.10
RTS (13.7–37.3)	13.7	37.3	23.6	20.9	5.01
SPQ-B ‘CP’ (0–8)	0	8	8	2.1	2.11
SPQ-B ‘ID’ (0–8)	0	8	8	2.5	2.19
SPQ-B ‘DT’ (0–6)	0	6	6	1.3	1.65
SOC (13–91)	23	91	68	62.2	12.21
RPBS (22–154)	22	117	95	63.0	23.75
TRB (4–28)	4	28	24	12.9	6.14
DES-trans (0–10)	0.6	3.1	3.2	1.8	1.83

2.5.2 Correlational analysis

In order to gain an overview of relationships between variables a complete correlational analysis was conducted (see Table 3). In confirmation of hypothesis 1, results revealed that, aside from the measures of CCS and AUIE all SRMs displayed significant intercorrelations. In particular, highly significant relationships were revealed between those measures expected to contribute toward ostensibly anomalous experiences (i.e., SPQ-B ‘all subscales’, LSHS-R, PDI-trans, SLESQ, RTS, RPBS, TRB, and DES-trans). Moreover, and in confirmation of hypothesis 2, the previously identified strong correlational relationship between positive schizotypal (SPQ-B ‘CP’) and transliminal (RTS) experiences was reconfirmed, as was the expected significant relationships between transliminality and the measures of religiosity (AUIE) and TRB (see section *2.1.2.6*). Additionally, intercorrelations between the SPQ-B and its three subscales were all found to be highly significant (see Table 3 and Figure 3), and suggest that the SPQ-B may be measuring some common element of schizotypy within this particular sample group. Notwithstanding, for the purposes of the forthcoming statistical analyses each subscale will be analysed independently.

Figure 3: SPQ-B and subscale intercorrelations



*All correlations are significant at $P \leq 0.0005$

Table 3: Phase 1 SRM correlational matrix

SRM	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.LSHS-R	—	0.67****	0.18*	0.36****	0.33****	0.66****	0.57****	0.33****	0.49****	-0.40****	0.49****	0.53****	0.45****
2.PDI-trans		—	0.20*	0.23*	0.43****	0.56****	0.63****	0.41****	0.54****	-0.48****	0.54****	0.48****	0.47****
3.CCS			—	0.00	0.15	0.17	0.11	0.01	0.14	0.15	0.16	0.10	0.04
4.AUIE				—	-0.03	0.28***	0.18*	0.07	0.02	-0.01	0.30***	0.60****	0.07
5.SLESQ					—	0.46****	0.52****	0.21*	0.45****	-0.31****	0.44****	0.15	0.43****
6.RTS						—	0.66****	0.33***	0.53****	-0.30***	0.50****	0.39****	0.59****
7.SPQ-B: ‘CP’							—	0.47****	0.58****	-0.45****	0.57****	0.39****	0.60****
8.SPQ-B: ‘ID’								—	0.42****	-0.54****	0.22*	0.22*	0.30***
9.SPQ-B: ‘DT’									—	-0.46****	0.40****	0.18*	0.46****
10.SOC										—	-0.32****	-0.22*	-0.51****
11.RPBS											—	0.58****	0.37****
12.TRB												—	0.25**
13.DES-trans													—

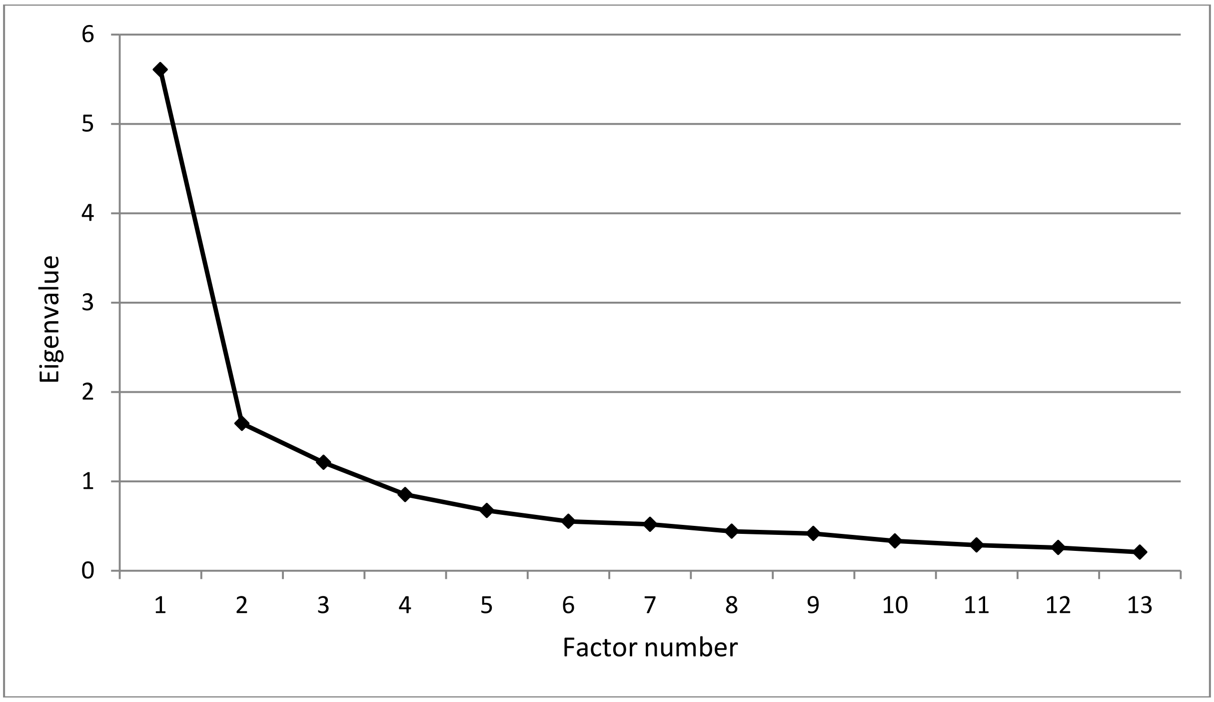
*$P \leq 0.05$
**$P \leq 0.01$
***$P \leq 0.001$
**** $P \leq 0.0005$

2.5.3 Principal components analysis (PCA)

PCA (Oblimin with Kaiser-normalisation procedure) was carried out. Oblimin rotation was utilised because it assumes that the underlying factors are not necessarily independent from one another, which may often be the case in perceptual experience (e.g., psychosis-like and spiritual experiences being strongly linked) (Bell, Halligan, & Ellis, 2006a). Delta and kappa were set to the SPSS defaults of 0 and 4, respectively. The Kaiser-Meyer-Olkin value was 0.866, substantially exceeding the recommended value of 0.6 (Kaiser, 1974), and Bartlett's Test of Sphericity was also significant (χ^2 = 788.540, df = 78, $P \leq 0.0005$), supporting the suitability of PCA with this particular data set.

In confirmation of hypothesis 3, PCA suggested a three-factor solution was optimal (see Table 4 for Rotated pattern matrix), confirmed by inspection of the scree plot (Cattell, 1978), which revealed a reasonably clear break after the third factor (see Figure 4). The rotation was converged in eight iterations and explained a cumulative total of 65.11% of the total variance. In order to enhance factor clarity values of less than +/- .32 have been omitted from the final table (Tabachnik & Fidell, 2006); but the four cross-loading SRMs (LSHS-R, SPQ-B 'ID', SOC, and RPBS) have been retained to maintain the integrity of the data, as when conducting an exploratory factor analysis it is important to understand possible reasons for joint contributions (Bradbury et al., 2009).

Figure 4: Scree plot



Although this study aims to assess personality correlates within individuals from the general population with no inferences as to personality disorder diagnosis being made (see, Widiger & Clark, 2000, for possible pitfalls), it is nonetheless important to ensure that the factors revealed are afforded succinct descriptors so as not to be misleading. As such, the three factors were ascribed the following nomenclature:

1. A psychological disposition (incorporating decreased subjective psychological wellbeing and increased stressful life events) towards reporting "Anomalous Cognitions" (ANCOG). Factor 1 (EV = 5.606) accounted for 43.12% of the total variance.
2. A psychological disposition towards adopting a "Lifeview System" (LVS)[14]. Factor 2 (EV = 1.647) accounted for 12.67% of the total variance.
3. A psychological disposition (including increased subjective psychological wellbeing and decreased negative schizotypy) to utilise "Social Adaptation Skills" (SAS). Factor 3 (EV = 1.212) accounted for 9.32% of the total variance.

Table 4: Rotated pattern matrix

Variable (SRM)	Factor 1 (ANCOG)	Factor 2 (LVS)	Factor 3 (SAS)	h^2
LSHS-R	.58	.43		.67
PDI-trans	.70			.67
CCS			.79	.66
AUIE		.90		.76
SLESQ	.72			.55
RTS	.69			.66
SPQ-B 'CP'	.81			.72
SPQ-B 'ID'	.58		-.43	.51
SPQ-B 'DT'	.81			.62
SOC	-.68		.54	.73
RPBS	.50	.43		.59
TRB		.84		.79
DES-trans	.75			.55

2.5.4 Relationships between factors and between factors and respondents' Age

Correlational analysis revealed a significant relationship between ANCOG and LVS, $r_{130} = 0.26$, $P = 0.003$, suggesting that the reporting of ostensibly psychosis-like (anomalous) cognitions and the

[14] LVS relates to Rhea White's (1998) conceptualisation of an individual's ability to "evolve in awareness of who they are, their place in the universe, and their view of the meaning in their individual lives" (p. 88) (see also, Kennedy, Kanthamani, & Palmer,1994).

adoption of a life philosophy (LVS) partially overlap (Jackson, 1997; Peters, Day, McKenna, et al., 1999). No significant relationships were revealed for ANCOG or LVS with SAS. A significant inverse (negative) relationship was revealed between respondent's Age and the reporting of ostensibly ANCOG, $r_{130} = -0.336$, $P \leq 0.0005$; however, no significant relationships were revealed for LVS or SAS with regard to respondent's Age.

2.5.5 Mean Gender and Ageband differences in factor scores

Independent samples *t*-tests revealed no significant mean Gender differences for ANCOG, $t(128) = 0.724$, $P = 0.470$, $\eta^2_p = 0.004$; or SAS, $t(128) = 0.462$, $P = 0.645$, $\eta^2_p = 0.002$. However, a trend toward a significant mean difference was revealed for LVS, $t(128) = 1.818$, $P = 0.071$, $\eta^2_p = 0.025$. Females outscored males for ANCOG and LVS, but not for SAS (see Figure 6).

A series of one-way ANOVAs revealed significant mean differences between Agebands with regard to ANCOG, $F(2, 127) = 7.080$, $P = 0.001$, $\eta^2_p = 0.100$; and post-hoc analysis revealed that the significant mean differences manifested between Agebands 18–34 and 55–85 (Tukey's test $P = 0.001$); furthermore, a trend toward significant mean differences manifested between Agebands 18–34 and 35–54 (Tukey's test $P = 0.093$). Significant mean difference were also revealed for LVS, $F(2, 127) = 3.280$, $P = 0.041$, $\eta^2_p = 0.049$; and post-hoc analysis revealed that the significant mean difference only manifested between Agebands 35–54 and 55–85 (Tukey's test $P = 0.037$). No significant mean differences were revealed between Agebands for SAS, $F(2, 127) = 0.866$, $P = 0.423$, $\eta^2_p = 0.013$. See Figure 6 for graphical representation of factor scores by Ageband.

2.5.6 Ageband by Gender interactions

Additionally, a series of two-way 3 × 2 ANOVAs (Ageband × Gender) revealed no significant Ageband by Gender interactions for any of the three factors. However, inspection of the factor means plots for Ageband revealed distinct patterns of distributions. In comparison with ANCOG—which demonstrate linear reductions in scores as Ageband increases—LVS and SAS possess V-shaped relationships with the Middle Ageband (35–54) producing the lowest factor scores (see Figure 6).

Figure 5: Mean factor scores by Gender

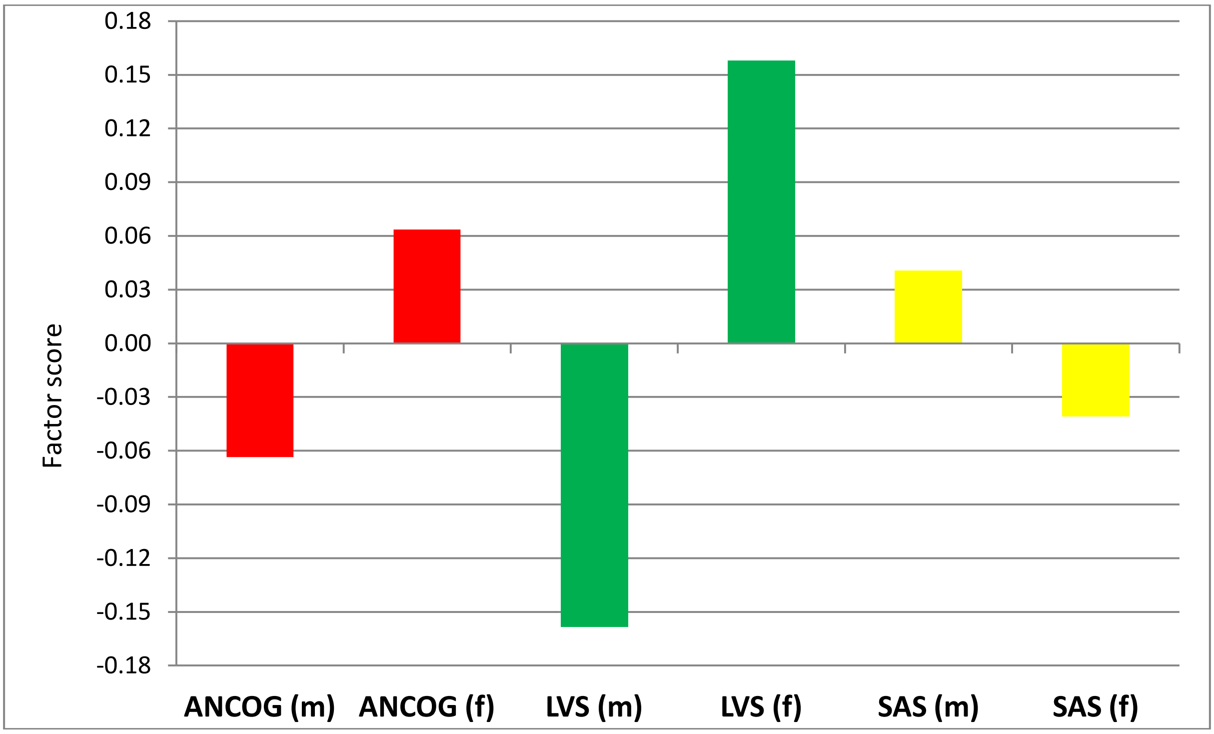
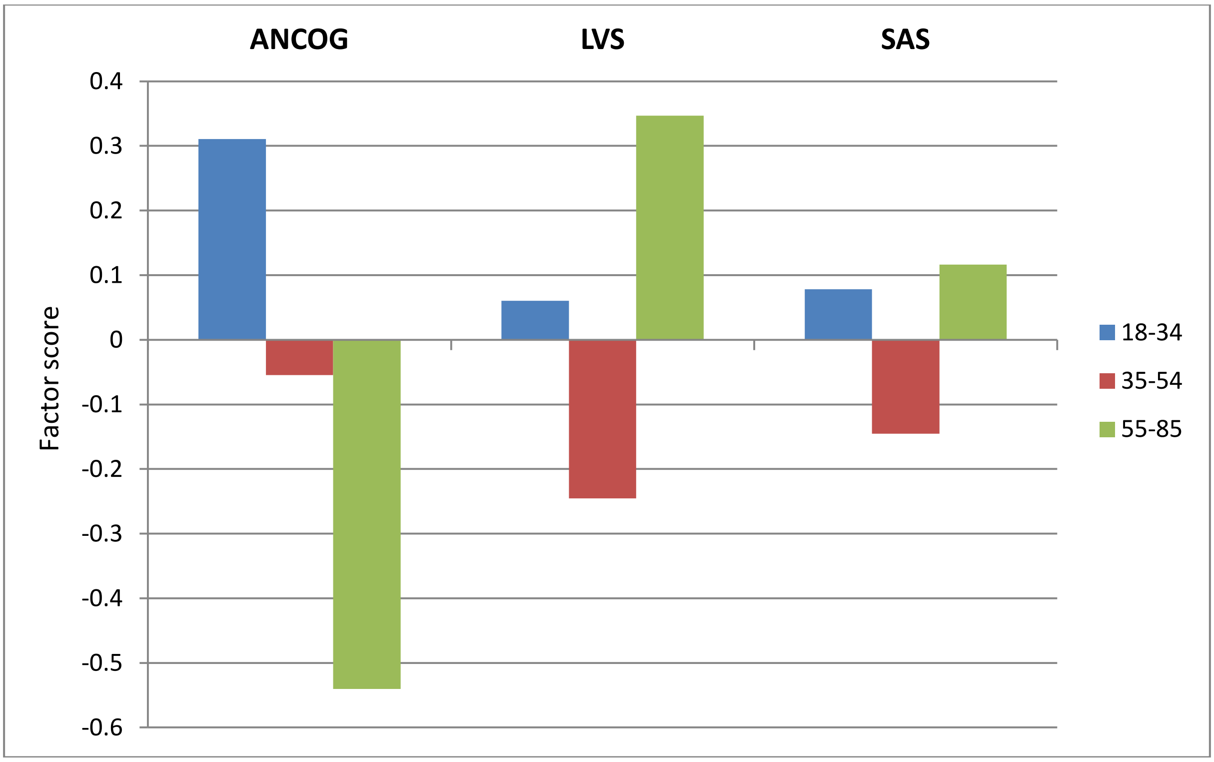


Figure 6: Mean factor scores by Ageband



2.5.7 Mean Gender and Ageband differences in uniquely contributing SRM scores for ANCOG

No significant Gender differences were found with regard to mean scores for the six unique contributors toward ANCOG (PDI-trans, SLESQ, RTS, SPQ-B ‘CP’, SPQ-B ‘DT’, and DES-trans). However, significant mean differences in scores were revealed for three of the six unique ANCOG contributors between Agebands (PDI-trans, SPQ-B ‘DT’, and DES-trans), with the remaining three contributors (SLESQ, RTS, and SPQ-B ‘CP’) displaying trends toward significance (see Table 5).

Investigation of the six means plots revealed similar patterns of distribution as ANCOG factor scores (see Figure 6) for the SLESQ, SPQ-B ‘CP’, SPQ-B ‘DT’, and DES-trans (Young to Middle = shallow-to-steep decline/Middle to Mature = steep decline); however the PDI-trans displayed a different pattern of change (Young to Middle = steep decline/Middle to Mature = shallow incline).

2.5.8 Mean Gender and Ageband differences in uniquely contributing SRM scores for LVS

No significant mean Gender differences were revealed for the measures of AUIE, $t(128) = 1.443$, $P = 0.151$, $\eta^2_p = 0.016$; and TRB, $t(128) = 1.624$, $P = 0.107$, $\eta^2_p = 0.020$. A significant mean difference was revealed between Agebands for the measure of AUIE but not TRB (see Table 5). Investigation of the means plots for AUIE and TRB revealed similar patterns of distribution as LVS factor scores (see Figure 6); that is, Young to Middle = relatively steep decline/Middle to Mature = extremely steep incline.

Predictably, a significantly higher mean LVS factor score was found in respondents reporting a definite religious affiliation than those who did not, $t(128) = 8.667$, $P \leq 0.0005$, $\eta^2_p = 0.370$; however, no significant mean differences were revealed between the religious and non-religious groups for ANCOG, $t(128) = 0.256$, $P = 0.798$, $\eta^2_p = 0.001$, or SAS, $t(128) = 1.096$, $P = 0.275$, $\eta^2_p = 0.009$.

2.5.9 Mean Gender and Ageband differences in the uniquely contributing SRM score for SAS

No significant mean Gender difference was revealed for the measure of CCS; and no significant mean differences were revealed between Agebands (see Table 5). Investigation of the means plot for CCS reveal similar patterns of distribution, although far less pronounced, as SAS factor scores (see Figure 6); that is, Young to Middle = extremely shallow decline and Middle to Mature = shallow incline.

Table 5: Descriptive statistics, ANOVAs, post-hoc analysis, and effect sizes (based on ANOVA) for uniquely contributing SRMs by Ageband

SRM	Ageband (Years)	M	SD	*F*	*P*	Comparison	Tukey's test (*P*)	Effect size (η^2_p)
	18–34	6.5	2.92			35–54	0.018	
PDI-trans	35–54	5.0	2.81	4.452	0.014	55–85	0.994	0.066
	55–85	5.1	2.81			18–34	0.082	
	18–34	2.6	2.34			35–54	0.513	
SLESQ	35–54	2.2	2.18	2.627	0.076	55–85	0.367	0.040
	55–85	1.5	1.18			18–34	0.062	
	18–34	22.1	5.49			35–54	0.115	
RTS	35–54	20.1	4.88	2.408	0.094	55–85	0.999	0.037
	55–85	20.1	3.75			18–34	0.245	
	18–34	2.6	2.16			35–54	0.477	
SPQ-B 'CP'	35–54	2.1	2.23	2.664	0.074	55–85	0.416	0.040
	55–85	1.4	1.53			18–34	0.062	
	18–34	1.8	1.81			35–54	0.094	
SPQ-B 'DT'	35–54	1.2	1.56	5.704	0.004	55–85	0.287	0.082
	55–85	0.6	1.07			18–34	0.004	
	18–34	2.0	0.44			35–54	0.210	
DES-trans	35–54	1.8	0.51	6.752	0.002	55–85	0.069	0.096
	55–85	1.6	0.36			18–34	0.001	
	18–34	15.5	8.81			35–54	0.469	
AUIE	35–54	13.7	5.82	6.723	0.002	55–85	0.001	0.096
	55–85	20.7	9.53			18–34	0.020	
	18–34	13.3	5.98			35–54	0.679	
TRB	35–54	12.3	6.39	0.416	0.660	55–85	0.778	0.007
	55–85	13.3	6.14			18–34	1.000	
	18–34	66.3	10.38			35–54	0.997	
CCS	35–54	66.1	10.26	0.022	0.979	55–85	0.989	0.000
	55–85	65.7	11.95			18–34	0.977	

2.5.10 Inclusion criteria for Phase 2 XPGs

Although this research has been conducted with an opportunity sample general population stratified by Gender and Age, the necessity to assess psychopathology between groups (multi-sample approach) is acknowledged (see, Aldao, Nolen-Hoeksema, & Schweizer, 2010). As such, participants for Phase 2 of the research can now be allocated to XPGs based on their scores on the principal factor (ANCOG). XPG membership is derived according to preset departmental protocols: XPG1 (low ANCOG) will be comprised of respondents scoring ≤ 20th percentile; XPG2 (mid ANCOG) will be comprised of respondents scoring ± 10% around the mean; and XPG3 (high ANCOG) will be comprised of respondents scoring ≥ 80th percentile—this protocol necessitates 26 participants for each XPG, total = 78. These individuals were duly contacted and all bar two agreed to take part in

Phase 2. Fortunately, two respondents were available for recruitment from the ongoing study into the relationship between positive schizotypy and transliminality (Bradbury et al., *manuscript in progress*), which utilises the same SRM pack.

2.5.11 Summary of results

Correlational analysis revealed that the majority of SRMs significantly intercorrelated, plus the previous finding of a strong relationship between positive schizotypal and transliminal personality traits was confirmed. Subsequent PCA revealed that the complete data set was subserved by three factors, with the principal factor (ANCOG) accounting for over 40% of the total variance. Independent contributors to the ANCOG factor were the PDI-trans, the SLESQ, the RTS, the 'cognitive-perceptual' (positive) and 'disorganised' dimensions of the SPQ-B, and the DES-trans. No significant mean Gender differences were revealed in ANCOG scores or for any of the six uniquely contributing SRMs. However, significant mean differences between Agebands were revealed for ANCOG.

Those respondents reporting a definite religious affiliation were, unsurprisingly, found to significantly outscore nonreligious respondents for LVS but not for ANCOG or SAS.

The three experimental hypotheses were upheld, and inclusion criteria for the three Phase 2 XPGs have now been ascertained.

2.6 Discussion

Anomalous experiences—defined as "... events that seemingly violate established scientific principles" (McClenon, 1993, p. 295)—may be an integral, and even adaptive, part of the human condition (Bering & Shackelford, 2004; Boden & Berenbaum, 2007); with a study utilising the Cardiff Anomalous Perceptions Scale (CAPS; Bell et al., 2006a) indicating that the acceptance of such experiences provided a degree of stress protection (Bell, Halligan, & Ellis, 2007). Phase 1 of this research aimed to assess the distribution of anomalous (psychosis-like) experiences and beliefs within a quota sample of the general population stratified by Gender and Ageband.

2.6.1 Reinterpretation of results

2.6.1.1 Correlational analysis

In line with Phase 1's first hypothesis, with the exceptions of the CCS and AUIE all SRMs displayed significant intercorrelations. More specifically (hypothesis 2), in line with previous research (Thalbourne et al., 2005; Thalbourne & Maltby, 2008) the 'CP' (positive) dimension of the SPQ-B was found to possess a significant and strong relationship with transliminality (RTS), suggesting that transliminality may be measuring similar personality traits as positive schizotypy. It is however cautioned that the RTS should not be used as a replacement for established measures of schizotypy but used in addition as a complementary index. For example, because the RTS taps into such ideas as mysticism and manic experiences it could provide supplementary data regarding the expression of positive schizotypal personality traits (see, Thalbourne & Delin, 1999).

2.6.1.2 PCA results

In confirmation of the third hypothesis, PCA confirmed that the complete data set was subserved by three factors. Factor 1 (43.10% of variance) because of its perceptual (e.g., hallucinatory, transliminal) and belief-oriented (e.g., delusional, paranormal) composition was portrayed as a psychological disposition towards reporting ANCOG, and the six unique contributors are the PDI-trans, SLESQ, RTS, SPQ-B 'CP', SPQ-B 'DT', and DES-trans. Delusional ideation (Bell, Halligan, & Ellis, 2006b) has been strongly linked to the reporting of psychosis-like symptomatology and as such its unique inclusion on the ANCOG factor is not unexpected. Exposure to incidents deemed by the percipient as being stressful (traumatic) are increasingly recognised in the mental health literature as being significant contributory factors to the expression of schizophrenic and schizotypal symptomatology (e.g., Berenbaum et al., 2008; Merckelbach & Giesbrecht, 2006; Read et al., 2003; Schürhoff et al., 2009; Spauwen et al., 2006); furthermore, lifetime exposure to both sexual and physical abuse has been shown to be a significant predictor of hallucinations and delusions (Thompson, Kelly, Kimhy, et al., 2009). With regard to transliminality, despite possessing an element of religiosity (Thalbourne & Houran, 2000) the RTS has been suggested as a proxy measure of positive schizotypy (Thalbourne et al., 2005; Thalbourne & Maltby, 2008). The inclusion of SPQ-B 'CP' and SPQ-B 'DT' are again unexpected as the cognitive-perceptual (Wolfradt et al., 1999) and disorganised thought (Schofield & Claridge, 2007) dimensions of psychometric schizotypy have both been strongly linked with the reporting of ANCOG. Dissociative experiences have also been strongly linked to the reporting of ANCOG (Watson, 2001).

The LSHS-R and RPBS loaded on both ANCOG and LVS. One possible reason why the LSHS-R loads on both factors might be that, in certain religious groupings hallucinatory experiences are characterised as relatively ‘normal’ phenomena (see caveat, section *2.1.2.1*), even reflective of a *higher state of being,* as opposed to the more secular perspective that they are psychologically disparate and potentially distressing phenomena (Scott, 1997; Stip & Latourneau, 2009). Moreover, in a study, admittedly utilising undergraduate students (N = 562), PCA of the LSHS-R indicated a distinct factor accounting for 13.9% of the total variance which was interpreted as “hallucinations with a religious theme” (Waters et al., 2003, p. 1,351). The almost equivalent RPBS loadings might reflect the fact that this scale also includes items which might reinforce religious beliefs (Hergovich, Schott, & Arendasy, 2005; McClenon, 1990) in addition to items that emphasise ‘exceptional human ability’ (Kennedy, 2004; see also, Kennedy, 2005). Furthermore, a consistent finding is that individuals reporting religio-spiritual experiences also report a variety of paranormal experiences (Zollschan, Schumaker, & Walsh, 1989); moreover, studies employing survey data have found that reports of paranormal experiences have antecedents and structures similar to those espoused in the reports of ecstatic or religio-spiritual experiences (Fox, 1992; Yamane & Polzer, 1994).

The second factor appeared to represent a psychological disposition toward adopting a LVS. Indeed, the adoption of a religious and/or spiritual aspect to one’s individuality is suggested to be a “nearly universal need … of the human psyche” (Appel & Kim-Appel, 2010, p. 277). In the present study LVS depended on unique contributions from the AUIE and TRB (possibly first-rank bases of a belief system), and partial contributions from the LSHS-R and the RPBS (secondary, yet possibly confirmatory of first-rank bases of a belief system). Following the conceptualisation of religio-spiritual phenomena as being “psychic intrusions in the stream of consciousness”, which may be perceived as mental phenomena not originating from the *self* (Laubach, 2004, p. 239; see also, McClenon & Nooney, 2002) the nomenclature of LVS in light of the significant correlation with ANCOG makes intuitive sense. Moreover, a link between the acceptance of bizarre phenomena seen in psychosis-proneness and the endorsement of religio-spiritual beliefs and experiences has been identified (Claridge, 2001, 2010; Day & Peters, 1999; Emmons & Sobal, 1981; Jackson, 1997; Parra, 2010), and the significant correlation (albeit mild) between the two factors of ANCOG and LVS is consistent with this viewpoint. Notwithstanding, previous research has shown religiosity to be only weakly associated with schizotypy; that is, such links may be both gender-specific and applicable only to certain aspects of religiosity (e.g., ‘quest’; Joseph, Smith, & Diduca, 2002) and schizotypy (e.g., ‘CP’ deficits: see Table 3) (see also, Johnstone & Tiliopoulos, 2008; Maltby, Garner, Lewis, et al., 2000; White, Joseph, & Neil, 1995).

The third factor (SAS), contained a unique contribution from the CCS and partial contributions from SPQ-B ‘ID’ and SOC and appeared to represent a psychological disposition toward utilising—in light of increased coping skills and subjective psychological wellbeing, coupled with decreased interpersonal dysfunction)—adaptive social skills (cf., Venables & Rector, 2000). Although the CCS was specifically chosen because of its relevance to the workplace, the SRM correlational matrix (Table 3) revealed that the CCS possessed no significant relationships with any of the other SRMs except for puzzling (albeit weak) correlations with the LSHS-R and PDI-trans. One possible explanation for these unexpected relationships could be that those individuals implementing effective coping strategies might do so by also adopting an aberrant perceptual style; that is, through processes such as imagination, fantasy, daydreaming, and escapism (Langens, 2002), i.e. detachment (Roger, Jarvis, & Najarian, 1993), individuals may bring about a resolution incorporating an acceptable compromise between restricted personal fulfilment and social (sc., occupational) constraints (Somer, 2002; see also, Kappes & Oettingen, 2012); such involvement has also been found to place restrictions on current cognitive processing (Kappes & Oettingen, 2011), which mediates individual differences variables such as ‘need for closure’ (Kruglanski, Webster, & Klem, 1993; Webster & Kruglanski, 1994). To this end, significantly increased levels of imaginative involvement and fantasy proneness have been identified in schizotypic individuals (Giesbrecht, Merckelbach, Kater, et al., 2007; Sánchez-Bernardos & Avia, 2006). In further confirmation of this line of reasoning, social (including occupational) functioning has also been shown to be dysfunctional (maladaptive) in schizotypic individuals (Henry et al., 2008; Husky, Grondin, & Swendsen, 2004; Jahshan & Sergi, 2007).

The SPQ-B ‘ID’ and SOC loaded on both ANCOG and SAS. The inclusion of ID on both factors is again unsurprising; as ID has been found to be related to an increased reporting of ANCOG (Kwapil, Barrantes-Vidal, Brown, et al., 2008) and decreased social coping (Horan et al., 2007). SOC, being allied with psychological wellbeing, was expected to possess a negative loading on the factor of ANCOG (cf., Goulding, 2005; sc., stressful life events [Richardson & Ratner, 2005]) and a positive loading on the factor of SAS, as amongst other things, elevated SOC has been found to provide a degree of stress protection[15] (Takayama, Asano, Yamazaki, et al., 1999; Wolff & Ratner, 1999).

2.6.1.3 Gender and Ageband distributions

No significant mean differences in Gender distribution were observed for ANCOG, LVS, or SAS or for any of the nine uniquely contributing SRMs. As far as ANCOG (Simmonds & Roe, 2000) and LVS (Miller & Hoffman, 1995) are concerned, this result is surprising insomuch as females have been consistently linked with the increased reporting of anomalous beliefs and experiences and religiosity as compared to males. With regard to Ageband distribution, one possible explanation for the linear (ANCOG) as opposed to V-shaped (LVS) distribution plots could be that younger individuals may be more receptive to the supernatural aspects inherent within both ANCOG and LVS (cf., Verdoux et al., 1998). Additionally, and as mentioned previously, their responses may have been influenced by an

[15] Note: SOC loads negatively on the ANCOG factor (see Table 4).

increased propensity for experimental and/or recreational drug use; a recognised vulnerability marker for unusual experiences (e.g., Ohayon, 2000). Adults in the middle Ageband may display reduced ANCOG and LVS scores possibly because the *realities of life* that this group face require a more psychologically grounded approach necessitating the abandonment of, for example, predilections to delusional ideation or fantasy-immersion (e.g., Verdoux et al., 1998; cf., Hoffman, Kaneshiro, & Compton, 2012). The increase in LVS scores for the mature Ageband may be related to this group's consideration of their own mortality (as they age) and that of friends and relations (Massoudi, 2010; Norenzayan & Hansen, 2006; see also, Vail III, Arndt, & Abdollahi, 2012); additionally, existential indifference—characterised as including, disinterest in self-knowledge, explicit religiosity, and spirituality—has been shown to possess a negative relationship with age (Schnell, 2010). Furthermore, religious certainty has been revealed to have a direct effect upon existential certainty, especially for older persons (Ellison, 1991). Additionally, individuals in this Ageband are more likely to have been raised during a time of greater religious acceptance, i.e. decreased secularisation (Brañas-Garza & Solano, 2010; Carroll, 2012; Voas & Crockett, 2005).

SAS factor scores, although not as marked in their distribution as LVS factor scores, were also distributed in a V-shaped pattern indicating that, in accordance with the *developmental* view of age-related changes, SAS scores vary in a non-linear manner across the lifespan (Amirkhan & Auyeung, 2007). Older adults (mature ageband in this study) may regress and become more primitive in their coping strategies, for example, becoming more egocentric, impulsive, and hostile (Gutmann, 1974; Pfeiffer, 1977). In support of this viewpoint, longitudinal data from the Berlin Aging Study (Smith, 2001) indicated that individuals aged > 70 years of age experience chronic health-related constraints on the potential to experience the positive side of life. Whereas another possibility is that older adults become more mature in their coping, for example, showing increased allocentric (inclusive) thinking, wise detachment, and adopt humour-based strategies (Valliant, 1978/1995). It is worth noting that Pfeiffer's (1977) study was based on individuals displaying psychopathology, whereas Valliant's (1978) work focused on coping and adaptation in a normal sample of college graduates followed over 30 years (Folkman, Lazarus, Pimley, et al., 1987). Additionally, Manfredi and Pickett (1987) revealed that loss and conflict were the two main types of stressor encountered by their elderly sample and that the main coping strategy was that of prayer. Indeed religious behaviours constitute a reliable coping strategy for certain individuals helping to ameliorate life stress (Aydin, Fischer, & Frey, 2010; Koenig, George, & Siegler, 1988). Notwithstanding, whatever the causes of the nonsignificant SAS Ageband disparities there can be no doubt that fluctuations throughout the lifespan are dynamic and idiosyncratic (Pavalko & Caputo, 2013; Schwarzer & Taubert, 2002; Taylor & Stanton, 2007), with recent literature suggesting that an individual's coping style may be a developmental and multifaceted process (Yancura & Aldwin, 2008).

2.6.2 Study limitations and future research directions

Although assessment of the internal consistency of established SRMs is advisable to check the quality of the data, it should not be used as a substitute for test-retest reliability (McCrae, Kurtz, Yamagata, et al., 2011). With this in mind, clearly, the main limitation of Phase 1 is its reliance upon one-shot (cross-sectional) SRMs (see also, Irwin, 2004). Nonetheless, additional SRMs could have been included to gain a more detailed picture of personality functioning with regard to anomalous cognitions, including: 1) a more indepth investigation of anomalous perceptions/experiences; (e.g., CAPS [Bell et al., 2006a]/AEI [Kumar et al., 1994]); 2) a more comprehensive assessment of positive schizotypy (e.g. O-LIFE)[16]; 3) due to the predominantly secular nature of this particular sample group (83.1%) a comprehensive measure of spirituality in addition to religiosity (see, Saucier & Skrzypińska, 2006) may offer an effective means of elucidating the contribution of transpersonal or self-actualising experiences (contributors toward a system of belief) from anomalous (unusual or bizarre) experiences (e.g., Aspects of Spirituality Questionnaire) (ASPQ; [Büssing, Ostermann, & Matthiessen, 2007]); 4) an investigation into the extent of fantasy proneness would help shed light on the ætiology of positive schizotypal (including paranormal) beliefs and experiences (Klinger, Henning, & Janssen, 2009) (e.g., Creative Experiences Questionnaire [Merckelbach, Horselenberg, & Muris, 2001]/Inventory of Childhood Memories and Imaginings [ICMI; Wilson & Barber, 1983]); 5) an assessment of boundary (levels of awareness) permeability may provide invaluable information regarding the psychogenesis of psychosis-like (anomalous) cognitions (e.g., Boundary Questionnaire; Hartmann, 1991); 6) an investigation of religio-spiritual experiences (e.g., Daily Spiritual Experiences Scale) [DSES; Underwood & Teresi, 2002]) and mystical experiences (Francis-Louden Mystical Orientation Scale [MOS; Francis & Louden, 2000]) may provide supplementary evidence regarding the expression of anomalous experiences that might not normally be reported under the auspices of ANCOG[17]; and 7) an assessment of respondents' preponderance to engage in dissimulation (socially appropriate responding) and falsification (see, Francis, 1991; Francis, Brown, & Pearson., 1991; Pearson & Francis, 1989), e.g. by interspersing items from the 21-item Lie Scale (LS) of the EPQ-Revised (Eysenck & Eysenck, 1991) throughout the SRM battery.

As with similar studies assessing anomalous experiences (cognitions) in the general population it would have been preferable to recruit a greater number of respondents, especially from the mature Ageband, although utilising a stratified quota sampling technique has gone some way towards addressing this issue. Furthermore, differences in ethnicity would no doubt have cast a broader light

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[16] It is acknowledged that a shortened version of the O-LIFE (Mason, Linney, & Claridge, 2006) is now available.

[17] Religio-spiritual/religio-magical experiences are seen by many authors as falling within the broad net of ANCOG (Spilka, Hood, Hunsberger, et al., 2003); that is, such experiences are by their very nature anomalous yet merely imbued with religious meaning and embedded in religious discourse to explain them (Mencken, Bader, & Kim, 2009).

on the epidemiology of both anomalous experiences (Fonseca-Pedrero, Paino, Lemos-Giráldez, et al., 2009a,b; Goulding, McClure-Tone, & Compton, 2009; Johns, Nazroo, Bebbington, et al., 2002; Kaoru, 2002; Kymalainen & Weisman de Mamani, 2008; Li, Law, & Andermann, 2012; Linscott, Dannette, Arnott, et al., 2006; Loewenthal, 2007) and the formation of a lifeview system (Kaoru, 2002; Markus, 2008; Morgan, Charalambides, Hutchinson, et al., 2010; Winkelman, 2004). However, despite best efforts, a zero-return was achieved from non-white respondents. Such a situation is discouraging because plentiful research indicates a disproportionate amount of psychotic individuals in the UK hailing from Black (Afro-Caribbean) backgrounds (review: Chorlton, McKenzie, Morgan, et al., 2012).

Additionally, with regard to the nonsignificance of SAS scores between both Gender and Ageband, this may well be due to the SRM utilised (CCS). In a study utilising the COPE (Carver, Pozo, Harris, et al., 1993; Carver, Scheier, & Weintraub, 1989), Horan et al. (2007) found significant differences between high scoring respondents (MI) who reported significantly lower social coping than controls, but no significant differences were revealed in active or avoidant coping. As such, the COPE may well have been a more sensitive instrument for assessing coping strategies within this particular sample group; however, due to the large number of items comprising the COPE (60 items) the fifteen-item CCS was adopted due to its brevity. Notwithstanding, it is belatedly acknowledged that an abbreviated version of the COPE (Carver, 1997) containing 28 items is also available.

2.6.3 Conclusions

In conclusion, the main finding from this Phase 1 investigation is that in an adult sample of respondents (stratified by Gender and Ageband), six of the thirteen SRMs uniquely loaded on the principal factor (accounting for over 40% of the overall variance) characterised as ‘anomalous cognitions’ (ANCOG). Two of the remaining measures made unique contributions to the second discernible factor constituting a ‘lifeview system’ (LVS). Finally, one solitary variable made a unique contribution to the third discernible factor: ‘social adaptation skills’ (SAS). Additionally, the two factors of ANCOG and LVS evince a mild but significant correlation with one another, this interaction accounted for an additional 6.8% of shared variance in the data set. The results also revealed that those respondents reporting a definite religious involvement did not, as popular literature has suggested (e.g., Dawkins, 2006), score higher than their non-religious counterparts for the measure of ANCOG (review: Menezes & Moreira-Almeida, 2010).

From the PCA it was possible to identify three XPGs for Phase 2 of the research, the CCTB.

Chapter 3. Phase 2: The cognitive antecedents of psychosis-like (anomalous) experiences—A series of experiments

3.1 Introduction

3.1.1 Schizophrenia and cognition

Schizophrenia is the most devastating form of human psychopathology as yet identified (Lenzenweger, 2006a; Stelton & Ferraro, 2008) and the psychometrically identified personality correlate of schizophrenia (i.e., schizotypy) provides a powerful framework for assessing and subsequently detecting cognitive impairment before the onset of a clinically-defined psychosis (Keshavan, Berger, Zipursky, et al., 2005; Klosterkötter, Hellmich, Steinmeyer, et al., 2001; Lenzenweger, 2010; Parnas, 2000; Yung, Phillips, & McGorry, 2004; cf., Garrett & Silva, 2003). Cognitive deficits are a core feature of schizophrenia (Dickinson, Iannone, Wilk, et al., 2004; Heinrichs, 2005; Kuperberg & Heckers, 2000; Lewandowski, Cohen, & Öngur, 2011; Mesholam-Gately, Giuliano, Goff, et al., 2009; cf., Aleman & David, 2006), especially the inability to ignore irrelevant stimuli (Gray & Snowden, 2005; Minas & Park, 2007). Moreover, abnormal subjective experiences throughout the schizophrenia spectrum are associated with cognitive (neuropsychological) disturbance (Brekke et al., 2001; Cuesta, Peralta, & Juan, 1996; Freedman, 1974; Parnas, Handest, Sæbye, et al., 2003), which has a major impact upon everyday activities such as social (interpersonal) functioning, education, and employment (Mitchell, Elliott, & Woodruff, 2001). The identification of distinct neuropsychological (neurocognitive) impairments can culminate in unravelling the ætiopathophysiology of the disorder (Bombin, Arango, & Buchanan, 2005; Brewer, Wood, Phillips, et al., 2006; Kelleher, Jenner, & Cannon, 2010), furthering our understanding of the heterogeneity and trajectory of such psychopathology (Malla & Payne, 2005; Orones, Navarette, Beltrán, et al., 2009), and aid in facilitating the development of therapeutic interventions (Kuipers, Garety, Fowler, et al., 2006; Meyer & Shean, 2006).

Neuropsychological (cognitive) impairment has been found to a lesser extent in at-risk samples (e.g., Byrne, Hodges, Grant, et al., 1999; Cadenhead, Perry, Shafer, et al., 1999; Cornblatt, Obuchowski, Roberts, et al., 1999; Mesholam-Gately et al., 2009; Suhr, 1997). As such, it appears that attenuated neuropsychological deficits may be evident before the onset of a psychotic disorder and thus may be indicative of increased risk (Addington, Penn, Woods, et al., 2008a; Becker, Nieman, van de Fliert, et al., 2006; Harvey, 2009; Simon, Cattapan-Ludewig, Zmilacher, et al., 2007); furthermore, such a cognitive profile might also incorporate those individuals scoring high on psychometric measures of schizotypal personality traits (Barkus, Stirling, French, et al., 2010).

These deficits may also be neuroanatomically related to the development of schizophrenia (e.g., Aichert, Williams, Möller, et al., 2012). For example, underactivity and dysregulation of frontal lobe functioning might lead to avolition, a feature of schizophrenia that can be measured with executive functioning tasks (e.g., Kantrowitz & Javitt, 2010). In addition, hippocampal abnormalities may play a role in the development of schizophrenia and manifest as mild memory deficits before the onset of schizophrenia (Boyer, Phillips, Rousseau, et al., 2007; Smith, Lang, Kopala, et al., 2003).

3.1.2 The positive symptoms of psychosis: Models of cognitive functioning

In order to help explain the psychological mechanisms underpinning the positive symptoms of psychosis various cognitive models have been posited. This thesis shall primarily concentrate on the cognitive (neuropsychological) model of Frith and colleagues (e.g., Frith, 1992, 2005; Frith, Blakemore, & Wolpert, 2000a,b). In order to augment the works of Frith et al., additional information will be briefly gleaned from the biopsychosocial models proposed by Garety and colleagues (e.g., Garety et al., 2007, 2001) and the metacognitive model of O'Connor (2009). Finally, an interesting Bayesian approach (Fletcher & Frith, 2009), which suggests that positive symptoms can be understood in terms of a disrupted hierarchical Bayesian framework, without relying on separate evaluations of experience and belief, shall be considered in detail.

3.1.3 Frith's (1992) cognitive neuropsychological model of schizophrenia

Inspired by advances in the cognitive sciences, especially cognitive neuroscience, there have been numerous theoretical models attempting to explain the symptoms of schizophrenia (Seal, Aleman, & McGuire, 2004); however, Frith's (1992) account is perhaps the most widely cited and influential model (Gallagher, 2004). Frith's account of the positive symptoms of schizophrenia is couched in terms of a disruption of the meta-representational aspects of self-monitoring (SM). Although acknowledged as possibly being the most parsimonious account regarding the cognitive (neuropsychological) underpinnings of the positive symptoms of schizophrenia (Campbell, 1999), Frith's model is not without criticism. For example, Stephens and Graham (2000) suggest three shortcomings: 1) they propose an inadequate explanation of how an individual experiencing thought insertion might misattribute that thought to someone or something else (an influencing agent); 2) that no clear distinction is made between thought insertion and thought influence; and 3) that Frith's model fails to explain how, on the one hand an individual can claim that it is they who are thinking a thought, yet on the other hand claim that the thought is attributable to someone or something else. Although serious, Stephens and Graham's (2000) concerns have been criticised for lacking a depth of scrutiny (Gallagher, 2004). Gallagher proposed that the criticisms of Stephens and Graham are not challenges to Frith's cognitive framework, per se; rather, they are misgivings only relating to certain explanatory failures within that framework. Gallagher proposes that Frith's model may be better understood in terms of a complementary neurophenomenological approach. However, firstly it is advisable to look at the underlying propositions of Frith's cognitive (neuropsychological) model in more detail.

Frith formulated his model from observations of motor disorders evinced by individuals with schizophrenia (e.g., Frith, 1987; Frith & Done, 1989). Individuals with schizophrenia display a variety of movement disorders (Gervin, Browne, Lane, et al., 1998), especially in relation to the administration of atypical antipsychotics (Caroff, Mann, Campbell, et al., 2002; Honer, Kopala, & Rabinowitz, 2005); however, such movement disorders may have developed anyway (Kubota, Miyata, Shibata, et al., 1999; Owens, Johnstone, & Frith, 1982). These abnormalities in movement can include rocking, posturing, pacing, strange mannerisms (e.g., grimacing), repetitive movements that serve no purpose, and what is known as *apathetic immobility* (e.g., stupor) (APA, 2000); notwithstanding, such movement disorders are often mistaken by the individual with schizophrenia with regard to the agency of those movements (Gallagher, 2004).

The sense of agency (SOA) refers to an "individual's perception that an action is the consequence of his/her own intention" (Nehab, Kundu, Gallea, et al., 2011, p. 48). For example, the motor action of speech is recognised as being the schizophrenic's own motor action—that is, the patient may acknowledge that it is his/her lips that have moved in order to form the speech—however, they make an error in identification by attributing the content of that speech to another agent. As such, it is the *SOA* that is disrupted rather than the sense of *ownership* (Gallagher, 2004). Another possibility is to view the subjective SOA and ownership in schizophrenia as being separated instead of the *normal* situation where they are fused, i.e., cognitively bound (Campbell, 2002).

The crux of Frith's model concerns the metarepresentational aspects of thoughts. That is, the process of *thinking* is equated to a form of *action*; to this end, the model suggests that any thought is accompanied by an effortful *intention*[18] to think—providing the individual with the sense that the thought belongs to them—a sense of *myness* (Zahavi & Parnas, 1998). Disruptions in this sense of myness (agency) are proposed to result in the positive symptoms of psychosis, such as hallucinations and thought insertion. To help explain this disruption to the SOA, Frith turns to a classic theory of motor control behaviour: the internal *comparator* model (Helmholtz, 1866), responses to which have

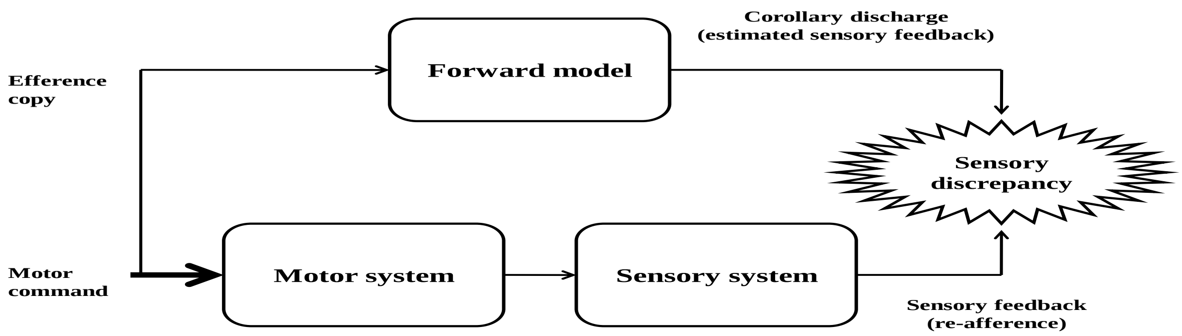
[18] *Intentionality* is a concept of great importance to cognitive models of the SOA, as intentions can be gleaned on a first-hand, self-experiential basis or from the experiences of others (Marbach, 1993; Owen, 2011). Schizotypal individuals have been shown to be impaired in recognising the experience of both the self (e.g., Raballo, Sæbye, & Parnas, 2011; review: Nelson, Fornito, Harrison, et al., 2009) and other (e.g., Barragan, Laurens, Navarro, et al., 2011); as such, experiences of the environment (endogenous and exogenous) are not consistently incorporated—either spatially or temporally—into the stream of consciousness (Arzy, Mohr, Molnar-Szakacs, et al., 2011); part, or indeed all, of the experience (self or other) is therefore necessarily out of kilter with reality.

been labelled *corollary discharge* (Sperry, 1950), *re-afference copy* (von Holst, & Mittelstaedt, 1950), and *error-monitoring* (Wolpert, Ghahramani, & Jordan, 1995).

Held (1961) proposed that the efference (motor) copy is sent to a comparator module and stored there to be subsequently compared to reafferent (visual or proprioceptive) information regarding the movement that is actually made (see Figure 7). In this model, verification that it was "I" that actually moved would seemingly depend upon confirmatory sensory feedback. For the individual with schizophrenia there appears to be the absence of a match between movement and efference copy at the comparator module. If something is disrupted in this simplistic sensory-feedback model, it is relatively easy to correct via sensory monitoring. However, Frith realised that such a model was inadequate for explaining motor control and a second component was consequently added, which incorporated the comparator module as part of a forward premotor system delivering information prior to the execution of a movement and prior to sensory feedback (Frith et al., 2000a,b; see also, Fletcher & Frith, 2009). Thus, the forward comparator acts to match the efference copy with motor *intentions*, anticipating the movement prior to sensory feedback, allowing for quicker and more automatic (nonconscious) corrections of movement prior to sensory feedback, so-called "sub-personal level feedback" (Jeannerod, 2009, p. 532). The forward model not only aids in the generation of controlled action, it also generates a sense of myness (agency), which is intrinsically linked to the action itself (Kircher & Leube, 2003; Marcel, 2003).

The comparator model posits that when an intention to move is forwarded (by the individual) an efference copy is also sent to a comparator (forward model; see Figure 7); as such, once the movement has been initiated—the instigator of the movement being aware that it was his/her decision to move (willed intention)—a supplementary copy of the movement (efferent) information is sent to the comparator module and the comparator mechanism checks that the sensory feedback (afferent information) equates with the initial decision to move, providing a magnitude of corollary discharge. Disturbances in this metacognitive (SM) system may give rise to anomalous sensory feedback.

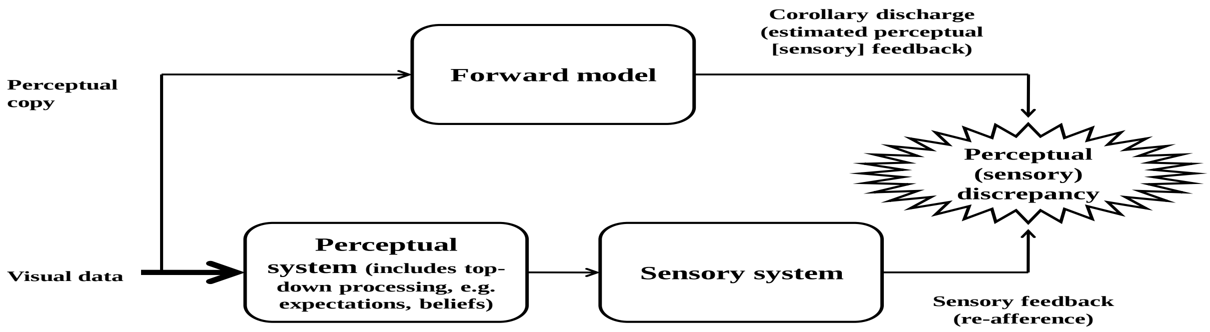
Figure 7: Hypothetical model of the generation of positive symptoms. The *comparator* hypothesis of motor (and thought) control



The efference copy is used to generate the predicted sensory feedback (corollary discharge), which estimates the sensory consequences of a motor command (top row). The actual sensory consequences of the motor command (bottom row) are used to compare with the corollary discharge to inform the CNS about external actions. Frith (1992) hypothesised a similar route to (mis)attributed perceptions and thought processes seen in the positive symptoms of psychosis. Corollary discharges briefly alter self-generated sensory responses to reduce self-induced desensitisation or help distinguish between self-generated and externally-generated sensory information (Poulet & Hedwig, 2007).

If the *motor* command element of Figure 7 is substituted with a *thought* command, the above model would conjecture that a hallucination (e.g., speech) or a delusion (e.g., thought insertion) could occur from the misrepresentation of perceptual data to a false agent—a misrepresentation of source. That is, the original percept although acknowledged by the psychotic individual as being *perceived* by them would not possess the necessary SOA (myness) to adaptively (and logically) integrate the percept; and as such the percept would be registered as being alien (nonself) in origin. See Figure 8 for a hypothetical example of a misinterpretation of source.

Figure 8: Re-interpretation of Frith's (1992) model simplifying the psychogenesis of one possible positive symptom (i.e., a paranoid delusion)



An example of how this forward model might generate a paranoid delusion can be illustrated by imagining an individual with paranoid schizophrenia wandering down the high street and suddenly noticing a piece of paper swirling in the breeze. The individual may be certain that the piece of paper (now a secret map) contains the route to a destination of great importance. The delusion will be further cemented by the fact that the individual, due to the swirling wind, cannot retrieve the document that has now become of crucial importance. The individual is now certain that they must possess the map, but other (possibly malevolent) forces are ardently trying to keep them from attaining it. In reality, of course, this is just the wind.

If we follow the model through, the informational (cognitive) stream begins with the visual data of a piece of paper, which happens to be in the vicinity of the percipient (i.e., within his/her visual field). The visual system will initially, and correctly, identify the object as being a random piece of paper and send a copy of this veridical information to the forward model, which will subsequently generate a template of the magnitude of the to-be-expected percept (corollary discharge). However, the bottom half of the model implies that the initial percept will be subjected to the individual's expectations, beliefs, etc. before a match is performed. And it is at the point of subjecting the perceptual data to top-down higher-order cognitive processes that the initial veridical percept is morphed into a delusion. This now unrealistic (delusional) percept is then sent to the sensory system from where it is assigned sensory feedback. The sensory feedback is then sent for matching (comparing) with the original veridical percept. Obviously, the two lines of perceptual data will not match, causing a perceptual (sensory) discrepancy.

One immediate problem with substituting thought for motor commands is that whereas the continual monitoring of motor action is a necessary condition for adaptively navigating the environment not all thoughts are preceded by an *intention* to think and as such can possess no efference copy. For example, it is difficult to reconcile the act of thinking with a predetermined intention to think. This situation would put us in a position of infinite regress (Akins & Dennett, 1986; Frankfurt, 1978; Gallagher, 2004). That is, if an intention to think is required before any thought is generated, does the intention to think also require an intention to think, and so on? The problem lies with the necessity in Frith's model for an individual to possess an *intention* to think as that process in itself is theorised to provide the SOA. It is difficult to imagine many circumstances where an individual initiates the act of thinking. One example proposed by Hoffman (1986), is that of inner speech. That is, it is odd to think of an individual having an intention to audibly say something; it is not so odd to accept that an individual may have an intention to say something in inner speech. To this end, all intentional thinking may be better described as inner speech, and an awareness of the intention to think is required to provide the necessary SOA.

It has been suggested that the efference copy—and the intention to think that it represents—is not itself available to consciousness (Campbell, 1999). This view implies that the efference copy (of a thought) is part of a subpersonal and nonconscious process, which generates an awareness of effort as thought itself is generated. Ultimately, Campbell's account takes the efference copy beyond the realm of conscious inspection firmly routing it in subconscious processes and, therefore, as being unavailable to conscious awareness. As discussed above, what Frith and colleagues (Frith, 1992; Frith et al., 2000a,b) might be referring to as an *intention to think* may be part of a subpersonal, nonconscious process that when working properly generates a SOA (Jeannerod, 2009). However, as with movement, can thought always be characterised by an intention? According to Gallagher (2004) the answer has to be no; and Gallagher provides two lines of evidence in support of this argument:

3.1.3.1 Unbidden thoughts

Firstly, as Frankfurt (1976, p. 240) puts it, unbidden thoughts "strike us unexpectedly out of the blue; and thoughts … run willy-nilly through our heads"; without conscious control certain memories may arise that may or may not be relevant to the present circumstance, disrupting the train of thought. Furthermore, intrusions from other states of awareness (e.g., dream states; see also Chapter 2, section *2.1.2.6*) can intrude upon present awareness impinging upon the continuity of the train of conscious thought. In such cases, the intention to think (or the disruption of an efference copy) is not performing as Frith's (1992) model would have it do. That is, no SOA can be provided without the provision of an efference copy. This point, at best, illustrates the absence of an intention to think, but not that such thoughts have been inserted (cf., Stephens & Graham, 2000).

Additionally, comorbid OCD is routinely diagnosed in individuals with schizophrenia (Fonseca-Pedrero, Lemos-Giráldez, Paíno-Piñeiro, et al., 2010; Poyurovsky & Koran, 2005; Poyurovsky, Weizman, & Weizman, 2004). Of specific import to this thesis, is that such comorbidity may be equally true of schizotypal individuals for whom the positive symptoms of such a personality disposition also share a strong relationship with obsessive-compulsive tendencies (Sobin, Blundell, Weiller, et al., 2000; Suhr, Spitznagel, & Gunstad, 2006). There appears to be a lack of 'intentionality of thought' attributed to OCD ideation, merely an unbidden and distressing intrusiveness (Owen, 2011). Such intrusions are driven from, for example, visual imagination, including visual imaginings contrary to reality, which predominates in causing anxiety leading to repetitive behaviour, e.g. checking, cleaning, counting, and so forth (Owen, 2011).

Imagery has been posited to be an important aspect of the phenomenology of psychosis (Morrison & Baker, 2000), including positive schizotypy (Holmes & Steel, 2004; Marzillier & Steel, 2007); furthermore, Morrison (2001) suggests that mental imagery is implicated in the formulation of hallucinatory and delusional cognitions. In confirmation of this proposition, it has been found that most patients with schizophrenia, schizoaffective or schizophreniform disorders report imagery in association with these positive psychotic symptoms (Morrison, Beck, Glentworth, et al., 2002). Many of the images in the Morrison et al. (2002) study were reported as recurrent, and associated with elevated affect and upsetting memories. To this end, Morrison (2001) suggests that traumatic (stressful) experiences may lead to some of the imagery reported in psychosis, although individuals may not be consciously aware of the origin (source) of the imagery (review: Varese & Bentall, 2011). Morrison (2001) further suggests that the distressing imagery associated with past trauma (memories and/or perceptions) may be misinterpreted by patients with psychosis as reflecting current reality. Additionally, individuals with psychosis possess abundant imagery due to a longstanding proneness to intrusive imagery (Steel, Fowler, & Holmes, 2005). Steel, Hemsley, Pickering, et al. (2002) suggest that, in high scoring positive schizotypals as identified by the UnEx factor of the O-LIFE, such imagery may be due to the maladaptive integration of contextual information during trauma episodes.

3.1.3.2 Redundancy of the efference copy

Secondly, is the efference copy and/or comparator mechanism required at all? That is, is a separate cognitive system required in a system that is already self-aware? In the case of visuomotor control, the efference copy serves to provide a pragmatic, executive function rather than a verificational one. That is, with regard to the motor system, the efference copy serves to inform adjustment systems (e.g., visual and vestibular) with regard to the stability of the visual field or postural balance. A distinction can be made between cognitive systems such as perceptual and memory systems. However, efference copy as described by Frith (1992) plays no communicative role among these systems (Gallagher, 2004) with consciousness essentially sending itself messages. Thus, Campbell (1999) suggests—following Feinberg (1978) and Frith (1992)—that the primary role of the efference copy is to keep thoughts on track, "that the thoughts you actually execute form coherent trains of thought" (Campbell, 1999, p. 616). Based on this account, it seems appropriate to attribute the supervision of the train of thought to a metarepresentational (SM) system, which can provide a continuous on-line check regarding the, for example, semantic and logical aspects of thought, rather than attributing such a supervisory mechanism to a non-semantic, subpersonal, nonconscious process. Put simply, why propose such a mechanism when we are already consciously aware of our thoughts and can keep track of them on a conscious level. It seems frugal, therefore, to attribute this kind of task to a metarepresentational introspection advocated by Frith (see, Frith, 2005; Frith et al., 2000a,b); this process is distinct from the verification process advocated in Frith’s (1992) original incarnation. To this end, the SOA depends on the monitoring of a metarepresentational introspection of the first-order phenomenal experience (Campbell, 1999). As such, phenomenal experiences that do not equate with individuals’ beliefs or desires might be subsequently interpreted as originating from the non-self (i.e., as being alien in origin).

Frith’s (1992) model proposed an interplay between higher-order (metarepresentational) cognition and subpersonal mechanisms; this hybrid model seems less than economical when the very thing we are monitoring (our thought processes) are already available to consciousness. The above critique of Frith’s model explains that individuals with schizophrenia can only misattribute agency to one source, i.e. themselves. According to Gallagher (2004) four possibilities may underlie this theoretical anomaly in Frith’s model, three shall be considered. The fourth, which Gallagher terms “Global problems” (p. 15) concerns the fact that individuals with schizophrenia display impairments not only in motor control, but also, for example, in numerous cognitive domains, e.g. language disturbances, including: 1) narrative construction (Gallagher, 2003; Lysaker & Lysaker, 2001; Lysaker, Wickett, & Davis, 2005); 2) irony comprehension (Langdon & Coltheart, 2004); 3) proverb comprehension (Brüne & Bodenstein, 2005; Thoma, Hennecke, Mandock, et al., 2009); 4) unintelligibility (Pinard & Lecours, 1983); and 5) pragmatising expressive language (Langdon, Coltheart, Ward, et al., 2002). As such, how can a simplistic cognitive model based in motor theory account for the multitude of impairments? Do we require one comparator model for each, or does one system control all? The three anomalies proposed by Gallagher (2004) are as follows:

1. *Hyper-reflexivity*

   Frith’s (1992) claim for a lack of metarepresentational SM in the case of schizophrenia is contrasted by clinical observations, which suggest that there may be too much of it. To this end, the observations of Sass (1992, 1998, 2000) suggest that metarepresentation can be generated in a hyper-reflexive manner, as a result of which the individual with schizophrenia may overmonitor aspects of his/her experience. As a result of overmonitoring certain aspects of self-experience, the individual with schizophrenia may enter a hyper-reflexive state focusing on what is absent from or bizarre about his/her experience. A tendency to engage in hyper-reflexivity (rumination, obsessing) has also been associated with individuals reporting schizotypal personality traits (e.g., Lee & Telch, 2005). This line of reasoning links in with the attentional difficulties evinced in individuals with schizophrenia, inasmuch as such attentional depletives may not result from a complete lack of attention, rather that the subject is primarily attending to certain aspects of his/her experience that are different (see, Parnas & Sass, 2001, for an observational discussion). As such, the failure in SM is that there is too much of it going on (Sass & Parnas, 2003).

2. *The episodic nature of positive symptoms*

Gallagher (2004) refers to the selectivity (episodicity) of positive symptoms as a problem in reconciling why, if either the comparator module malfunctions or an efference copy fails to generate the thought intention, do not all thoughts seem to be inserted as not all schizophrenic thoughts are experienced as inserted thoughts? The argument revolves around the observation that if an individual with schizophrenia claims that a thought seems to be inserted why then do they not simultaneously claim that his/her awareness of the thought insertion was also implanted. That is, there is a clear sense (realisation) that the thought has been inserted—the subject claims so in his/her own voice. This is verified not only from patient's empirical reports (e.g., Fish, 1967), but must be true by logical necessity (Gallagher, 2004). The disparity appears to lie between those thoughts that seem inserted and those that do not seem to be inserted, and as such the thoughts that constitute the subject's complaint cannot seem inserted. If all thoughts were experienced as inserted the subject would not be able to report the phenomena as such; the subject would not maintain an appropriate sense of ownership for his/her cognitive life, or a sense of cognitive 'space' in which to define an insertion (Gallagher, 2004; see also, Thornton, 2002).

The selectivity problem cannot be explained by a failure of the comparator; as such, a failure should presumably also affect the sense of recognition that the thought has been inserted. A theory advocating a higher-order cognitive (a metarepresentational or introspective judgment) also fails on this same problem. That is, it would fail to explain why a higher-order cognition, which fails to generate a SOA for a certain thought or experience is itself experienced as self-agentive (Gallagher, 2004; see also, Pacherie, 2008).

3. *The problem of specificity*

With regard to thought insertion, specific kinds of thoughts, but not all thoughts, appear to be inserted. For example, the individual with schizophrenia may report that the thoughts are always being inserted by a particular person and that they are always related to a specific theme (e.g., persecution) (Gallagher, 2004). This is also true of auditory verbal hallucinations for which the individual with schizophrenia may report that the voice/s always utters the same thing/s or conducts intimate dialogues (Nayani & David, 1996; see also, Thomas, McLeod, & Brewin, 2009). Indeed, 46% of Nayani and David's study (total N = 100) reported the co-occurrence of inserted thoughts and auditory verbal hallucinations (see also, Morrison, Haddock, & Tarrier, 1995). This specificity implies a discrete phenomenology that has a semantic and experiential consistency and a personal-level complexity that cannot be readily explained by the disruption of subpersonal (nonconscious) processes alone (Gallagher, 2004). However, Langland-Hassan (2008) proposed that disruptions to the subconscious mechanisms that control inner speech may, at least in part, be responsible for reports of thought insertion and auditory verbal hallucinations. More specifically, Langland-Hassan theorised that thought insertion and auditory verbal hallucinations may result from a single general deficiency—a lack of the proper 'filtering' of inner speech—and, therefore, that these two cardinal symptoms of schizophrenia may themselves best be thought of as marking distinctions in the degree of a single underlying cognitive disorder, that of stimulus filtering.

3.1.3.4 Frith's (1992) cognitive neuropsychological model of schizophrenia: Concluding comments

Although seemingly parsimonious in explaining the positive symptoms of schizophrenia, Frith's cognitive (neuropsychological) model is now deemed to be inadequate in that the notion of metarepresentation requires a fuller development and redefinition (Roy, Roy, & Grondin, 2008). Regarding the concerns of Gallagher (2004), Frith (2004) in response, advised that he was not, as Gallagher intimated, attempting to conceptualise schizophrenia as a unitary entity, but rather to provide one possible cognitive explanation of the positive symptoms of schizophrenia (Harrington, Siegert, & McClure, 2005). By explaining positive symptoms (e.g., delusions of control) in terms of maladaptive cognitions, such symptoms may become more understandable (see also, Jaspers, 1962). In support of Frith's model, neuroimaging studies contest to the involvement of specific brain regions in the causation of the SOA (e.g., Farrer, Franck, Georgieff, et al., 2003; Farrer & Frith, 2002; Frith et al., 2000a,b; Jeannerod, 2009; Blakemore, Wolpert, & Frith, 2002; Chaminade & Decety, 2002; David, Newen, & Vogeley, 2008; Northoff & Bermpohl, 2004) and SM dysfunction (e.g., Allen, Amaro, Fu, et al., 2007; Carter, MacDonald III, Ross, et al., 2001; Fu & McGuire, 2003; Frith, 2005). To this end, Frith's (1992) model and its subsequent incarnations (e.g., Frith, 2005; Frith et al., 2000a,b; Wolpert et al., 1995) have engendered bountiful research (e.g., Blakemore, Oakley, & Frith, 2003; Blakemore & Sirigu, 2003; Carruthers, 2010; Hauser, Knoblich, Repp, et al., 2011; Jones & Fernyhough, 2007a; Schimansky, David, Rössler, et al., 2010; Synofzik, Vosgerau, & Newen, 2008; Voss, Moore, Hauser, et al., 2010) and as such Frith's (1992) model can be viewed as a resounding success. However, Schofield (2006) notes that conceptualisations of the comparator model in accounting for the positive symptoms of schizophrenia as advocated by Frith (1992), Gallagher (2004) and Stephens and Graham (2000) remain inadequate in explaining the phenomenon of thought insertion proposing that such ideation (and experience) might be better understood in terms of being a type of uncontrollable or autochthonous thinking[19] (see also section *3.1.2.1.1*).

Taken as a whole, the above data exemplify that the concept of the SOA has proved to be phenomenologically complex (Gallagher, 2007, 2010, 2013) involving differing levels of experience,

[19] The word *autochthonous* refers to "events originating from within an organism (relatively) independent of outside influences … for example … obsessions, insights and ideas" (Reber & Reber, 2001, p. 69).

from basic motor processing (Farrer et al., 2003; Tsakiris, Bosbach, & Gallagher, 2007; Tsakiris & Haggard, 2005) to higher levels of intention formation and retrospective judgment (Pacherie, 2006, 2007; Stephens & Graham, 2000; Synofzik et al., 2008).

3.1.4 Relating the comparator model to psychometric schizotypy

It is now relatively well established that individuals, in order to make coherent sense of their environment (both exogenous and endogenous), require an optimally functional SM system, including some form of comparator module for the formulation of a SOA. Given the hypothesised continuum of psychosis, one must quite rightly ask: does this mode of disrupted metacognition also apply to members of the general population scoring high on measures of psychometric schizotypal personality traits? (see, e.g., Allen, Freeman, Johns, et al., 2006). The answer is, quite possibly—and a series of three experiments conducted by Asai and colleagues, amongst others, attempted to address this question. Additionally, recent work by Moore, Dickinson, and Fletcher (2011) is also considered:

In their first study, Asai and Tanno (2007) assessed positive schizotypy with the STA (Claridge & Broks, 1984) and SOA using a no-visual-feedback (NVF) paradigm. Participants (N = 20) were required to move an unseen wireless mouse in order to navigate the cursor to a specific screen location and to judge whether an angular bias had been applied or whether the cursor moved in conjunction with their own movements. Results revealed no significant main effect for the perception of angular bias; however, the attribution of self-generated movements (SOA) was found to be weaker in high scoring schizotypals (F = 4.617, P < 0.05). This finding suggests that high scoring positive schizotypals are more likely to attribute their actions to an outside source, in this case, computer-manipulated cursor feedback.

In a second study (Asai & Tanno, 2008), which involved 18 participants (10 high schizotypal/8 low schizotypal) and used the STA as an index of positive schizotypy, participants were required to judge whether they had been the originator of a computer-generated auditory tone presented with differing temporal delays (0, 15, 30, 45, 60, 75, 90, 105, 120, or 135 msecs) or whether the experimenter had initiated the tone. Repeated measures ANOVA revealed a main effect for temporal delay in the high schizotypy group (F = 20.9, P < 0.01) but not for judgment (self or experimenter). In the low schizotypy group there was a main effect for temporal binding (F = 47.6, P < 0.001) and also for judgment of source (F = 7.83, P < 0.05). The authors interpreted these results as indicating that the low schizotypy group sometimes possessed a SOA in addition to perceiving a temporal delay, but that the high schizotypy group judged the sense of self-agency in accordance with the perceived temporal delay, in essence attributing the SOA to another (i.e., the computer-generated temporal delay).

In a third study involving 41 university students (21 male, 20 female) and using the O-LIFE as an index of general schizotypy, the STA as an index of positive schizotypy, and the Auditory

Hallucination Experience Scale (AHES; Tanno, Ishigaki, & Morimoto, 1998)[20] as an index of auditory hallucinations—Asai, Sugimori, and Tanno (2008) found that the estimation (under and/or over) of individual's left hand movements[21] were significantly predicted (forced entry linear regression) by positive schizotypal personality traits as indexed by the STA (R^2 = 0.342); however, greater predictory power was attributed to the AHES (R^2 = 0.463). Although acknowledging that their results could only be regarded as preliminary due to small sample size; the authors concluded that the proneness to passivity phenomena, such as delusions of control and auditory hallucinations may be caused by the abnormal estimation (over and/or under) of the schizotypal individual's motor movements. This study places a fundamental mentalising deficit ordinarily attributable to individuals with schizophrenia into the realm of the general population providing further support for notion of the existence of latent psychosis-like cognitions at the level of normal individuals (Garrett, Stone, & Turkington, 2006).

A recent study (Moore et al., 2011) assessed positive schizotpy with the PAS, MI, and PDI investigating the SOA with a learning outcome blocking paradigm. Theoretical and empirical work on the SOA suggests that learning has an important role. Numerous findings point to the role of learning in the generation of a SOA. For example, the SOA appears to be sensitive to the causal relationships between action and outcome (Cravo, Claessens, & Baldo, 2009; Franck, Farrer, Georgieff, et al., 2001; Moore & Haggard, 2008; Moore, Lagnado, Deal, et al., 2009); furthermore, pharmacological manipulations suggest that SOA is dependent upon those neural circuits associated with instrumental learning (Moore, Schneider, Schwingenschuh, et al., 2010). Certain theoretical models of the SOA also indicate the importance of learning; for example, SOA may be informed by sensorimotor predictions generated as part of the normal system of motor control (Blakemore, Wolpert, & Frith, 2002; Frith, 2005; Frith et al., 2000a,b; Haggard, Clark, & Kalogeras, 2002). Moore at al.'s (2011) experiment (N = 15) involved three sequential phases:

i. Phase 1 involved pre-training in which participants pressed one of two keys (left or right, free choice); the key presses caused a flash of light (red or pink) in a rectangular box (duration = 250msecs). The mapping of colour to key press was kept constant throughout.
ii. Phase 2 (compound training) involved participants again freely choosing key presses; however, this time the flash of colour (red or pink from Phase 1, or a new colour–black) was accompanied by a simultaneous tone (duration = 200msecs) after a delay of 200msecs. The tone was either high or low pitched. The mapping of the compound stimuli (flash of light/tone) was again kept constant

[20] The AHES is derived from the LSHS-R.

[21] Participants were required to locate—by means of a straight line—four targets (target area = 2 x 2 pixels) presented in each corner of a computer screen. Participants were required to use a wireless mouse and click on the target once the cursor had arrived. Following Lenzenweger and Maher (2002) and Ogawa, Inui, and Sugio (2006), reaching movements were assessed under NVF conditions. Prediction error (PE) was defined as the distance between the click point and the target.

throughout. The presentation of stimuli ensured that for each key press (either left or right) each participant received a novel stimulus compound (surprise condition), whereas the other key caused a stimulus compound which had been previously presented from pre-training (expected condition).

iii. Phase 3 (test) involved the experimental testing of the temporal experience of action-outcome associations. Participants freely pressed one of the two keys (left or right) when they felt the urge to do so. Pressing the key caused, after a delay of 250msecs, the same tone that had followed that key press in Phase 2 (compound training). Time judgments were made using a rapidly rotating clock with a standard display (one revolution = 2.56secs) presented in the middle of the computer screen. The clock hand continued to rotate for a random amount of time after stimulus presentation (tone). When the clock hand stopped rotating participants were requested to verbally report the position of the clock hand, either when they had pressed the key or when they had heard the tone. Surprise-action tone pairings were those in which the tones had previously been presented with a pre-trained colour: 40 trials were completed in total.

For the purposes of the results, data were split into early (first 20 blocks) and late (last 20 blocks) because it has been shown that training may change over time (Flach, Osman, Dickinson, et al., 2006; Moran, Al-Uzri, Watson, et al., 2003). Schizotypy was assessed in terms of the magnitude of the effect of surprise on binding. All measures of positive schizotypy were found to correlate (Spearman's rho) in the latter 20 blocks. The PAS displayed a significant inverse relationship (r = -0.62, $P < 0.01$), the MI also displayed a significant inverse relationship (r = -0.52, $P < 0.05$), however the PDI displayed a trend toward significance (r = -0.43, P = 0.057). These results suggest that the effects of surprise during training are reduced in those individuals scoring high for positive schizotypal phenomena. The authors concluded that the element of surprise exerts an influence over SOA. Using an outcome blocking procedure, the authors were able to demonstrate that training with more surprising outcomes augmented binding at test, at least in the latter trials. Surprise has been implicated in previous theoretical accounts of agency experience (e.g., Anscombe, 2000). The authors also suggest a role for associative processes, which may be related to higher level experiences of the environment and that resemble those found in individuals with schizophrenia (e.g., Kiang et al., 2010). That is, the attention paid to an antecedent event (sc., a response) is determined by whether or not the event has previously been associated with a PE generated by surprising outcomes (i.e., colour changes/auditory tones). Moore et al. proposed that individual differences in the extent to which an agent recognises itself as the originator of an event will lead to different error-driven learning effects. As such, if an individual is more likely to attribute error to an external agent, he/she will be less likely to update their conceptualisations of the world based on this error, thereby failing to increase the strength of the action-outcome association, possibly because they fail to recognise that they are the instigator of the error. In such circumstances the individual's error itself may promote a stronger sense that it was not of their origin, i.e. the error will be attributed to another external (nonself) source

(Sugimori, Asai, & Tanno, 2011). Indeed, PE signaling is thought to underpin many of the symptoms of schizophrenia (see section 3.1.7), and more broadly the psychogenesis of psychotic disorders (Corlett, Murray, Honey, et al., 2007; Synofzik, Thier, Leube, et al., 2010; Voss et al., 2010).

It is worth noting that as the negative dimension of schizophrenia is viewed as being critical in the formation of disrupted conditional blocking (Bender, Muller, Oades, et al, 2001; Moran, Owen, Crookes, et al., 2007; Oades, Zimmermann, & Eggers, 1996), so too has the negative dimension of schizotypy. For example, a group of participants scoring high (N = 38) for the 'introvertive anhedonia' (negative dimension) of schizotypy as measured by the O-LIFE were found to be impaired in associative learning, especially blocking[22] (Haselgrove & Evans, 2009).

3.1.5 Garety et al.'s (2007, 2001) model of the positive symptoms of psychosis

Garety et al. begin their well-cited 2001 paper by proposing that cognitive models of psychotic symptomatology provide an important link when evaluating phenomenological experiences in respect to social, psychological, and neurobiological levels of explanation. In this respect, cognitive models are proposed to provide psychological descriptions of the phenomena in question from which hypotheses pertaining to causality can be derived and subsequently tested allowing the impact of individual (differences), social, and neurobiological processes on cognition to be evaluated (Garety et al., 2007; Garety et al., 2001). The model proposes two proximal routes to positive psychotic symptoms: 1) a cognitive route based in maladaptive reasoning processes, poor self-concept, and adverse environmental conditions, which propagate positive symptoms; and, 2) an emotional route based in levels of emotional distress (see, Bak, Krabbendam, Janssen, et al., 2005, for a synthesis of both viewpoints).

The cognitive route proposes that disruptions to processes underlying basic "automatic"[23] cognitions may be conceptualised in two ways. Firstly, they might be viewed as "[A] weakening of the influences of shared memories of regularities of previous input on current perception" (Garety et al., 2001, p. 189) resulting in ambiguous, even fragmented, sensory input; and subsequent intrusions into conscious awareness from unbidden (nonconscious?) material from memory (Hemsley, 1993; Morrison, 2001; see also, Kopp, 2007). Secondly, cognitive dysfunction may result from difficulties with the SM of intentions and actions (Frith, 1992; 2005; Frith et al., 2000a,b).

[22] *Blocking* in respect of selective association (Kamin, 1968) refers to "a circumstance in which, if an association is first formed between two stimuli, (*x* and *y*), then later a compound stimulus (*x*+*z*) is associated with *y*, the association between *z* and *y* tends not to be learned; that is, it is 'blocked' by the previously established link between *x* and *y*" (Reber & Reber, 2001, p. 96).

[23] *Automatic* in this context is presumed to mean cognitively low-level (first-order, e.g. perceptual) as opposed to high-level (second order) processes such as beliefs and expectations.

3.1.6 O'Connor's (2009) metacognitive model of psychosis

O'Connor's metacognitive model centres on the individual with psychosis's tendency to live in a made-up (fictional) world as if it were reality, advocating that such experiences—and the emotional reactions, thereof—should be viewed within the individual's cultural context. Furthermore, in agreement with, for example, Garety et al. (2001) and Bentall and Kaney (1996), the psychotic experience is viewed by O'Connor as incorporating a combination of factors including cognitive styles, threat appraisals, feelings of vulnerability, subcultural beliefs, and emotional stress. For example, O'Connor proposes that differences in delusional ideation between clinical and nonclinical populations lie not in the cognitive content (e.g., "I am in direct communication with God . . .") but rather in the degree and type of perceived threat, the judgment or appraisal imposed on the delusion (e.g., ". . . because I am surrounded by evil-doers"). That is, such delusional ideation is dependent upon the level of coping over threat beliefs and the predisposition toward a particular cognitive style (Szily & Kéri, 2013), including inferential confusion[24].

OVI is hypothesised to lie on a continuum with delusional beliefs and is associated with a strong intellectual investment in a fixed idea not shared by others, where the content of the ideation is bizarre; that is, not emanating from normal everyday experiences (O'Connor, 2009). Overvalued ideation involves the abnormal interpretation of intrusive beliefs and values, and Veale (2002) refers to the psychogenesis of overvalued ideation as involving "[A] value that has become dominant and excessively identified with the self" (p. 388) and, as such, defies credibility. In the North American literature, overvalued ideation is thought to lie on a continuum of obsessional doubts through delusional certainty. Individuals espousing such ideology tend to lack insight (Veale, 2002, 2007), which is known—in clinical populations—to affect treatment outcome (Goldberg, Green-Paden, Lehman, et al., 2001).

3.1.7 Fletcher and Frith's (2009) Bayesian account

In agreement with recent research into the SOA in schizotypy (in particular, Moore et al. (2011), section 3.1.4) the mainstay of Fletcher and Frith's model involves the error-dependent updating of individual's inferences and beliefs about the world. The model proposes that both perceptions of the world (and consequently beliefs) and the associated learning are dependent on predictions and the extent to which they are fulfilled. If an action (e.g., speech or movement) is self (internally) generated it is more readily predictable and as such easily ignored, as the sensory consequences can be dampened; whereas experiences formed by the outside world are to a large extent unpredictable and

[24] *Inferential confusion* refers to OVI that is arrived at punctually and in a confusing manner (O'Connor, 2009).

as such not readily interpretable and therefore difficult to ignore. However, it is paramount to incorporate such external experiences into our worldview to adaptively understand the environment (Kolb, 1983). How individuals experience the world at a basic sensory level depends upon prior knowledge, which is expressed in terms of probability; that is, such experience is affected by what the individual believes. Moreover, the extent to which an individual updates their beliefs about the world is dependent on the experiential data each encounter adds to it; which is, as Fletcher and Frith (2009, p. 52) point out, "the insight that was captured by Bayes' theorem" (Bayes, 1763).

The model simplistically predicts that the sensory consequences of a self-generated action will involve less brain activity than an externally generated act. This is true in the motor domain, where people have to overcompensate when trying to match a self generated force with an externally generated one (Shergill, Bays, Frith, et al., 2003). Such a distinction can also be drawn in the auditory domain. For example, the electrophysiological response to hearing one's own voice is lesser in magnitude than the response to hearing someone else's voice or to hearing one's own voice distorted (Heinks-Maldonado, Mathalon, Gray, et al., 2005). Complementary data from magnetoencephalography studies suggest that self-produced speech and sounds attenuate auditory cortex responses (Curio, Neuloh, Numminen, et al., 2000; Houde, Nagarajan, Sekihara, et al., 2002); this effect is more pronounced for self-produced speech than nonverbal sounds (Martikainen, Kaneko, & Hari, 2005). Indeed, it has been shown that misperceptions of inner speech may give rise to auditory hallucinations (Ford, Gray, Faustman, et al., 2007; Hugdahl, 2009, 2012; Hugdahl, Løberg, Jørgensen, et al., 2008; Kumari, Fannon, ffytche, et al., 2010; review: Allen, Aleman, & McGuire, 2007), and that such experiences are associated with activity in brain areas relating to speech, including the auditory cortex (e.g., O'Daly, Frangou, Chitnis, et al., 2007; Ford & Mathalon, 2004; Ford, Mathalon, Kalba, et al., 2001; Lennox, Park, Medley, et al., 2000; McGuire, Shah, & Murray, 1993; Shergill, Brammer, Williams, et al., 2000; Shergill, Bullmore, Simmons, et al., 2000). It has been shown that synchronisation of activity in the brain areas associated with self-produced speech is attenuated in individuals with schizophrenia, and that this attenuation strongly predicts the likelihood of experiencing auditory hallucinations (Shergill, Cameron, Brammer, et al., 2001). Additionally, a recent study suggests that the misattribution of inner speech (to exogenous sources) may give rise to auditory verbal hallucinations in normal individuals reporting such phenomena (Daalman, van Zandvoort, Bootsman, et al., 2011), providing further evidence for a continuum of psychosis.

An obvious necessity for dampening self-induced experience is adaptive motor and sensory integration, including the functional connectivity between motor and sensory domains: sensory and motor disturbances have both been noted in schizophrenia (Chen, Levy, Sheremata, et al., 2004; Ford, Roach, Faustmann, et al., 2007). A disruption to this connectivity may result in prediction-based attenuation and, ultimately, difficulties in distinguishing internal from external stimuli (Dakin, Carlin, & Hemsley, 2005; Teufel, Kingdon, Ingram, et al., 2010). Structural observations provide support for disconnectivity in schizophrenia (Kubicki, McCarley, Westlin, et al., 2007), and functional magnetic-resonance imaging (fMRI) has linked dysfunctional connectivity with hallucinations (Mechelli, Allen, Amaro, et al., 2007).

The interaction between experiences and beliefs causes a problem; that is, if experiences do not challenge a belief system then they become predictable and as such ignored. An immediate bonus of the non-challenging of belief is that of saving the cognitive resources and energy required for integrating the constant stream of experiences to which we are subject. The disadvantage is that this can lead to cognitive inflexibility with strongly held beliefs becoming ever more resistant to otherwise informative experiences (e.g., Colbert, Peters, & Garety, 2010a; Garety, Freeman, Jolley, et al., 2005; Thoma, Wiebel, & Daum, 2007). A well researched example of this is latent inhibition (Lubow, 1973), which posits that through repeated exposure to a stimulus the probability of a particular stimulus is increased, and one can decrease the extent to which it will later be associated with another stimulus. As such, the seemingly simple process of stimulus perception is itself a learning condition and is critical for higher-order associative and inferential processes (Barlow, 1990). The model an individual generates of the world in which they live has an enormous impact on perception (Fletcher & Frith, 2009). It was Helmholtz (1866) who first introduced the notion that perception is an inference regarding the world, a hypothesis which combined sensory signals with prior knowledge (e.g., expectations, beliefs). The revolutionary ideas of Helmholtz have been given a computational grounding in the form of Bayesian inference (Yuilie & Kersten, 2006). Individuals do not only make predictions about when stimuli are likely to occur, they also predict how stimuli might relate to each other, which has been investigated under the rubric of *blocking* (see, Haselgrove & Evans, 2009).

Do our senses provide us with an accurate description of the world? In short, they do not. Rather, what we perceive, and how we perceive it, is often determined by what we anticipate and what fits most comfortably with our prior expectations and biases (Corlett, Simons, Pigott, et al., 2009). The everyday experience of taking in data from the world, weighing it up and drawing conclusions implies that information flows exclusively in one direction: from perception to belief. Actually, this process is bi-directional (Fletcher & Frith, 2009). Our beliefs about what is normal, predictable, or logical may prevent us from experiencing the perceptions that violate our assumptions. Knowing how the brain normally does this may help us to understand why, under certain conditions, people entertain perceptions and beliefs that may seem unusual and illogical. It may also tell us why individuals so frequently engage in behaviours that are detrimental to their overall health. For example, high scoring schizotypal subjects from the general population have been found to be significantly more likely to engage in health-endangering behaviours such as tobacco smoking (Larrison, Briand, & Sereno, 1999; Williams, Wellman, Allan, et al., 1996).

Why would our brain be so ready to refine, distort, add or remove sensory information when constructing our picture of the world? Perhaps it is because survival and success are not necessarily related to how accurately we represent the world but rather to how efficiently we can *predict* it (e.g., Anno, Ohshima, & Abe, 2010; Schultz, Dayan, & Montague, 1997; Seymour, O'Doherty, Dayan, et al., 2004). If our brain tried to represent everything as accurately as possible, we would be paralysed (overloaded) with information. Since our aim must be to interact with our environment decisively, for example, to gain reward (Schultz, 1998), to avoid pain (Talmi, Dayan, Kiebel, et al., 2009), and adaptively integrate fearful stimuli (Olsson, Nearing, & Phelps, 2007; Olsson & Phelps, 2007), it seems parsimonious to sacrifice a detailed portrait of our surroundings in favour of quick snapshots of the important things, gleaned from a mixture of current information and prior experience (Bargh & Pratto, 1986; Higgins & Bargh, 1987; see also, Cohen & Lezak, 1977). Such selectivity allows our knowledge to inform our perceptions and helps us to achieve this while reducing the brain's workload, possibly through modality-specific selective attention (Mozolic, Hugenschmidt, Peiffer, et al., 2008). Indeed, the over-selection of irrelevant stimuli by those with schizophrenia is now considered a distinguishing feature (Gray & Snowden, 2005; James & Barry, 1980; Minas & Park, 2007), which has also been linked to positive schizotypy as indexed by the UnEx (positive) dimension of the O-LIFE (Le Pelley, Schmidt-Hansen, Harris, et al., 2010). Moreover, such preoccupation with the irrelevant aspects of the environment is suggested to be intrinsically involved with the formation of positive symptoms (Kiss, Fábián, Benedek, et al., 2010; see also, Fisher, Heller, & Miller, 2007), especially under conditions of stress (Braunstein-Bercovitz, Dimentman-Ashkenazi, & Lubow, 2001).

Our perceptions do not just represent our world: they create it (Frith, 2007). In the case of psychosis, the distorted integration of perceptions can create a very frightening and bizarre world, one in which voices make critical and threatening comments and unseen persecutors control thoughts and actions. What happens in the brain to cause these altered perceptions? Advances in the cognitive neurosciences have helped reveal how the brain learns about, predicts, and responds to the world; this has begun to offer clues as to the processes that may be disrupted in psychosis (e.g., Barch, 2005; Spitzer, 1997). One process that may be particularly affected is the brain's response to a mismatch between a *predicted* and an *actual* outcome: so-called *prediction error* (PE). Because PE effectively signals that we must learn something new about the world, it is very useful in preventing us from becoming stereotyped, inflexible and unable to adapt to a changing environment; persistent and inappropriate PE signaling, though, would be detrimental. Imagine a world in which everything seemed to violate your expectations, everything competed for your attention because of its novelty and strangeness, even your own actions and thoughts; such experiences are clearly reported by individuals in the early stages of schizophrenia (McGhie & Chapman, 1961). Such a world could rapidly become perplexing and threatening. Perhaps the only way of explaining such a change to yourself would be to conclude that you were the victim of some powerful persecutor—a common delusional belief in psychosis (Freeman, 2007). PE informs the individual that their currently held model of the world may be wrong, suggesting a change in the environment (Courville, Daw, & Touretzky, 2006). If PE cannot be adaptively interwoven with previous knowledge no new learning will be generated and prior beliefs will not be revised (updated) in light of new evidence (Einhorn & Hogarth, 1978; Fletcher & Frith, 2009).

Corlett and colleagues have carried out a series of functional brain imaging studies in psychotic patients and individuals with drug-induced (transient) psychosis-like experiences with regard to PE (e.g., Corlett, Honey, Aitken, et al., 2006; Corlett, Krystal, Taylor, et al., 2009; Corlett et al., 2007; Corlett, Taylor, Wang, et al., 2010). The results show that brain responses to violated expectations are indeed abnormal in psychosis and that the degree of abnormality seems to correlate well with the unusual beliefs and experiences that characterise psychosis. It is even possible to predict in healthy volounteers undergoing brain imaging what sorts of symptoms they will experience when they subsequently receive a drug that disrupts PE signal (e.g., ketamine) (Umbricht, Schmid, Koller, et al., 2000). The work of Corlett and colleagues provides evidence that a disrupted PE signal changes the relationship between prior beliefs and perceptions. This change could underlie some symptoms of psychotic illness, and by association, perhaps the unusual experiences and beliefs evinced in high scoring positive schizotypals (Steel, Hemsley, & Pickering, 2007). Furthermore, a disruption in PE accompanying self-generated actions might possibly lead to those actions being felt as if they were under an externally-generated (non-self, alien) force (Shergill, Samson, Bays, et al., 2005). Moreover, as well as placing great attentional demands, stimuli creating large PEs may become more readily associable (Fletcher & Frith, 2009; Hogarth, Dickinson, & Duka, 2010), which may account for the bizarre coincidences frequently reported by individuals with schizophrenia (Chapman, 1966). Notwithstanding, it may only take a weak disruption in PE signaling to "push someone over the edge from a state in which perception/belief formation is altered but still self correcting, to a state in which ever increasingly flexible and imaginative inferences no longer accommodate persistent, unreliable prediction error" (Fletcher & Frith, 2009, pp. 55–56). To this end, it is possible that the disruption in PE may be of sufficient magnitude for delusion formation whilst being insufficient to produce sizeable distortions in sensory or motor performance.

Memory PEs—for example, "It is *likely* that I have seen that word before" or the misattribution of familiar objects from memory (see, Corlett et al. [2007] for how such PE-related dysfunction might lead to delusional ideation) have been associated with the expression of positive schizotypal personality traits (e.g., Corlett et al., 2009), and previous research suggests that current memory functioning (both illusory and recognition) is impacted upon by prior experiences and expectations in a similar way to dysfunction evinced in individuals with schizophrenia (see, Krishnan, Kraus, & Keefe, 2011). For example, individuals with schizophrenia are significantly more impaired at correctly recognising fragmented line drawings than healthy controls (Cavezian, Danckert, Lerond, et al., 2007; see also, Doniger, Foxe, Murray, et al., 2002; Doniger, Silipo, Rabinowicz, et al., 2001). Such cognitive dysfunction has obvious ramifications with regard to the integration of everyday (subjective) events into the stream of experience (Zacks, Kurby, Eisenberg, et al., 2011). For example, it is contested that individuals make sense of the world (experiences, behaviour, beliefs, etc.) by segmenting these experiences into *events*, which appears to be an ongoing component of everyday perception (Kurby & Zacks, 2008; Schwan & Garsoffsky, 2008; see also, Tversky, Zacks, & Hard, 2008). Events are proposed to be grouped simultaneously (and hierarchically) over multiple time frames (see, Arzy et al., 2011, for a recent investigation regarding the perceptual aberration of time in schizotypal individuals), and the fluid integration of perceptual data over brief time periods has been found to be negatively associated with the positive dimension of schizotypy, in particular (e.g., Lee, Dixon, Spence, et al., 2006). The parsing (segmentation) of ongoing events is, in the first instant, reliant on updating WM—a cognitive domain known to be compromised in positive schizotypal individuals (e.g., Schmidt-Hansen & Honey, 2009)—then onward to the contents of long term memory, and finally to the learning of new procedures (Kurby & Zacks, 2008), which may be the point at which intelligence functioning is updated, i.e. new learning[25].

3.1.7.1 Fletcher & Frith's Bayesian approach: Concluding comments

The Bayesian account offered by Fletcher and Frith (2009) couches the formation of positive symptoms within a computational framework. This viewpoint argues that symptoms become apparent as disruptions in PE manifest affecting the ability to make inferences about the world. Symptoms such as hallucinations and delusions are believed to ensue through the maladaptive integration of experiences. On this account, an individual's experiences and beliefs are being continually challenged through the rich environment to which they are exposed (Fletcher & Frith, 2009; Revonsuo, 2010, p. 149). However, if PE signaling is disrupted at any point through the proposed hierarchy (low-order sensory through higher-order reasoning and belief formation)[26] new information is not gleaned from the environment to challenge beliefs, expectations, etc., and no new learning will ensue. In review of the above evidence, a hierarchical Bayesian model may constitute a fundamental brain function (e.g., Corlett & Fletcher, 2012; Friston, Kilner, & Harrison, 2006; Lee & Mumford, 2003; Murray, Kersten, Olshausen, et al., 2002; Schultz & Dickinson, 2000; Summerfield & Koechlin, 2008).

3.1.8 Cognitive models of positive psychotic (sc., schizophrenic) symptomatology: Conclusion

Frith's (e.g., 1992, 2005; Frith et al., 2000a,b) neuropsychological model of the positive symptoms of schizophrenia hypothesises that the expression of unusual experiences and beliefs might be explained by a dysfunction of SM, which centres on a disturbed SOA. As has been discussed above, such dysfunction is also apparent with regard to individuals scoring highly for the positive aspects of schizotypy (e.g., hallucinations). Cognitive models further propose that vulnerable individuals make

[25] The integration of perceptual (visual) data into awareness is also reliant upon sustained attentional processes (e.g., Nakayama & Mackeben, 1989; Nuechterlein, Parasuraman, & Jiang, 1983), which have been found to be impaired in positive schizotypals.

[26] Note that the relationship between experiences and beliefs is bi-directional.

idiosyncratic appraisals that may result in specific positive symptoms (Garety et al., 2007, 2001; O'Connor, 2009). The biopsychosocial mechanisms that underpin such models are genetic, cognitive, emotional, and psychosocial in origin. To this end, it has been suggested that incorporating sophisticated bi-directional (interactive) causal models, which include, for example, assessments of trauma exposure, coping, and emotional processes allowing for the inclusion of more specific clinical phenotypes may benefit neurobiological research (Bak et al., 2005; Garety et al., 2007, 2001; O'Connor, 2009).

Furthermore, as had been illustrated, influences that are beyond the range of conscious cognition may also impinge upon the expression of psychotic symptomatology. The notion of unbidden (uncontrollable) thoughts arriving into conscious awareness poses a clearly definable alternative to disruptions in SM or PE. As clearly enunciated by Morrison (e.g., 2001), such interplay between our conscious experience and nonconscious (perhaps repressed) processes may help forge the expression of psychotic symptoms. With a wealth of neurophysiological and neuroimaging data to back it up, the Bayesian approach as proposed by Fletcher and Frith (2009) provides an exciting alternative approach to the purely cognitive models.

3.2 Linking schizophrenia and schizotypy: Cognitive correlates

Schizophrenia is associated with a pattern of cognitive impairment most commonly manifesting as disturbances of attention, memory, and executive functions (e.g., Aleman, Hijman, de Haan, et al., 1999; Fioravanti, Carlone, Vitale, et al., 2005; Heinrichs & Zakzanis, 1998). Numerous studies have revealed that certain of the cognitive features indicative of individuals with schizophrenia are also present in SPD patients (e.g., Bowie, 2005; Siever, Koenigsberg, Harvey, et al., 2002) and high scoring schizotypal subjects (e.g., Cochrane, Petch, & Pickering, 2012; Ducato, Thomas, Monestes, et al., 2008; Langdon & Coltheart, 1999; Stefanis, Trikalinos, Avramopoulos, et al., 2007). Moreover, individuals who score highly on psychometric measures of schizotypy have been found to resemble schizophrenics on a number of experimental correlates[27]. For example: latent inhibition (Baruch, Hemsley, & Gray, 1988; Gray, Fernandez, Williams, et al., 2002; Lubow, Ingberg-Sachs, Zahlstein-Orda, et al., 1992; Weiner, 2003), local-global processing (Goodarzi, Wykes, & Hemsley, 2000; Rawlings & Claridge, 1984), visuo-construction (Gooding & Braun, 2004), visuo-spatial processing (Thakkar & Park, 2010; Tsakanikos & Reed, 2003), verbal memory error (Brébion, Larøi, & Van der Linden, 2010), and sustained attention (Lenzenweger, Cornblatt, & Putnick, 1991; Rawlings & Gooding, 2001), which provides some validity to the concept (Peters, Day, McKenna, et al., 1999), especially when analysed in light of negative symptoms (e.g., Giráldez, Caro, Lopez Rodrigo, et al.,

[27] Psychotic symptoms are associated with disruptions in mental activity throughout the entire population, suggesting that "clinically relevant" psychotic symptoms are an exaggerated form of latent personality/cognitive attributes (Garrett et al., 2006; see also Chapter 1, Figure 2).

2000; Gooding & Tallent, 2003; Trotman, McMillan, & Walker, 2006). Such cognitive impairment in psychometrically identified schizotypals may, however, be selective in nature rather than directly mirroring the pervasive pattern found in schizophrenia (Smyrnis, Avramopoulos, Evdokimidis, et al., 2007; Spaulding, Garbin, & Dras, 1989). However, when subjected to experimental cognitive measures, the positive and negative dimensions of schizotypy have been found to represent two distinct factors (e.g., Dinn, Harris, Aycicegi, et al., 2002); further, the literature regarding typical cognitive and sociocognitive development "provides a rich source of hypotheses about the ontogenetic pathways leading to psychosis" (Bentall, Fernyhough, Morrison, et al., 2007, p. 155; see also, Thompson, Papas, Bartholomeusz, et al., 2012).

3.3 Schizotypy and cognition: A question of social (interpersonal) ambiguity?

As suggested above, the negative dimension of schizotypy might represent the factor that accounts for the majority of cognitive dysfunction. To this end, ambiguous or novel social settings, such as attending a party alone, are particularly aversive to individuals who exhibit elevated levels of schizotypic features (Quirk, Subramanian, & Hoerger, 2007). This finding is consistent with the proposition that social withdrawal might represent a repercussion of cognitive and emotional deficits (Horan, Blanchard, Clark, et al., 2008; see also, Phillips & Seidman, 2008). In particular, social interaction demands complex cognitive operations, such as anticipating the behaviour of someone else, searching memory for behavioural repertoires, and predicting the impact of specific behaviours (Langdon & Coltheart, 1999; Young & Mason, 2007). These operations are especially significant when the social context is ambiguous or novel, because schizotypic individuals cannot readily invoke automatic and practiced routines (Quirk et al., 2007). In support of this, schizotypy is associated with deficits in attention, WM, and other cognitive domains (e.g., Barch, Mitropoulou, Harvey, et al., 2004; Laws et al., 2008). Hence, individuals who exhibit these features might operate unsuccessfully and feel especially uneasy in these ambiguous environments (Reed, Wakefield, Harris, et al., 2008).

3.4 Developing an experimental protocol

An enduring question in cognitive neuroscience is how the physical properties of the world are represented in the brain providing conscious experience (Rich & Mattingley, 2002). To this end, it has been suggested that psychosis can be viewed as a breakdown in consciousness (e.g., Frith, 1979; Greenfield, 2002; Koethe, Gerth, Neatby, et al., 2006) and that the experimental study of consciousness should start by including a detailed account of the neurocognitive events underlying visual awareness (Crick & Koch, 1990; Kim & Blake, 2005; Searle, 2000; Wilenius-Emet, Revonsuo, & Ojanen, 2004). Furthermore, it has been suggested that the prefrontal cortex—a region found to be compromised within the schizophrenia spectrum (e.g., Callicott, Egan, Mattay, et al., 2003; Mohanty, Herrington, Koven, et al., 2005; Suzuki, Zhou, Takahashi, et al., 2005)—is important for subjective conscious perception (e.g., Lau & Passingham, 2006; review: Seth, Izhikevich, Reeke, et al., 2006). To this end, the experimental cognitive measures have been specifically designed for presentation solely within the visual domain.

As far as psychosis-proneness is concerned, it has been recently suggested in a study utilising an adolescent psychiatric population that neuropsychological impairment may be symptom-specific and, further, may only be applicable to truly prodromal subpopulations (Simon et al., 2007; see also, Therman, Suvisaari, Kalska, et al., 2009). Indeed, it has been suggested that cognitive impairment may be evident before the onset of clinically diagnosable schizophrenic symptoms (O'Carroll, 2000; Pflueger, Gschwandtner, Stieglitz, et al., 2007; van Rijn, Schothorst, t' Wout, et al., 2011). To this end, deficits in social cognition in normal populations scoring high for the positive and disorganised dimensions of schizotypy may represent a vulnerability marker for schizophrenia (van 't Wout & Sanfey, 2011). Additionally, recent research reported that individuals presenting an at-risk mental state displayed similar cognitive profiles to healthy volounteers expressing high schizotypy (Barkus et al., 2010; see also, Brewer, Wood, Phillips et al., 2006). With these observations in mind, the primary factor of ANCOG as identified from Phase 1—including independent contributions from the positive and disorganised schizotypal dimensions—provides a comprehensive framework within which to investigate cognitive functioning in healthy normals with a predisposition to report hypothetical PLEs.

3.4.1 CCTB: Test criteria

From the above literature review it can be seen that some of the SRMs employed in Phase 1 can be directly linked to the variations in cognitive functioning displayed in individuals at hypothetical risk for developing a schizophrenia spectrum disorder, including: 1) hallucinatory experiences (LSHS-R); 2) the content of delusional ideation (PDI); 3) maladaptive coping strategies (CCS); 4) trauma exposure (SLESQ); and 5) disruptions in consciousness (RTS and DES). Further, five areas of mental functioning have been highlighted that need to be controlled for in order to complement Phase 2 cognitive testing (i.e., emotional support, drug use, comorbid psychopathology, apathy, and visual imagery).

From the preceding sections various areas of cognitive functioning have been highlighted (i.e., sustained attention, associative processing, probability judgment, reality/source monitoring, and SM) and, as such, will form the spine of the Phase 2 CCTB. With this in mind, a literature search was conducted to identify the most common tests of cognitive functioning utilised by previous researchers who have looked into the concepts of schizophrenia and/or schizotypy, especially the positive symptoms (i.e., hallucinations and delusions). Utilising "cognition", "neuropsychology", “schizophrenia”, “schizotypy”, “psychosis”, “anomalous experiences”, “positive symptoms”, and “psychosis-proneness” as overarching search terms, an extensive electronic literature search was conducted from 1980–2008 via PubMed and PsycINFO, which highlighted six discrete realms of cognitive functioning for Phase 2 experimentation: 1) Sustained visual attention[28]; 2) Illusory (false) memory; 3) Probability reasoning; 4) OR[29]; 5) RM; and 6) SM. Two tests of intelligence functioning (current and premorbid) were also highlighted (‘fluid’ and ‘verbal’) and were subsequently incorporated into the CCTB as experimental controls, i.e. if any significant differences in cognitive performance are found between XPGs it is preferable to make sure that such differences, if found, are not due to intellectual depletives. This line of reasoning with regard to intellectual dysfunction has been highlighted with regard to schizophrenia (e.g., Dibben, Rice, Laws, et al., 2009), and may also be applicable to psychometric schizotypy (e.g., Noguchi, Hori, & Kunugi, 2008). As with the Phase 1 literature search, such inclusion criteria (i.e., a restricted range of direct correlates plus one personal preference [sc., OR]) may have unwittingly omitted additional pertinent areas of interest (e.g., tests of executive function). Indeed, tests of executive function (e.g., Stroop test, category and letter fluency) have been suggested to manifest themselves only at the onset of schizophrenia (Laws et al., 2008) and would therefore prove more efficacious for detecting those individuals at clinical high-risk for developing a psychotic disorder. Furthermore, the areas of cognitive interest extracted from the database searches were subsequently cross-referenced and further distilled by conducting a full internet search via Google to account for any database-specific occurrences. That is, the database search only accounted for articles within a necessarily restricted range. Applying a full internet search via Google incorporated a more diverse literature search.

With regard to CCTB administration, one of the first problems (i.e., how much can I possibly expect participants to do?) needed to be addressed. It was decided that a CCTB that could be completed in 1¼-hours +/- 15-miutes, including the possibility of spreading the testing over two sessions (if required) would be satisfactory.

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[28] Sustained visual attention as measured by the CPT represents the only measure of a cognitive *deficit* (i.e., information processing). All other CCTB experimental measures pertain to cognitive *biases*, which are thought to trigger, maintain, or aggravate positive psychotic symptoms (Moritz & Woodward, 2007).

[29] Although no previous research was found directly assessing OR ability in light of psychometric schizotpy, impairments have been revealed in nonclinical individuals scoring above the median for paranormal beliefs (Blackmore & Moore, 1994) and in patients with chronic schizophrenia (e.g., Doniger et al., 2002, 2001).

3.5 Phase 2: Overarching experimental hypothesis

There is a paucity of research into cognition associated with PLEs (Kelleher & Cannon, 2011); however, a wealth of research has identified numerous neuropsychological (neurocognitive) deficits in schizophrenia patients (meta-analysis: Fioravanti et al., 2005). Furthermore, certain authors have also highlighted the fact that pre-psychotic symptomatology coincides with cognitive disturbances (e.g., Bartók, Berecz, Glaub, et al., 2005; Ruhrmann, Schultze-Lutter, & Klosterkötter, 2003). In general, previous research has indicated that the positive aspects of psychotic symptomatology display little if any significant relationship with cognitive deficits, whereas the negative and disorganised aspects correlate with cognitive impairment (Mohanty, Heller, Koven, et al., 2008; O'Leary, Flaum, Kesler, et al., 2000; Van Der Does, Dingemans, Linszen, et al., 1993). Notwithstanding, specific cognitive impairment may be associated with positive symptomatology, e.g. verbal-WM (Green & Walker, 1985), auditory-WM (Menon, Anagnoson, Mathalon, et al., 2001), diminished expression of speech (Cohen, Morrison, Brown, et al., 2012; Minor & Cohen, 2010), and source memory (Aldebot Sacks, Weisman de Mamani, & Garcia, 2012). As an overarching hypothesis, it is predicted that significant mean differences will be revealed as a function of XPG. Chapter 4 will look more closely at the two measures of IQ, the six experimental measures, and the five complementary SRMs as identified from the literature review.

Chapter 4. Phase 2 CCTB: Two measures of intelligence functioning, six experimental cognitive measures, and five accompanying SRMs

The following sections will look in greater detail at the two measures of intelligence functioning, the six experimental cognitive tests, and the five accompanying SRMs.

4.1 Intelligence functioning

Assuming that the reporting of ANCOG represents dimensional aspects of personality functioning—involving psychological health or ill health (Claridge, 1997; Goulding, 2004)—in order to assess an individuals' intellectual functioning it is therefore necessary to compare individuals' current IQ performance with an estimate of their premorbid intellectual level (Crawford, Nelson, Blackmore, et al., 1990). Through inclusion as a control measure, GCA (proxy IQ) is of analytical import as it may aid in explaining differences between XPG's CCTB performance. In order to assess participants' GCA it was decided to adopt the experimental (neuropsychological) protocol of Edelstyn, Mayes, Condon, et al. (2007)—in a study which investigated aspects of memory functioning in medicated Parkinson's patients—by incorporating tests of fluid/visuoconstructive (MR [Wechsler, 1999]) and verbal (NART [Nelson, 1982]) intelligence as indices of GCA. This combination of IQ tests has been utilised in previous research involving schizotypy (e.g., Burch, Pavelis, Hemsley, et al., 2006; Spitznagel & Suhr, 2002); additionally, it has been shown to be an effective measure of intelligence functioning in healthy and brain-damaged patients (Brooks & Weaver, 2005; Garland, 2005a,b). Contributory evidence for utilising this combination of IQ tests comes from the observation that correlations between the two-subtest (FSIQ) version of the WASI (Wechsler, 1999) and the WAIS-III (Wechsler, 1997) have been found to be inconsistent and as such that particular combination of tests should be used cautiously (Axelrod, 2002; cf., Thompson, 1987), e.g. on homogenous samples. As such, the combination of MR and the NART seem parsimonious for assessing proxy IQ with this sample of adults given the limited time restrictions.

Intellectual deficits are routinely reported in the schizophrenia literature (e.g., Frith, 1996); and are associated with negative signs and incoherence but not to positive symptoms (Frith, Leary, Cahill, et al., 1991); however, when assessed in schizotypal (putatively psychosis-prone) individuals the relationship between IQ and positive and negative symptomatology is less clear. In a study involving undergraduate students (visual artists) and utilising the O-LIFE, participants were delineated into those scoring low and high (median split) for positive schizotypy (Burch, Pavelis, Hemsley, et al., 2006)—the authors found no relationship between UnEx as indexed by the O-LIFE and IQ as measured by the WASI (FSIQ; Vocabulary and MR subtests). However, Burch, Hemsley, and Joseph (2004) found that UnEx scores were negatively correlated with verbal intelligence as measured by the

Mill Hill Vocabulary Scale (Raven, Raven, & Court, 1988), and Burch, Hemsley, Corr, et al. (2006) also found a negative correlation between UnEx and the WASI (r = -0.22, P < 0.050). Furthermore, recent research (Matheson & Langdon, 2008) has further highlighted the efficacy of MR for distinguishing between those scoring low and high for the positive (reality distortion) dimension of the SPQ, concluding that MR is a significant predictor (CDA) of SPQ scores. With regards to verbal IQ, the NART has been extensively used to assess the premorbid functioning of those presenting or who are at risk for psychotic disorders (e.g., Addington, van Mastrigt, & Addington, 2003; Almundena, Fearon, Sham, et al., 2002; Gilvarry, Takei, Russell, et al., 2000; O'Carroll, Walker, Dunan, et al., 1992; Smith, Roberts, Brewer, et al., 1998; Tracy, McGrory, Josiassen, et al., 1996). Furthermore, research with undergraduate students and utilising the O-LIFE revealed no significant mean differences in NART performance between low (≤ 10^{th} percentile) and high (≥ 90^{th} percentile) scoring participants (Morgan, Bedford, & Rossell, 2006). This last finding raises the intriguing possibility that the nonsignificance of NART results reported by Morgan et al. may be due to their sample demographics. Firstly, because the sample was made up of undergraduate students the IQ range was necessarily restricted; and secondly, because mean differences in the Ages of the two groups was also nonsignificant—low schizotypy (21.2, S.D. 1.7)/high schizotypy (21.1, S.D. 2.7)—the effect of Age on IQ was also restricted. However, the relationship between Age and IQ is a complex issue (Kanaya, Ceci, & Scullin, 2005), involving numerous confounds (e.g., illness). Because of the significant mean differences between XPGs with regard to Age, the relationship between Age and IQ is pertinent—a potential experimental confound that will be accounted for in the results chapter.

4.1.1 Experimental hypotheses

Three experimental hypotheses will be explored with regard to intelligence functioning:

4. A difference is predicted in MR as a function of XPG (hypothesis 4).
5. A difference is predicted in NART as a function of XPG (hypothesis 5).
6. A difference is predicted in GCA ([MR+NART]/2) as a function of XPG (hypothesis 6).

4.2 Sustained visual attention

Sustained attention deficits are routinely reported in individuals with schizophrenia (e.g., Chen & Faraone, 2000; Liu, Chin, Chang, et al., 2002; Silver & Feldman, 2005; Michie, Kent, Sienstra, et al., 2000), whether they are chronically hospitalised (Orzack & Kornetsky, 1966) or in remission (Asarnow & MacCrimmon, 1978; Wohlberg & Kornetsky, 1973). Additionally, sustained attention performance is known to be subject to genetic influence (Bellgrove & Mattingley, 2008; Cornblatt, Risch, Faris, et al., 1988). Indeed, individual differences in executive functioning, at least in part, are attributable to genetic variation (review: Goldberg & Weinberger, 2004). To this end, CPT deficits as indexed by *d'* (discrimination accuracy) have been reported in the first-degree relatives of schizophrenia patients (e.g., Grove, Lebow, Clementz, et al., 1991). Keefe, Silverman, Mohs, et al. (1997) found that positive schizotypal personality traits were associated with decreased CPT performance in a sample of relatives. Furthermore, the severity of the attentional deficit may depend upon familial loading. For example, nonpsychotic siblings from multiplex schizophrenia families have been found to display significantly inferior performance on the degraded CPT and less proficiency in processing the perceptual load than siblings from simplex schizophrenia families (Tsuang, Lin, Liu, et al., 2006). CPT performance has also been found to be significantly lower in individuals with SPD (Roitman, Cornblatt, Bergman, et al., 1997).

Considering the proposed continuum of psychosis (e.g., Claridge, 1997), the question is, therefore, are such differences also present when assessed in those with a liability for developing schizophrenia? Variations of the CPT have been used with community and student samples with regard to psychometric schizotypy (e.g., Bergida & Lenzenweger, 2006; Chen, Hsiao, Hsiao, et al., 1998; Gooding, Matts, & Rollmann, 2006; Ng, 2002; Rawlings & Goldberg, 2001) and also schizophrenia spectrum samples (e.g., Avila, Robles, Hong, et al., 2006; Chen, Liu, Chang, et al., 1998). Results, in the main, show a decrease in performance for those scoring high for schizotypy, and as such it has been suggested that sustained attention deficits may be seen as a possible endophenotypic marker of a schizophrenia diathesis (e.g., Nuechterlein, Asarnow, Subotnik, et al., 2002; Obiols, Serrano, Capparós, et al., 1999); although it must be taken into consideration that such results depend on the exact methods of assessment (schizotypy and/or sustained visual attention).

Many studies have shown that individuals who exhibit schizotypal features demonstrate deficits in attention and WM (e.g., Barch, Mitropoulou, Harvey, et al., 2004). For example, sustained attention is especially deficient in individuals reporting elevated levels of reality distortion (i.e., positive schizotypal features) (e.g., Bergida & Lenzenweger, 2006). The results of Chen et al. (1998) which used the PAS as an index of positive schizotypy and total SPQ scores as a general index of schizotypal traits are consistent with the finding that the CPT may be measuring some underlying structure relating to schizotypal personality. Elevated perceptual aberration, which is a symptom-like indicator of positive schizotypy (Lenzenweger, 1994), have been related to CPT performance decrements (Lenzenweger et al., 1991; Obiols, Garcia-Domingo, de Trinchería, et al., 1993). To this end, Chen et al (1998) also found that a higher PAS score was associated with a significant increase in the false alarm rate ($P < 0.0001$) and a borderline (trend toward a significant) decrease in *d'*. In the same study, a higher SPQ score was associated with a borderline decrease in *d'*[30]. The observations of Chen et al. are given further credence from research with psychometrically-defined schizotypals and individuals with a clinically-defined diagnosis of SPD. Participants with PAS-defined (positive) schizotypy (2-SD above the mean) have been found have a lower hit rate and *d'* on the CPT-IP[31] (Bergida & Lenzenweger, 2006) and patients with a DSM-III-R (APA, 1987) diagnosis of SPD have also been found to exhibit lower *d'* for the degraded CPT[32] (Condray & Steinhauer, 1992; Harvey, Keefe, Mitroupolou, et al., 1996).

Gooding et al. (2006) assessed sustained visual attention with the CPT-IP. Their study incorporated 160 individuals with elevated scores on the PAS and MI scales, 96 individuals with elevated scores on the Social Anhedonia Scale, (SAS; Chapman, Chapman, & Raulin, 1976) and 137 controls. Results revealed that as compared to controls the two hypothetically psychosis-prone groups (PAS-MI [positive schizotypy] and SAS [negative schizotypy]) displayed significant impairment in discrimination ability as measured by *d'* (PAS-MI, $P < 0.001$; SAS, $P < 0.05$). These results suggest that a tendency to report elevated levels of positive (over and above negative) schizotypal personality traits equate to significantly greater impairment on the CPT-IP task.

Bergida and Lenzenweger (2006), utilising the SPQ and the CPT-IP, found that in a community sample ($N = 305$) the 'reality distortion' (positive) factor of the SPQ elucidated significant relationships: discrimination accuracy as indexed by *d'* (partial $r = -0.10$, $P = 0.046$); random errors as indexed by In*R* (partial $r = 0.15$, $P = 0.004$)[33]. No significant relationship was revealed for response bias as indexed by In*ß* ($r = -0.02$, $P =$ ns). Rawlings and Goldberg (2001) found subjects reporting higher "disorganised" schizotypal features as assessed by the O-LIFE to perform significantly worse on a nondegraded version of the CPT, whereas subjects reporting higher UnEx traits displayed a significant tendency to perform worse on a high-load version; subjects reporting high "introvertive-

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[30] The study of Chen et al. (1998) utilised both nondegraded and degraded versions of the CPT-X procedure and the results were analysed between adolescent ($N = 115$; mean age = 14.0, SD = 0.8) and adult ($N = 345$; mean age = 41.3, SD = 13.0) samples. The results for the nondegraded CPT with the adult sample are reported here.

[31] IP refers to the independent-pairs variant of the CPT in which a relative target is designated (Cornblatt et al., 1988).

[32] The degraded variant of the CPT (Nuechterlein, 1983) refers to an insufficient presentation of perceptual stimuli during test to make an automatic recognition; for example, through the processes of fragmentation or blurring.

[33] The partial correlations reported in Bergida and Lenzenweger's (2006) study controlled for the effects of "age, sex, and educational level" (p. 548).

anhedonia" (negative) schizotypal features were found to display a tendency for reduced (but nonsignificant) sensitivity (*d'*).

The literature reported above seems to indicate a robust relationship between positive schizotypy, especially as measured by the PAS, SPQ (reality distortion) and O-LIFE (UnEx) and sustained attention deficits. The ANCOG factor also contains high loadings of the positive and disorganised aspects of the SPQ-B and a partial contribution from the negative factor. Despite the findings of Rawlings and Gooding (2001), previous research into the relationship between CPT deficits and the disorganised/negative aspects of schizotypy are not so clear cut (Bergida & Lenzenweger, 2006).

4.2.1 The experimental protocol

For the purposes of Phase 2, participants will undertake a five-minute test session, during which they must respond to the letter "f") unless it is immediately preceded by the letter "d". Although appearing simplistic, the task is increased in difficulty due to the WM component.

4.2.2 Experimental hypotheses

Two experimental hypotheses will be explored with regard to sustained visual attention:

7. A difference is predicted in discrimination accuracy as measured by SDT (*d'*) as a function of XPG (hypothesis 7).
8. A difference is predicted in the number of In*R* as a function of XPG (hypothesis 8).

4.3 False (illusory) memory

Although playing a crucial role in survival, memory is sometimes inaccurate and can be so in predictable ways (Ballard, Gallo, & de Wit, 2012). One form of memory corruption is the process of incorrectly recalling an event, or details of an event, that did not actually take place (Roediger, 1996). Previous research has revealed significant individual differences in the ability to consciously avoid relations between word lists and their critical lures (Dodson, Koutstaal, & Schacter, 2000). That is, to increase recognition memory performance by discounting irrelevant associates. False memory paradigms, specifically the DRM (Deese, 1959; Roediger & McDermott, 1995), have been shown to differentiate between those scoring high and low for psychometric schizotypy—both in the proportion of correctly recognised 'true' (presented) and 'false' (nonpresented) items (words). The experimental protocol for Phase 2 will replicate Laws and Bhatt (2005), who utilised eight fifteen-item word lists taken from the norm-referenced lists of Stadler, Roediger, and McDermott (1999).

An individual differences approach presupposes that certain (cognitive) mechanisms are common to all types of false memory and, as such, individuals can reliably vary in such processes, and hence in their propensity for false memories. Supporting these assumptions, positive (but modest) correlations have been found between the DRM illusion and false memories in differing experimental paradigms. For example, false memories have been elicited for both words and pictures (Lövdén, 2003; cf., Salthouse & Siedlecki, 2007) and the acceptance of misleading information regarding previous experiences (Eisen, Cardenas, Kistorian, et al., 1999). Additionally, Blair, Lenton, and Hastie (2002) found stable individual differences across testing times, illustrating test-retest reliability.

4.3.1 False (illusory) memory and autobiographical memory: The case of anomalous experiences

It is generally thought that some of the processes contributing to the DRM illusion might also contribute to the generation of false autobiographical memories (Gallo, 2010). The first study to report a relationship between the DRM illusion and autobiographical memory accuracy was conducted by Platt, Lacey, Iobst, et al. (1998). In this study, undergraduate students were contacted on the evening of a famous public event (the O. J. Simpson trial) and reported details about their hearing of the verdict (e.g., location, informant). Several months later, the same individuals were recontacted and asked to re-report their memories of the event, and the consistency between the two reports were analysed. Crucially, some of the inconsistencies were reported with a high degree of confidence demonstrating autobiographical memory distortion. Platt et al. found a significant negative correlation between autobiographical memory accuracy with DRM false recall of related items (r = -0.30, P < 0.05) and a marginally significant correlation with DRM false recognition (r = -0.23, P = 0.05). The above study illustrates that those individuals with less reliable autobiographical memory are susceptible to the DRM illusion.

The DRM procedure has been found to be one measure of false memory that, although utilising deliberately manipulated stimuli, significantly differentiates, for example, between a group reporting experience of a particular anomalous experience (alien abduction) and a group who had not (Clancy, McNally, Schacter, et al., 2002). Clancy et al. found that abductees were more prone to false recall (M = 0.29) than a control group (M = 0.14), and similarly for false recognition (M = 0.67 and 0.42, respectively). The groups did not, however, differ in true memory of the actual studies words. Similar findings were reported by French, Santomauro, Hamilton, et al (2008): the researchers also found that those individuals reporting extraterrestrial experiences were more prone to DRM false recognition (experients M = 0.59; controls M = 0.49), but this difference was nonsignificant, potentially because experients reported a UFO sighting without an actual memory of abduction. A more recent study (Meyersburg, Bogdan, Gallo, et al., 2009) provided a conceptual replication of the Clancy et al.'s

(2002) study; the authors found that individuals reporting experiences from a past life (e.g., selling newspapers in the 1800s) were more susceptible to DRM false recall (M = 0.44) than controls matched for age and education (M = 0.30), and similarly for false recognition (M = 0.76 and 0.48, respectively). As with the Clancy et al. (2002) study, the groups did not significantly differ in the true memory of studied words. Additionally, Meyersburg et al. (2009) found that recognition effects were greater when preceded by prior recall, which potentially implicates a source (reality) monitoring difficulty (see section 4.6).

Given the evidence for compromised memory functioning in schizophrenia (e.g., Moritz, Woodward, Cuttler, et al., 2004; Moritz, Woodward, & Rodriguez-Raecke, 2006; Stip, 1996a,b), the logical question to ask is, do such memory impairments manifest in those self-reporting elevated rates of psychosis-like cognitions? DRM task performance can be mediated by individual differences in the subclinical aspects of positive psychosis-like symptomatology as assessed by SRMs; for example, the proclivity for reporting delusional ideation and dissociative experiences (Dehon, Bastin, & Larøi, 2008), schizotypal personality traits (Dagnall & Parker, 2009), and paranormal experiences/beliefs (Wilson & French, 2006; see also, French & Wilson, 2006). Notwithstanding, the following sections shall evaluate false memory with respect to the *independent* contributors to the ANCOG factor.

4.3.2 False (illusory) memory and delusional ideation

Laws and Bhatt (2005) used the PDI when assessing memory functioning in 105 healthy individuals with regard to DRM performance. Participants were divided (median split) for PDI scores. Results revealed that, as compared to the low PDI group, the high PDI group recalled significantly more critical lures (F = 163.89, P < 0.0001) and nonpresented words (F = 10.82, P < 0.0001); conversely, the low PDI group recalled significantly more correct (previously presented) words (F = 5.57, P < 0.02). Laws and Bhatt's (2005) results suggest that individuals scoring low on the PDI display significantly greater recall by correctly recalling significantly more correct and fewer incorrect words. Moreover, the greatest level of statistical significance was for the recognition by the high PDI group of nonpresented critical lures.

In a recent study, Dehon et al. (2008) used a modified version of the DRM (Brédart, 2000; Dehon, 2006) and failed to fully replicate the results of Laws and Bhatt (2005). The authors found that delusional ideation was associated with increased false recall but not with true memory. The above findings are of great importance because they demonstrate that a subclinical feature of positive schizophrenia-like symptomatology can affect the memory functioning of ostensibly healthy individuals from the general population. Notwithstanding, positive schizotypy is defined by a broad range of symptoms, including ideas of reference, hallucinations, and magical ideation (Hurst, Nelson-Gray, Mitchell, et al., 2007; Raine et al., 1994; Yaralian et al., 2000).

4.3.3 False (illusory) memory and traumatic life events

The veridical nature of memories pertaining to alleged childhood abuse, are of particular concern (Ceci & Loftus, 1994; Lindsay & Read, 1994; Loftus, 1997; McNally, 2003; Spanos, 1996). Clancy, Schacter, McNally, et al. (2000) examined whether female participants reporting CSA were more prone to the DRM illusion: controls reporting no history of abuse and women reporting recovered, repressed, or ongoing memories of childhood sexual abuse (CSA) undertook the DRM test. The authors found that, relative to the other groups, women reporting recovered CSA more often recognised the critical lures suggesting that these women relied more on memory for gist than on verbatim memory traces (e.g., Brainerd & Reyna, 2006). A higher frequency of false recognition has also been found in women with continuous memories of CSA with associated PTSD as compared to women reporting continuous memories of CSA without any associated PTSD (Bremner, Shobe, & Kihlstrom, 2000). Zoellner, Foa, Brigidi, et al. (2000) found that victims of criminal assault with or without PTSD more often falsely recalled critical lures than did non-traumatised individuals. Taken as a whole, these results suggest that those individuals reporting memories of traumatic experiences may be more prone to memory aberrations as assessed by the DRM.

However, one criticism of applying the DRM paradigm to those reporting, for example, CSA, is that DRM items are not emotionally charged (Freyd & Gleaves, 1996). To this end, utilising the experimental strategy of Clancy et al. (2002), Geraerts, Smeets, Jelicic, et al. (2005) assessed 114 women reporting CSA (recovered memories = 23, repressed memories = 16, continuous memories = 55; no history of CSA = 20). Results revealed that women reporting recovered memories of CSA were more prone than the other groups in falsely recalling and recognising neutral words that were never presented ($t = 4.30$, $P < 0.001$ and $t = 3.17$, $P = 0.002$, respectively). However, when the words were emotionally charged (valenced) false recall was nonsignificant but false recognition remained statistically significant ($t = 0.84$, $P > 0.05$ and $t = 2.46$, $P = 0.015$, respectively). The results of Geraerts et al. (2005) confirm the findings of Pesta, Murphy, and Sanders (2001)—that emotionally valenced critical lures are misremembered but at a lower rate than neutral lures, possibly because of the emotional items' distinctiveness (Ochsner, 2000).

With regard to reports of abuse (trauma), significant associations between DRM performance and the DES, in general, have been reported (e.g. Candel, Merckelbach, & Kuijpers, 2003; Clancy et al., 2000; Dehon et al., 2008; Monds, Paterson, Kemp, et al., 2013). As such, it might be speculated that false memories that have an autobiographical or episodic signature may be related to dissociative experiences (Candel et al., 2003). See section 4.3.6 for a brief review of studies using the DES and DRM in normal populations.

4.3.4 False (illusory) memory and schizotypal personality traits

Previous research has revealed that schizotypy is linked to dysfunctional semantic memory, (e.g., Kiang & Kutas, 2005; Kiang et al., 2010)—although this may be task-specific rather than a global impairment (Morgan, Bedford, O'Regan, et al., 2009)—and associative processing (e.g., Lenzenweger, Miller, Maher, et al., 2007). More specifically, in a recent article, Dagnall and Parker (2009) assessed schizotypy with the SPQ-B in a sample of 80 undergraduate psychology students. The main aim of their study was to assess true and false memory in respect of the three dimensions of the SPQ-B (positive, negative, and disorganised). They found that participants scoring in the lower quartile range for the cognitive-perceptual (CP) subscale recognised a greater proportion of both true (previously presented) and false (not previously presented) words than participants scoring in the upper quartile range; participants scoring in the upper quartile range on the ID (negative) subscale recognised less true words than participants in the lower quartile range; no differences were found for overall schizotypy (SPQ-B total) or for the disorganised (DT) subscale[34]. These results suggest that false memories in normal individuals might be syndrome-specific; that is, related only to the positive and negative dimensions of psychometric schizotypy.

4.3.5 False (illusory) memory and transliminality

Transliminality has been found to correlate with everyday aberrations in memory (Dagnall, Munley, & Parker, 2008; Houran & Thalbourne, 2003), and as noted in Chapter 2 (section *2.1.2.6*) transliminality is a strong correlate of both positive schizotypy (Thalbourne et al., 2005; Thalbourne & Maltby, 2008) and dissociative experiences (Thalbourne, 1998). Hence, participants reporting elevated levels of transliminal traits may be expected to perform in a similar manner to positive schizotypals and those reporting high levels of dissociative experiences on a false memory task. Recruiting 60 participants and utilising the RTS, Robbins and Roe (2010) exposed participants to five genuine and five false Chinese characters during encoding and at test interspersed the ten encoding items with ten distractors (decoys). The authors found that transliminality was positively related to the recognition of presented items (r = 0.38, P = 0.003) but found no correlation between transliminality and decoy items (r = 0.14, P = 0.28). These findings indicate that a strong correlate of positive schizotypy and dissociative experiences is related to the endorsement of previously presented false items but is not related to the erroneous recognition of subsequent decoy items.

[34] Dagnall & Parker's (2009) study was complicated by including an assessment of list type (low mean backward associative strength [BAS] vs. high mean BAS) for the SPQ-B (total) and each of its dimensions; as such, only a brief summary (minus statistics) is explicated here.

4.3.6 False (illusory) memory and dissociative experiences

A link between false memory development and certain individual differences has also been documented in various “clinical” samples. For example, Peters, Horselenberg, Jelicic, et al. (2007) showed that people with previous-life memories (i.e., memories of highly unlikely events) reported elevated levels of dissociation. Clancy et al. (2000) found a significant correlation between performance on the DES and DRM false recognition in people reporting continuous and recovered memories of CSA. Also, Dehon et al. (2008) found that scores on the DES were positively associated with increased DRM false recall rates. In another study using a misinformation paradigm in undergraduate students, Hyman and Billings (1998) reported a positive association between false memories and dissociative experiences, and suggested that habitual dissociation may facilitate the acceptance of external information as self-defining, thereby increasing the likelihood to accept falsely suggested events as autobiographical memories. Using a variety of stimulus materials (e.g., video footage, slides), Giesbrecht and colleagues (e.g., Giesbrecht, Geraerts, & Merckelbach, 2007; Merckelbach, Zeles, van Bergen, et al., 2007) also showed that there is a robust connection between dissociative symptoms and false memories (i.e., memory commission errors) in undergraduates.

4.3.7 False (illusory) memory: Conclusion

The above corpus of knowledge suggests that each of the uniquely contributing components of the ANCOG factor possesses a distinct relationship with false (illusory) memory production.

4.3.8 Experimental hypotheses

Three experimental hypotheses will be explored with regard to false (illusory) memory:

9. A difference is predicted in true memory as measured by SDT (d') as a function of XPG (hypothesis 9).
10. A difference is predicted in the number of critical lures recognised as a function of XPG (hypothesis 10).
11. A difference is predicted in the number of new (not previously presented) words recognised as a function of XPG (hypothesis 11).

4.4 Probability reasoning/jumping to conclusions (JTC)

4.4.1 The concept of probability judgments

Human decision making (reasoning) ordinarily involves discriminating between several alternatives (Edwards, 1954), and is, as the title of a well-cited book proclaims, "Predictably irrational" (Ariely, 2008). But where do such (irrational) judgments come from? This question has been fiercely debated during the last five decades, with importance placed on 'judgment under uncertainty'. In the late 1960s the conclusion was that probability judgments are fairly accurate reflections of *extensional* properties of the environment such as frequencies (Peterson & Beach, 1967). This changed with the influential *heuristics and biases* program in the 1970s and 1980s, which emphasised that probability judgments are guided by *intensional* aspects such as similarity (Kahneman, Slovic, & Tversky, 1982; Tversky & Kahneman, 1974; Tversky & Kahneman, 1973, 1983). The 1990s saw a renewed interest in the idea that extensional properties are reflected in people's probability judgments as specified by the *ecological models* (Gigerenzer, Hoffrage, & Kleinbölting, 1991; Juslin, 1994). A third alternative combines intensional and extensional properties in an exemplar model to produce *similarity-graded probabilities* (Juslin & Persson, 2002). In exemplar models, decisions are made by comparing new objects with exemplars stored in memory. The *context model* (Medin & Schaffer, 1978) responds to both similarity (intensional property) and frequency (extensional property) in general, and to only one of these factors in predictable circumstances (Juslin & Persson, 2002). PROBEX (i.e., PROBabilities from EXemplars; Juslin & Persson, 2002) is a model of probability judgment based on the context model. With PROBEX, probability judgments are made by comparisons between the probe and retrieved exemplars. Inferences about target variables can be achieved by deliberate integration of probabilistic cues or by retrieving similar cue-patterns (exemplars) from memory (see, e.g., Byrne & Crawford, 2010). During tasks with cue information presented in on-screen displays, rule-based strategies tend to dominate unless the abstraction of cue-target relations is unfeasible (Bröder, Newell, & Platzer, 2010). This dominance has also been demonstrated in experiments that demanded the retrieval of cue values from memory (Persson & Rieskamp, 2009).

4.4.2 Heuristics

According to the representativeness heuristic, people judge the probability that an object or event belongs to a category on the basis of the degree to which it is representative of the category, or reflects salient features of the process that generated it (Kahneman et al., 1982; see also, Hilbert, 2012). Research on subjective probability judgment has been characterised by a normative stance, where judgments are compared to norms from probability theory (Fishburn, 2001). Cognitive theory has primarily been evoked to provide post hoc explanations, as in most applications of the representativeness heuristic, or as frameworks for more general predictions, as in the applications of cue-based relative frequency. Previous evidence provides clear support for the hypothesis of a similarity-graded probability (e.g., Juslin & Persson, 2002; Nilsson, Olsson, & Juslin, 2005). That an exemplar model is successful may not appear surprising considering the impressive performance of exemplar models in categorisation studies (Nosofsky & Johansen, 2000). Yet the results are at variance with crucial ideas in judgment research, such as the notion of a representativeness heuristic (Kahneman et al., 1982) or cue-based relative frequency (Gigerenzer et al., 1991; Juslin, 1994).

The idea that probability judgments derive from cue-based relative frequency is represented by Probabilistic Mental Model theory (PMM-theory; Gigerenzer et al., 1991; see, Juslin, 1994, for similar ideas). These ideas have been used to scaffold global predictions in studies of the realism of confidence. A subjective probability judgment is a reflection of the validity of the cue with the highest cue-validity that is present in the event or object being judged. This strategy is known as *Take The Best* meaning that the individual relies on the cue with the highest validity (Gigerenzer, 2004; Gigerenzer, Todd, & the ABC Research Group, 1999). Despite Gigerenzer's (1991) claim that "heuristics are meant to explain what does not exist" (p. 102), in reply, Kahneman and Tversky (1996) assert that any theory of decision making (judgment) must encapsulate—that is, not exclude—those variables (e.g., motivation) that make the nature of human judgment exactly what it is: subjective. As such, equating human reasoning to mathematically-based (computational) norms may be a futile exercise (Vranas, 2000; Wang, 1996). Alternatively, heuristics may serve as a starting point in human decision making (judgment) allowing for the rapid assessment of relevant factors leading to a logical conclusion, rather than being the sole basis for illogical (intuitive?) reasoning (Moshman, 2004; see also, Krynski & Tenenbaum, 2007).

4.4.3 Probability reasoning/JTC and the BT

The BT (and variants, thereof) have been posited as being sensitive to the cognitive mechanisms underlying schizophrenia spectrum disorders (Woodward, Munz, LeClerc, et al., 2009). The JTC bias involves gathering limited information to reach overconfident probability decisions (McKay, Langdon, Coltheart, 2006), and is proposed to be integral in the maladaptive appraisals of psychotic experiences (Garety, Freeman, Jolley, et al., 2011). Starting with the research of Garety and co-workers (e.g., Garety, Hemsley, & Wessely, 1991; Hemsley & Garety, 1986; Huq, Garety, & Hemsley, 1988), who stimulated cognitive research into schizophrenia with a view to refining cognitive-behavioural therapy intervention in this population, an extensive literature has investigated decision-making in schizophrenia; especially, the tendency to JTC (reviews: Fine, Gardner, Craigie, et al., 2007; Garety & Freemen, 1999; Glöckner & Moritz, 2009). In this reasoning task, it has been observed that 40–70% of individuals with schizophrenia gather scant information before arriving at a definite conclusion (e.g., Dudley, John, Young, et al., 1997a,b; Dudley & Over, 2003; Fear & Healy, 1997; Moritz & Woodward, 2005; Van Dael, Versmissen, Janssen, et al., 2006). This response pattern, termed JTC, may not come as a surprise, as individuals with schizophrenia often take far-fetched cues or coincidences as confirmatory evidence (Lindner, Their, Kircher, et al., 2005; Tschacher & Kupper, 2006) without mindful recourse to alternative hypotheses (Speechley, Whitman, & Woodward, 2010). JTC is thought to play an important role in the formation and maintenance of schizophrenia (Moritz, Veckenstedt, Randjbar, et al., 2009) and is not a mere epiphenomenon of delusions (Lincoln, Ziegler, Mehl, et al., 2010; Peters, Thornton, Siksou, et al., 2008). This is supported by the fact that a JTC bias also occurs in participants with psychosis-prone symptoms such as attenuated delusional ideation (Colbert & Peters, 2002; LaRocco & Warman, 2009; Linney, Peters, & Ayton, 1998; Moritz & Woodward, 2005; Van Dael et al., 2006; Warman & Martin, 2006) and subclinical paranoid ideation (Freeman, Pugh, & Garety, 2008).

The longitudinal course of JTC is not yet clearly understood. It seems that JTC is most pronounced in active paranoia (Lincoln, Lange, Burau, et al, 2010; see also, Moutoussis, Bentall, El-Deredy, et al., 2011), but even remitted patients show this response pattern (Moritz & Woodward, 2005; Peters & Garety, 2006). Moreover, recent studies have found that patients do not only collect less information but also weigh information inadequately (Averbeck, Evans, Chouhan, et al., 2011; Glöckner & Moritz, 2009; Moritz & Woodward, 2006b; Moritz, Woodward, Jelinek, et al., 2008). Other research findings suggest that patients adopt liberal criteria for a decision (Moritz & Woodward, 2004; Moritz, Woodward, & Hausmann, 2006; Moritz, Woodward, & Lambert, 2007). To illustrate, in psychological statistics, a decision is considered justified when the probability reaches 95%. There is still a 5% chance that the decision is wrong, but this is considered an acceptable level of risk. Cognitive research confirms that humans are not very good with probabilities (Evans, Over, & Manktelow, 1993; Manktelow, 1999; Oaksford & Chater, 2001). In our everyday life, we rarely ask ourselves if our judgments have reached the 95% probability level. Under laboratory conditions, however, healthy people were found to be more conservative in their judgments than individuals with schizophrenia: a probability level of 54% was sufficient for the average schizophrenia patient to endorse a response option, while healthy subjects needed at least 70% probability to be convinced (Moritz et al., 2006; cf., Mellet, Houdé, Brazo, et al., 2006). Interestingly, evidence suggests that individuals with schizophrenia are largely unaware of their hastiness and often view themselves as rather hesitant and indecisive (Freeman, Garety, Kuipers, et al., 2006).

4.4.4 Probability reasoning/JTC and subclinical PLEs

Certain personality traits (e.g., individual differences in delusion proneness) have been shown to present a relationship with reasoning styles similar to those exhibited by deluded patients (Bensi, Giusberti, Nori, et al., 2010; Moritz & Woodward, 2006a; Zawadzki, Woodward, Sokolowski, et al., 2012), which refer to a potentially maladaptive data gathering strategy (Garety et al., 1991; Huq et al., 1988; Menon, Quilty, Zawadzki, et al., 2013). Such dysfunctional interpretations have undoubted repercussions with regard to social functioning (Blackwood, Howard, Bentall, et al., 2001). That is, the concept of a *perceived reality* arising from individual's ability to adaptively integrate the flood of perceptual data that bombards the physical senses affording intersubjective communication within a shared reality is of cardinal importance (Echterhoff, Higgins, & Levine, 2009; Hardin & Conley, 2001; Hardin & Higgins, 1996). When such a capacity becomes dysfunctional an individual's reasoning style becomes out of kilter with perceived (i.e., socially-recognised) reality and clinically-relevant delusional misinterpretations may necessarily arise (Langdon, Ward, & Coltheart, 2010).

For example, Freeman et al. (2008) found that participants (total N = 200) scoring high for perceptual anomalies as indexed by the CAPS (Bell et al., 2006a) and paranoid ideation as indexed by the Green-Paranoid Thoughts Scale (G-PTS; Green, Freeman, Kuipers, et al., 2008) presented a JTC bias by requesting two or less additional beads (N = 40; 20%). JTC resulted in significantly more errors on the task—45% as compared to 16% deciding that the beads were being drawn from the wrong jar (χ^2 = 16.36, df = 1, P < 0.001). For the purposes of this research, responses to BT stimuli will not be analysed with regard to whether the correct jar is chosen but will be based purely on prescribed percentage judgments (GE; probabilistic reasoning) and the number of beads required when formulating a final decision (DTC).

However, it has been found that hypothetically delusion-prone individuals from the general population (N = 30) did not differ from non-delusion-prone individuals (N = 30) based on a median split of PDI (Peters et al., 1999) scores on the BT (JTC) (Warman, Lysaker, Martin, et al., 2007). Following Dudley et al. (1997a), this nonsignificance was not replicated for salient self-referent material (personality characteristics). It was however found that individuals with delusions (N = 37) and delusion-prone individuals were more confident in their decisions than non-delusion-prone individuals (P = 0.02) (Warman et al., 2007). These results suggest that self-referent material might impact upon information processing in both delusional and delusion-prone groups.

Lawrence and Peters (2004) assessed reasoning in 174 individuals from the Society for Psychical Research who expressed belief or disbelief in the paranormal. Participants completed a deductive reasoning task (evaluating statements manipulated for congruency with paranormal belief) and completed the PDI. It was revealed that those individuals reporting a strong paranormal belief made more errors and displayed more delusional ideation than their sceptical counterparts. However, no significant differences were found when statements were congruent with an individual's belief system, suggesting that reasoning abnormalities may play a causal role in formation of unusual beliefs. In a prior study, Colbert and Peters (2002) also utilising the PDI: the authors found that delusion-prone individuals significantly differed in data gathering (JTC) but not with regard to probability reasoning (GE), which suggests, as before, that JTC might be involved in the formation, rather than the maintenance, of delusional ideation.

4.4.5 Probability reasoning/JTC: Conclusion

The evidence reviewed above is suggestive of probability reasoning deficits extending beyond those with a clinically-defined psychotic disorder into the ostensibly healthy population[35]. Further, such reasoning biases have been routinely identified in those individuals scoring high for psychometric schizotypy and its correlates (e.g., subclinical delusional and paranoid ideation, paranormal belief, anomalous perceptions).

4.4.6 Expounding an experimental protocol for this study

Based on the evidence reviewed above, individuals make realworld judgments (inferences) regarding the probability (likelihood) of an occurrence or event based on prior knowledge, and that this prior knowledge—conceptualised in terms of frequencies, similarity, heuristics, etc.—can mould judgments based on its relative strength and goal-specific application. As such, how can we best capture such reasoning (decision making) in an experimental setting? Phillips and Edwards (1966) sought to capture such cognitions by developing a paradigm to examine judgments under conditions of uncertainty (cf., Kahneman et al., 1982), based on a Bayesian model of probabilistic reasoning (Bayes, 1763). In its simplest form, the so-called BT involves making a judgment (probability and/or final decision) based upon a series of coloured beads that are drawn from one of two jars containing opposing numbers of coloured beads (e.g., RED/BLACK, 85:15/15:85).

There are two aspects of reasoning/decision making that can be appropriately investigated with the BT: 1) probability reasoning (GE); and 2) JTC. GE will be assessed by asking participants to make confidence judgments against a series of 20 beads with regard to three jar ratios (85:15, 70:30, and 55:45); and JTC (DTC) will again be assessed with the same three ratios of beads. It is proposed that, as the DVs clearly overlap, each BT variable (GE and DTC) will be considered under one experimental hypothesis each, delineated as variant a, b, or c, respectively.

[35] It is worth noting that because members of the general (nonclinical) population have been shown to be less than optimal at probability reasoning, such biases, if found, may not be as a direct consequence of subclinical PLEs.

4.4.7 Experimental hypotheses

Two experimental hypotheses will be explored with regard to the BT:

12. A difference is predicted in probability reasoning for the three GE variants as a function of XPG (hypothesis 12a,b,c).
13. A difference is predicted in probability reasoning for the three DTC variants as a function of XPG (hypothesis 13a,b,c).

4.5 Object recognition (OR)

4.5.1 OR and perceptual closure (PC)

OR is a fundamental if highly complex (and as yet poorly understood) human capability (Farber & Petrenko, 2008; Logothetis & Sheinberg, 1996; Palmeri & Gauthier, 2004). One of the most remarkable features of human visual perception is the visual system's ability to "fill in" (complete) an image from limited visual information (Grützner, Uhlhaas, Genc, et al., 2010; Murray, Imber, Javitt, et al., 2006; Rensink & Enns, 1998). For example, we can easily recognise our favourite cup in a cupboard full of others, and we can decipher training shoes from work shoes, ping-pong balls from golf balls, etc., all with apparent ease (Riesenhuber & Poggio, 2000). To this end, it has been contested that it is often the case that only partial or degraded views of an object are ever available yet recognition is still accomplished with apparent ease (Doniger, Foxe, Schroeder et al., 2001). This ability to 'fill-in' an object from limited visual information is referred to as *perceptual closure* (PC), which specifically refers to the neurocognitive processes involved with filling in missing information from an image under adverse viewing conditions (e.g., fragmentation, blurring, occlusion) (Sehatpour, Zemon, Molholm, et al., 2005); more generally, PC is a process whereby an incomplete image is perceived as being complete (Snodgrass & Kinjo, 1998).

Ordinarily, neurocognitive accounts of OR focus on processes at the moment of identification, when individuals can *name* what they see (Viggiano & Kutas, 1998). This range of recognition abilities (e.g., identification and subsequent naming) suggests that visual OR may be dependent on more than a unitary process (Peissig & Tarr, 2007). A potential complication with regard to this OR investigation is that it has been suggested that coloured images, especially those containing high colour diagnosticity (e.g., banana) (Therriault, Yaxley, & Zwaan, 2009; cf., Tanaka & Presnell, 1999; Wurm, Legge, Isenberg, et al., 1993) are more easily recognised (e.g., Reis, Faísca, Ingvar, et al., 2006). However, contrary evidence indicates that colour aids naming, but not recognition (e.g., Mapelli & Behrmann, 1997; Ostergaard & Davidoff, 1985). Notwithstanding, this OR task is primarily concerned with OR in its most basic form; that is, the recognition of fragmented black-and-white line drawings.

4.5.2 OR and schizotypy

A variety of visual deficits are observed in high scoring schizotypals, e.g. disturbances in early visual processing (Koychev, El-Deredy, Haenschel, et al., 2010), visual context processing (Uhlhaas, Silverstein, Phillips, et al., 2004), and visual marking (Mason, Booth, & Olivers, 2004; Richardson & Gruzelier, 1994). However, although face and facial affect recognition ability (e.g., Abbott & Green, 2013; Poreh, Whitman, Weber, et al., 1994; Williams, Henry, & Green, 2007) and 'self-face' recognition ability (e.g., Irani, Platek, Panyavin, et al., 2006; Larøi, D'Argembeau, Brédart, et al., 2007; Platek & Gallup, 2002) have been previously studied with respect to schizotypy, studies into visual OR ability, after an extensive literature search, appear to be nonexistent[36]. In lieu of any relevant literature regarding OR ability in psychometric schizotypy, focus will be put upon two theoretically associated constructs: firstly, a study utilising degraded photographs of objects in a group of undergraduate students (Blackmore & Moore, 1994), which assessed OR ability in light of paranormal belief, an integral component of positive schizotypy and anomalous cognitions, per se (Fox & Williams, 2000; Kennedy & Kanthamani, 1995; Wolfradt, et al., 1999); and secondly, with respect to a series of studies that utilised degraded (fragmented) black-and-white line drawings in individuals with chronic schizophrenia (Doniger, Foxe, Murray, et al., 2002; Doniger, Silipo, Rabinowicz, et al., 2001).

4.5.3 OR and paranormal belief

It has been previously found that believers in the paranormal are more likely to detect meaningful patterns in visual noise where non in fact exist (Brugger & Taylor, 2003). To this end, the study of Blackmore and Moore (1994) assessed OR ability utilising a series of 12 black-and-white fragmented pictures (e.g., sheep in a field). The dimensions of each image measured 183 by 122 pixels, and images were presented for durations of 25msecs via a tachistoscope. For each level of image presentation, participants were required to say if they could recognise an object in the noise and, if so, to say what it was (free choice). Between image presentations a background slide of black-and-white noise was presented. Stimuli became sequentially more discernible by the reduction of computer-

[36] One study was found that utilised fragmented black-and-white line drawings and employed the SPQ in a wider study which aimed at identifying a bias against disconfirmatory evidence (BADE) with regard to psychometric schizotypy (Orones et al., 2009). The sample of college students were split with regard to schizotypy scores (low *N* = 27 and high *N* = 30); following Blackmore and Moore (1994) and Doniger et al. (2002, 2001) no significant difference was found in the mean percent of images required to make correct recognitions.

generated random noise (70%, 50%, 20%, and 0%; providing visible perceptual data for 30%, 50%, 80%, and 100% of images, respectively). A significant result was revealed between the Paranormal Belief Scale (PBS; Jones, Russell, & Nickel, 1977) and the 50% level of images presentation (r = 0.55, $P < 0.01$, 2-tailed). The authors concluded that because believers in the paranormal are more likely to perceive objects, forms, or shapes in random noise (see also, Gianotti, Mohr, Pizzagalli, et al., 2001), that they may do so in other (more natural) settings. For example, they may believe that they have seen (experienced) a ghost or apparition during suboptimal viewing conditions (e.g., in the absence of adequate lighting, or in the peripheral vision). Furthermore, a tendency was found for believers in the paranormal to report a greater number of identifications (recognitions) and for those recognitions to be incorrect (see also, Blackmore, Galaud, & Walker, 1994). Blackmore and Moore's (1994) results suggest that individuals who report paranormal beliefs may adopt a "laxer criterion" (p. 95), i.e. paranormal believers require less evidence to formulate a conclusion when extracting perceptual data (information) from noise (see also, Bressan, 2002).

4.5.4 OR and schizophrenia

Disturbances of visual processing are a feature of individuals with schizophrenia (e.g., Kantrowitz, Butler, Schecter, et al., 2009; Kim, Zemon, Saperstein, et al., 2005; Yang, Tadin, Glasser, et al., 2013; review: Uhlhaas & Silverstein, 2005), including difficulties with PC (Snyder, 1961) and have been suggested to propagate higher-order cognitive biases such as JTC (Moritz & Woodward, 2006a). A series of experiments conducted by Doniger and colleagues (2002, 2001; see also, Cavezian, Danckert, Lerond, et al., 2007; Gabrovska, Laws, Sinclair, et al., 2002) assessed OR in individuals with chronic schizophrenia and utilised fragmented black-and-white line drawings drawn from the norm-referenced object bank of Snodgrass and Corwin (1988). 26 chronic schizophrenics were compared with 23 non-psychiatric controls. Stimuli consisted of 18 black-and-white line drawings presented in accordance with the ascending method of limits (ASTM; 1979)—that is, images were presented from the 'least' to the 'most' clear (recognisable)—and involved eight levels (degrees of degradation) of images. The dimensions of each image measured 246 by 246 pixels (8.3cm by 8.3cms). Images were presented for 750msecs followed by a blank screen for 1250msecs, and then the next image would be presented. Participants were required to perform a button press when they recognised an image (free recall) otherwise the test would automatically proceed to the next image. Results revealed that individuals with chronic schizophrenia, as compared to non-psychiatric controls, showed significant impairment in the ability to correctly recognise degraded, fragmented line drawings (F = 16.9 $P < 0.001$, 2-tailed). These results were obtained at the exact point at which identification was made (i.e., initial correct recognition). Further, the OR results found no significant differences in the early (1 and 2) or late (6, 7, and 8) levels of images presentation. The significant differences manifested around the mid range (levels 3, 4, and 5) of images presentation. Unfortunately, Doniger et al. (2002) do not provide any percentage details relating to the levels of images presentation, they refer readers to Snodgrass and Corwin (1988).

Doniger and colleagues also applied repetition priming (pre-exposure to the objects) and word prompting paradigms in their 2001 study. After completing these higher-order tasks individuals with schizophrenia's OR performance reached a nonsignificant (comparable) level to that of nonpatient controls. The authors concluded that schizophrenic patients evinced dysfunctional information processing at the sensory level (visual OR) but because this effect disappeared after pre-exposure to the objects or valid word prompts, suggested a dissociation in OR ability in which the sensory OR system (bottom-up) is disengaged from the effects of higher-order (top-down) cognitive processes (see also, Javitt, 2009).

Following, for example, Doniger et al (2001) this research will employ the experimental protocol of Gollin (1960) during which fragmented black-and-white line drawings are presented according to the ascending method of limits. Furthermore, participant confidence in recognitions will be inputted on an 11-point linear scale (0–100%, multiples of ten) as individuals "use confidence to gauge the accuracy of their own recollections" (Chandler, 1994, p. 280).

4.5.5 Experimental hypotheses

Three experimental hypotheses will be explored with regard to OR ability:

14. A difference is predicted in the number of NCRs as a function of XPG (hypothesis 14).
15. A difference is predicted in the point (mean % of images required) to make an Initial recognition as a function of XPG (hypothesis 15).
16. A difference is predicted in confidence when uncertain ($Conf_{50:50}$) as a function of XPG (hypothesis 16).

4.6 Reality Monitoring (RM)

4.6.1 The concept of RM

RM refers to the discrimination of the origin of psychophysiological information (Bayen, Murnane, & Erdfelder, 1996; Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981; Simons, Henson, Gilbert, et al., 2008). Discrimination between what is *perceived* (a physiological process) and what is *imagined* (the mental invocation of a previously encountered percept) indicates that these are two discrete cognitive processes. However, such conceptual simplicity implies that what is perceived is in some manner correct and what is imagined is therefore a mirror-image and as such immune to misinterpretation. Such reasoning is flawed (Reed, 1988). The interaction for any given stimuli between what is perceived and what is subsequently imagined as a result of the perceptual experience is a highly complex process involving, amongst other things, prior experiences, expectations, and current mood (affect) (Bentall, 1990a,b; Brébion, David, Jones, et al., 2005; Haddock, Slade, & Bentall, 1995; Johnson, Bush, & Mitchell, 1998; Larøi & Woodward, 2007).

4.6.2 RM and schizophrenia

RM is well documented as being impaired in individuals with schizophrenia (e.g., Anselmetti, Cavallaro, Bechi, et al., 2008; Baker & Morrison, 1998; Bentall, 1990a,b; Johnson, Foley, Suengas, et al., 1988; Morrison & Haddock, 1997; Startup, Startup, & Sedgman, 2008). The source (reality) monitoring deficits found in individuals with schizophrenia reflect the misattribution of self-generated items to outside sources (Bentall, 1990a,b; Bentall, Baker, & Havers, 1991; Brébion, Amador, David, et al., 2000; Brébion, Gorman, Amador, et al., 2002; Vinogradov, Willis-Shore, Poole, et al., 1997). Numerous relationships between source monitoring and clinical and psychopathological variables have been reported. For example, the presence of positive symptoms such as thought disorder (Harvey, 1985; Nienow & Docherty, 2004), confabulation (Nathaniel-James & Frith, 1996), delusions and hallucinations (Brébion, Amador, David, et al., 1997; Brébion, Amador, David, et al., 1998), and symptoms of alien control (Keefe, Arnold, Bayen, et al., 1999; Keefe, Arnold, Bayen, et al., 2002). Keefe et al. (2002) using multinomial modelling revealed a failure of the recognition of internal stimuli, which was stronger in individuals with schizophrenia as compared to controls; however, main contributions were from patients presenting Schneiderian First Rank Symptoms (FRS; Schneider, 1959).

Moreover, numerous studies have attempted to understand if this bias is due to a general cognitive deficit or if it reflects a distinct neuropsychological impairment. Johnson et al. (1993) provided initial evidence suggesting that reality (source) monitoring impairment might be due to a lack of control over thoughts that produce weak information regarding context, inasmuch as such thoughts might be easily confused with external stimuli. This so-called *autonoetic* model becomes all the more intriguing if we consider neuropsychological models of delusion formation. Frith and co-workers (e.g., Frith, 1992, 2005; Frith et al., 2000a,b) proposed that symptoms such as delusions and thought interference are the consequence of a failure of a system within which individuals monitor intended actions allowing the distinction between internally-generated (willed) and externally-generated (elicited) actions (Frith & Done, 1989; Mlakar, Jensterle, & Frith, 1994; see also Chapter 3, section 3.1.3). On this account, individuals with schizophrenia encounter problems with tasks involving the continual monitoring of action (Blakemore, Wolpert, & Frith, 2002; Duprati, Franck, Georgieff, et al., 1997; Johns, Rossell, Frith, et al., 2001; Stirling, Hellewell, & Qurashi, 1998). However, the above conclusions have been reached with regard to *perceptual* processes not involving *memory* processes, which have been suggested to be a major component of source (reality) monitoring for previous events (Anselmetti et al., 2008). Following Johnson and colleagues (e.g., Johnson, 1988, 2006; Johnson et al., 1993) the majority of RM decisions are arrived at rapidly and unconsciously—using memory processes—but when perceptual and contextual information is weak the judgment regarding the origin of a memory is subject to higher-order reasoning processes expected to involve executive functions (Anselmetti et al., 2008). As such, a reality (source) monitoring deficit may occur when traces of external events are weak due to diminished memory processes, or when judgment processes are disrupted such that less evidence will be required to attribute internally-generated information to an external source (Ferchiou, Schürhoff, Bulzacka, et al., 2010; Johnson & Raye, 1998; Johnson, Raye, Wang, et al., 1979; Mitchell & Johnson, 2000; see also section 4.4.2). Within the context of this thesis, deficits in RM, in individuals with schizophrenia, have been associated with social dysfunction indicating that negative, as opposed to positive and/or disorganised symptomatology may play a greater role in the generation of RM biases in clinical groups (Divilbiss, McCleery, Aakre, et al., 2011).

4.6.3 RM and psychosis-proneness (schizotypy)

Although reality (source) monitoring deficits are routinely reported in the schizophrenia literature, it is pertinent to ask whether such deficits are also indicative of high, albeit nonclinical, levels of schizotypal traits. Larøi, Collignon, and Van der Linden (2005) reported that individuals scoring high for hallucinatory experiences as measured by the LSHS (Launay & Slade, 1981) were more prone to source misattributions. This study was a first indication that schizotypal traits might lead to a perturbation in the control of internally generated cognitive events and hence could inform theories regarding how people make accurate RM decisions (Johnson et al., 1993). Various studies have now indicated a relationship between elevated positive schizotypal personality traits (sc., hallucinations; e.g., Aleman, Nieuwenstein, Böcker, et al., 2000) and its correlates, e.g. paranormal beliefs (Irwin, 2003, 2004) and RM dysfunction (e.g., Lagioia, Eliez, Schneider, et al., 2011).

The study of Aleman et al. (2000) found that college students scoring high for vividness of visual imagery were also high scorers on the LSHS, however smaller differences were revealed on imagery and perception tasks. In their study, participants were requested to discriminate between 44 previously encoded items: 22 triads of line drawings (objects) and 22 written object names. In the triad (perceptual) condition the item that was most deviant (visual form) had to be indicated. After completion of the recognition phase a perceptual-difference score was calculated by subtracting correct responses in the imagery condition (words) from the perceptual condition (pictures). Results revealed a significant mean difference between low- and high-scores on the LSHS (M = 2.5 and 0.8, respectively)—$F[1, 34] = 7.0$, $P < 0.05$. The results were also analysed in terms of the vividness of visual imagery, which was found to possess a significant relationship with object imagery vividness ($r = 0.64$, $P < 01$). The authors concluded that although the vividness of visual imagery as assessed by the VVIQ (Marks, 1973) may be associated with subclinical hallucinatory experiences, the cognitive processes associated with RM rather than the perceptual characteristics of mental imagery might play a role at the level of information processing.

A recent study by Peters, Smeets, Giesbrecht, et al. (2007) sought to address whether schizotypal traits might underlie RM deficits (confusing action and imagination): 67 undergraduate students were enrolled into the study, which involved discriminating between *performed* and *imagined* actions, i.e. participants had to perform certain movements (e.g., "break a toothpick into three pieces") or imagine that they had performed the same action; the reality (source) monitoring component was tested 24hrs later. Participants completed the STA as an index of positive schizotypy. STA scores were negatively related to correct source attributions ($r = -0.36$, $P < 0.01$), indicating that higher STA scores were related to lower source (reality) monitoring decisions. Additionally, two subgroups were formed based on their STA scores (Low STA ≤ 25th percentile, $N = 17$ and High STA ≥ 75th percentile, $N = 17$). Subsequent analyses revealed that the low STA group outperformed the high STA group with regard to correct recognition ($t = 2.60$, $P < 0.01$) and correct source attribution ($t = 3.46$, $P < 0.01$). Furthermore, participants in the high STA group made more misses ($t = 2.20$, $P < 0.05$) and false alarms ($t = 2.08$, $P < 0.05$), indicating decreased discrimination accuracy.

Utilising a degraded auditory paradigm, previous research (Barkus, Stirling, Hopkins, et al., 2007) found that participants scoring high for positive schizotypal traits ($N = 30$) as indexed by the UnEx dimension of the O-LIFE and the LSHS were significantly more likely than low- ($N = 15$) or mid-scoring ($N = 18$) participants to report hearing a voice when none was present ($P < 0.03$). The authors concluded that the misattribution of auditory stimuli (response bias) in normal subjects is a process similar in cerebral function to that found in individuals with schizophrenia.

Taken together the above corpus of knowledge suggests that source (reality) monitoring deficits indicative of individuals with schizophrenia are also present in individuals scoring highly on measures of positive schizotypal personality traits.

4.6.4 An RM paradigm for the current study

Since both memory and executive function are known to be disrupted in individuals with schizophrenia (Green, 1996; Schillerstrom, 2002), a paradigm that involves the analysis of memory (attribution) and discrimination (recognition) will be beneficial in studying the differential contributions of these two basic components of reality (source) monitoring. Both aspects of the RM paradigm will be analysed in terms of SDT (see, DeCarlo, 2003, for an illustration of the application of SDT to source monitoring paradigms). The RM paradigm for the CCTB is based on a previous neuropsychological methodology, which assessed RM in visually hallucinating and non-hallucinating individuals with Parkinson's disease (Barnes, Boubert, Harris, et al., 2003).

4.6.5 Experimental hypotheses

Three experimental hypotheses will be explored with regard to RM:

17. A difference is predicted in RM 'Memory' as a function of XPG (hypothesis 17).
18. A difference is predicted in RM 'Mode' as a function of XPG (hypothesis 18).
19. Due to the undoubted impact of the vividness of visual imagery on RM performance (see section 4.8.5), it is predicted that when analysing variations in RM 'Mode' scores (linear regression) that the VVIQ (Marks, 1973) will account for the greatest proportion of variations (hypothesis 19).

4.7 Self-monitoring (SM)

4.7.1 The concept of SM

SM is a specific type of source monitoring, namely the capacity to identify the *consequences* of self-generated items from those that are externally generated (Knoblich, Stottmeister, & Kircher, 2004). The hypothesis that alterations in SM underlie the positive symptoms of psychosis has been expounded by different authors (e.g., Frith, 1992; Johns et al., 2001): one prominent theory asserts that SM in healthy subjects is based on a central process that determines deviations between the *predicted* and *observed* consequences of physical or mental actions (e.g., Blakemore & Frith, 2003; Frith et al., 2000a,b). When predicted and observed outcomes match, the observed consequences are experienced as self-generated. Other authors have postulated that SM is normally based on a direct comparison between the intention underlying an action and its observed outcome (Fourneret, Franck, Slachevsky, et al., 2001; Franck, Farrer, Georgieff, et al., 2001; Jeannerod, 1999; Jeannerod, Farrer, Franck, et al., 2003). To this end, human beings are unique in their ability to reflect upon their own performance, for example, when we are told that our abilities are being evaluated (Bengtsson, Lau, & Passingham, 2009). The ability to consciously self-monitor and remember errors has additionally been theorised to be mediated by increases in both age and IQ (Rabbitt, 1990).

4.7.2 SM and schizophrenia

SM errors in schizophrenia have been linked to Schneiderian FRS, including delusions of control and thought insertion, and such cognitive biases may be linked to the conscious monitoring of individual's own actions in the absence of visual feedback (Fourneret et al., 2001). In support of this line of argument it has been posited that schizophrenic patients possess an intact *automatic* level, which provides an immediate signal for controlling and adapting actions (including learning) to a desired goal state; however, profound impairment is located in the *conscious* level, which provides information regarding the intentions, plans, and desires of the individual. Investigation of the schizophrenic process has suggested these two levels are dissociated from one another: whereas the self-identification (automatic level) has been found to be functional in this patient group, the SOA (conscious level) has been found to be profoundly impaired (Jeannerod, 2009). Furthermore, failures in SM in the context of personality disorders have been linked to biased mindreading and the worsening of self-regulation (Dimaggio, Nicolò, Popolo, et al., 2006). Moreover, despite different processes mediating mindreading and SM, it has been proposed that individuals can glean insight from tasks where they are explicitly required to monitor their own learning (and actions) and that this insight can be transferred to the learning of others, thus facilitating a shift from experience-based to theory-based judgments (Koriat & Ackerman, 2010). Such an explanation incurs, by necessity, an increased load on aspects of WM; however, performance on visual search tasks[37] with varying perceptual loads has been shown to be independent of WM effects (e.g., He & McCarley, 2010).

4.7.3 SM and psychosis-proneness (schizotypy)

As already reviewed in Chapter 3 (section 3.1.4) high scoring positive schizotypals have been found to be significantly impaired at monitoring the errors associated with their own actions on a SOA task (e.g., Asai et al., 2008). A study conducted by Versmissen, Myin-Germeys, Janssen, et al. (2007) sought to identify if individuals at psychometric high-risk (N = 40) displayed SM deficits comparable to individuals with a lifetime history of non-affective psychosis (N = 37), a genetically-defined risk group (N = 41), and a control group (N = 49). The authors employed an action-recognition test first utilised by Franck et al. (2001), during which participants must navigate with the use of a joystick mirror images generated from an upside-down computer screen. An image of a virtual hand was presented in the mirror, superimposed on the participants own hand. Such a procedure allowed participants to move the joystick, while being exclusively exposed to the virtual hand, moving analogously to their own. Participants had to decide whether the movements they saw on screen were exact replications of their own movements. Multilevel random effects modelling

[37] The SM test for this CCTB involves continual visual search (see Chapter 5, section *5.2.7.2*).

revealed that the association between committing an error on the action-monitoring task was significantly associated with the ascending level of psychosis risk (Odds Ratio linear trend over 3 levels = 1.13, 95% CI 1.00–1.26). Versmissen, Myin-Germeys, et al. (2007) concluded that in individuals at psychometrically-defined risk for psychosis[38], SM deficits may be expressed as increased failures to recognise self-generated actions. However, a study conducted by the same research group (Versmissen, Janssen, Johns, et al., 2007) found no evidence for deficits in SM, irrespective of level of risk for psychosis, utilising a verbal SM paradigm. The latter finding suggests that sensory modality may play an important role in SM biases (Kapralos, Hogue, Kopinska, et al., 2009). Indeed, evidence has found that auditory stimuli (objects) are more rapidly detected and readily processed than visual stimuli (e.g., Cowan, Saults, & Brown, 2004; Fort, Deipeuch, Pernier, et al., 2002), which may go some way to explaining the sensory modality discrepancies of Versmissen, Janssen, et al. (2007).

4.7.4 Developing an experimental protocol

The experimental protocol is based on a series of experiments conducted by Stirling et al. (1998) who "loosely" (p. 677) derived their four SM tests based on procedures described by Garrud, Lucas, and Harrison (1989). The SM procedure employed for this research, again, *loosely* followed Stirling et al.'s Test 1B (left-right test; error correction) during which geometric shapes were presented to participants to the left (or right) of the centre on a computer screen. Participants had to respond with either a left or right click of the mouse according to test parameters.

4.7.5 Experimental hypothesis

One experimental hypothesis will be explored with regard to SM performance:

20. A difference is predicted in the proportion of errors corrected (PEC) as a function of XPG (hypothesis 20).

4.8 Accompanying SRMs to assess for variations in Phase 2 CCTB performance

Utilising "schizophrenia", "psychosis", "schizotypy", "anomalous experiences", "cognition", "comorbid", "questionnaire", "psychopathology", "covariance", and "neuropsychology" as guiding search terms, articles were electronically-sourced from the years 1980–2008 via PubMed and

[38] Versmissen et al. (2007) employed the Community Assessment of Psychic Experiences (CAPE; Hanssen, Peeters, Krabbendam, et al., 2003) to assess PLEs at the community (nonclinical) level.

PsycINFO. Five areas of psychological functioning were highlighted, which may have an impact on cognitive test performance, and as such require controlling for; these are: 1) emotional support; 2) recreational (substance) drug use; 3) comorbid psychopathology (including depressive- and anxiety-related symptomatology); 4) apathy; and 5) visual mental imagery. Of the five areas to be assessed, three (measures 3–5) possessed psychometrically valid SRMs. As such, emotional support and drug (substance) use were assessed with single-item measures, which formed part of the Phase 2 screening interview (see Appendix IV). As with the Phase 1 and Phase 2 literature searches, such inclusion criteria (i.e., a restricted range of direct correlates plus personal preferences (sc., emotional support and drug use) may have unwittingly omitted additional pertinent areas of interest, e.g. the Cognitive Biases Questionnaire for psychosis (CBQp; Peters, Moritz, Schwannauer et al., *article in press*; see also, Bastiaens, Claes, Smits, et al., 2013), which aims to assess five cognitive distortions considered important for the pathogenesis of psychosis: (i) JTC, (ii) intentionalising, (iii) catastrophising, (iv) emotional reasoning, and (v) dichotomous thinking. Furthermore, the five areas of interest extracted from the database searches were subsequently cross-referenced and further distilled by conducting a full internet search via Google to account for any database-specific occurrences. That is, the database search only accounted for articles within a necessarily restricted range. Applying a full internet search via Google incorporated a more diverse literature search. The five SRMs shall now be briefly explicated. Cronbach's α for SRMs 3–5 (BIMP, AES, and VVIQ) will be enumerated within each scale's description.

4.8.1 ESNS

The possession of a healthy emotional support network (family and/or close friend) has been found to be important in mediating relapse rates for psychosis (Hogarty, Kornblith, Greenwald, et al., 1997; Wiles, Zammit, Bebbington, et al., 2006). Moreover, considering the information acquired whilst talking to several of the participants, especially those from XPG3 (high ANCOG), rigidity of family structure seemed to be a pertinent factor for them. For example, several XPG3 participants came from "broken" homes or homes where "they were always to blame," and their family members "just didn't understand them" and therefore they were "forced" to leave the family domicile at an early age (early/mid teens). It is therefore suggested that such maladaptive family environments coupled with the possession of limited close personal relationships (King & Terrance, 2006; Malmberg, Lewis, David, et al., 1998) may be an environmental factor pertinent to the onset and maintenance of subclinical PLEs (Tiliopoulos & Goodall, 2008). Therefore, a single item 5-point scale was constructed—the Emotional Support Network Scale (ESNS).

4.8.2 Drug (substance) use scale (DUS)

As cannabis, amongst other substances (e.g., ketamine), usage has been found to be a possible environmental risk factor for developing a psychotic disorder (Ben Amar & Potvin, 2009; Compton & Ramsay, 2009; Ferdinand, Sondeijker, van der Ende, et al., 2005; Honey, Corlett, Absalom, et al., 2008; Le Bec, Fatséas, Denis, et al., 2009; Løberg & Hugdahl, 2009; Verdoux, Tournier, & Cougnard, 2005; reviews: McLaren, Silins, Hutchinson, et al., 2009; Semple, McIntosh, & Lawrie, 2005; Smit, Bopier, & Cuijpers, 2004) a single-item 9-point measure of recreational drug use was developed (adapted from, Barkus, Stirling, Hopkins, et al., 2006a,b): the DUS. Drug use, both recreational and medicinal, has been found to possess positive relationships with the increased affirmation of schizotypal (psychosis-proneness) items (e.g., Fridberg, Vollmer, O'Donnell, et al., 2011; Henquet, Krabbendam, Spauwen, et al., 2005; Mason, Morgan, Stefanovic, et al., 2008; Moss, Bardang, Kindl, et al., 2001; Stirling, Barkus, Nabosi, et al., 2008; van Os, Bak, Hanssen, et al., 2002; Verdoux, Sorbara, Gindre, et al., 2003), especially the recreational usage of cannabis, which has profound effects on information processing (Koethe, Gerth, Neatby, et al., 2006; Messinis, Kyprianidou, Malefaki, et al., 2006) and day-to-day/moment-to-moment functionality in those with a liability for psychosis (Barkus & Lewis, 2006; Skosnik, Park, Dobbs, et al., 2008; Skosnik, Spatz-Glenn, & Park, 2001).

4.8.3 Comorbid psychosomatic pathology: BIMP

The British Inventory of Mental Pathology (BIMP; Bedford & Deary, 2006) is a 36-item scale ($\alpha = 0.91$) deigned to assess six common domains of psychosomatic functioning: 1) Psychological distress [PD] (depression and anxiety); 6 items); 2) Grandiose beliefs [GB] (6 items); 3) Persecutory beliefs [PB] (6 items); 4) Euphoric mood [EM] (6 items); 5) Intrusive thoughts and acts [IT] (OCD); 6 items); and 6) Somatic distress [SD] (6 items). The BIMP has been suggested to be an appropriate measure for quick psychiatric screening and as a monitor of change in both clinical and normal populations (Bedford & Deary, 2006). PCA of total item scores revealed three higher-order factors, including *psychosis* (GB+PB) and *neurosis* (PD+IT+SD), which both significantly differentiated between 479 psychiatric patients and 234 non-patients. Notwithstanding, total BIMP scores (summation of all 36 items) will be utilised.

Of the six psychophysiological variables measured by the BIMP, affective components such as depression and anxiety are most commonly cited as co-occurring with psychosis-like phenomena (Varghese, Scott, Welham, et al., 2011; Vollmer-Larsen, Jacobsen, Hemmingsen, et al., 2006; Wigman, Lin, Vollebergh, et al., 2011). For example, expressing a depressed mood has been found to mediate psychosis onset in individuals reporting hallucinatory experiences (Krabbendam, Myin-

Germeys, Hanssen, et al., 2005). In confirmation of the need to assess mood-related variables, Wright, Startup, and Mathews (2005), in a study of the association between transient mood states and false memory found that participants' mood mediated DRM performance dependent on task demands, confirming the mood-as-input hypothesis of cognition (Martin, Ward, Achee, et al., 1993).

4.8.4 Apathy (amotivation): Apathy evaluation scale (AES)

The AES (Marin, Biedrzycki, & Firinciogullari, 1991) is an 18-item scale (α = 0.87) designed to assess lack of motivation not attributable to a diminished level of consciousness, cognitive impairment, or emotional distress (Marin et al., 1991; Resnick, Zimmerman, Magaziner, et al., 1998). Previous literature with regard to the AES and schizophrenia spectrum disorders is limited; however, one study (Faerden, Nesvåg, Barrett, et al., 2008), which aimed at assessing the factor structure of the AES, and using a first-episode psychosis sample (N = 104) concluded that the main factor (Apathy) is appropriate for assessing apathy in patients diagnosed with first-episode psychosis. After an extensive literature search, no previous literature could be found with regard to apathy and schizotypy, although the concept of apathy (amotivation) has been recently suggested to be a prime component in the negative symptomatology of schizophrenia (Foussias & Remington, 2010).

4.8.5 Vividness of visual imagery: VVIQ (Marks, 1973)

In the context of this thesis, *mental imagery* is defined as "the act of schematically representing things internally or the process of transforming these schematic representations" (Forisha, 1983, p. 311), which, in turn, "affects our thoughts and attitudes long after the original objects [percepts] have gone" (Pinker, 2002, p. 215). The notion of mental imagery is a pertinent one as images generated in the 'mind's-eye' are not exact replicas of the original percepts, rather, they are imperfect facsimiles morphed by past experience and situational requirements. Subsequently mental images are open to constant reconstruction and re-evaluation in light of current beliefs and experiences.

The VVIQ is a 16-item scale (α = 0.93), which involves participants visualising a series of specific scenes and situations. The VVIQ involves participants making two discriminations with regard to each of the sixteen scenarios: 1) With their eyes open (EO); and 2) With their eyes shut (ES). Total VVIQ involves the addition of participants' scores for both conditions (EO and ES). Vividness of visual imagery has been suggested to be a trait marker across the schizophrenia spectrum (e.g., Oertel, Rotarska-Jagiela, van de Ven, et al., 2009; Sack, van de Ven, Etschenberg, et al., 2005; cf., Bell & Halligan, 2010). With regard to psychometric schizotypy, van de Ven and Merckelbach (2003) reported a correlation of -0.34[39] (P < 0.01, two-tailed)[40] between the shortened version of Bett's Questionnaire upon Mental Imagery (QMI; Sheehan, 1967) and the STA; this study also found a lesser correlation between the QMI and the LSHS (r = -0.27, P < 0.01, two-tailed). In fact, the greatest relationship in van de Ven and Merckelbach's study was with *fantasy proneness* as measured by the Creative Experiences Questionnaire (-0.48, P < 0.01, two-tailed).

Furthermore, and more generally, shifts in mental imagery associated with visual perspective taking have historically been reported to facilitate the acceptance of positive events (first-person) and the dismissal of negative events, helping individuals to maintain a coherent self-concept. However, the utilisation of visual imagery in such a manner has been challenged with recent research suggesting that visual perspective taking (imagery-based) is manipulated by individuals dependent on whether they focus on the experience of the event or its influence toward the coherence of the self-concept (Libby & Eibach, 2011); these results implicate how visual imagery plays a broader role in social cognition with regard to the construction and maintenance of the temporally-extended self (see also footnote 18).

4.9 CCTB: Concluding comments

The domains of cognitive functioning covered above indicate that those individuals scoring high for positive schizotypy (and its correlates) can be reliably distinguished from control participants. Moreover, two major theories of positive schizophrenic symptomatology as elucidated in Chapter 3 (Frith, 1992; Fletcher & Frith, 2009) are also important theoretical benchmarks when assessing subclinical PLEs in individuals from the general population. For example, deficits in RM (and SM) are well couched within Frith's (1992) theory of a dysfunctional SM system; and Fletcher and Frith's (2009) Bayesian account may explain the false memory (DRM), OR, RM, and SM difficulties experienced by high scoring schizotypals. For example, Shiffrin (2003) has provided an interesting framework within which both episodic (DRM) and recognition (OR) memory biases may be quantitatively analysed. Moreover, the examination of cognition in subclinical psychotic (schizotypal) states may illuminate theories regarding the schizophrenic process (Lenzenweger, 2010), and vice versa (Maher, 1999).

Aside from the measurers of intelligence functioning (MR and NART) and the five accompanying SRMS, the literature search (PubMed and PsycINFO) highlighted six experimental cognitive (CCTB) domains that should prove beneficial in elucidating mean differences in those areas of cognitive functioning that might subserve the tendency to report ANCOG. Exact descriptions of the measures of

[39] The correlation is negative because decreased scores on the QMI equates to elevated scoring.

[40] As a point of interest, the correlation between the VVIQ and SPQ-B (total) in this study was 0.40, P ≤ 0.0005 (two-tailed).

proxy IQ (control measures) and the six cognitive tests will be fully explicated in Chapter 5 (Methods).

Chapter 5. Methods for Phase 2 testing

5.1 Design and statistical analysis

A between-groups methodology was employed. Participants' responses were logged via Excel (2007) and SPSS v.19 (2010) then subsequently, where appropriate, subjected to *d'* analysis. SDT is considered ideal for investigating decision making processes under conditions of uncertainty, since it produces two separate measures: sensitivity and bias (e.g., Green & Swets 1966; McNichol, 1972; Swets, Tanner, & Birdsall, 1961). Consequently, SDT can be applied to the problem of whether perceptual misattributions arise from a sensory or judgmental disorder (e.g., Baerwald, Tryon, & Sandford, 2005; Ishigaki & Tanner, 1999; Yonelinas, Dobbins, Szymanski, et al., 1996).

5.1.1 Participants: Inclusion criteria and delineation of Phase 2 XPGs

Participants (N = 78) were selected from the exploratory factor analysis of the Phase 1 questionnaire battery data. Groups were delineated utilising scores from the principal factor (ANCOG) by applying the following selection criteria: XPG1 (N = 26) scored at or below the 20th percentile; XPG2 (N = 26) scored 10% above and below the mean; and XPG3 (N = 26) scored at or above the 80th percentile. All prospective participants were duly contacted and two (from XPG2) advised that they did not wish to take part. As such, due to the total amount of SRM packs received back by this time (144) the next two participants who scored in the XPG2 range were contacted and, thankfully, agreed to take part.

5.1.1.1 XPG and Gender (mean Age differences and interaction)

One-way ANOVA revealed significant mean Age differences between XPGs: $F[2, 75] = 9.761$, $P \leq 0.0005$; and in further confirmation, LTA was also significant, $F[1, 77] = 19.301$, $P \leq 0.0005$, $\eta^2_p = 0.207$. See Table 6 for descriptives and Figure 9 for graphical illustration. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction for participants' Age ($F[2,72] = 0.366$, $P = 0.695$, $\eta^2_p = 0.010$).

Table 6: Gender and Age data for Phase 2 participants

XPG	*N*	Gender (M / F)	Age (M/F)
XPG1 ≤ 10th percentile	26	10/16	54.60 (14.36)/51.94 (17.58)
XPG2 10% above/below the mean	26	14/12	46.43 (17.70)/39.00 (9.54)
XPG3 ≥ 80th percentile	26	8/18	36.75 (10.24)/35.89 (9.60)

*SD in parentheses

Figure 9: Bar chart for participants' Age by Gender

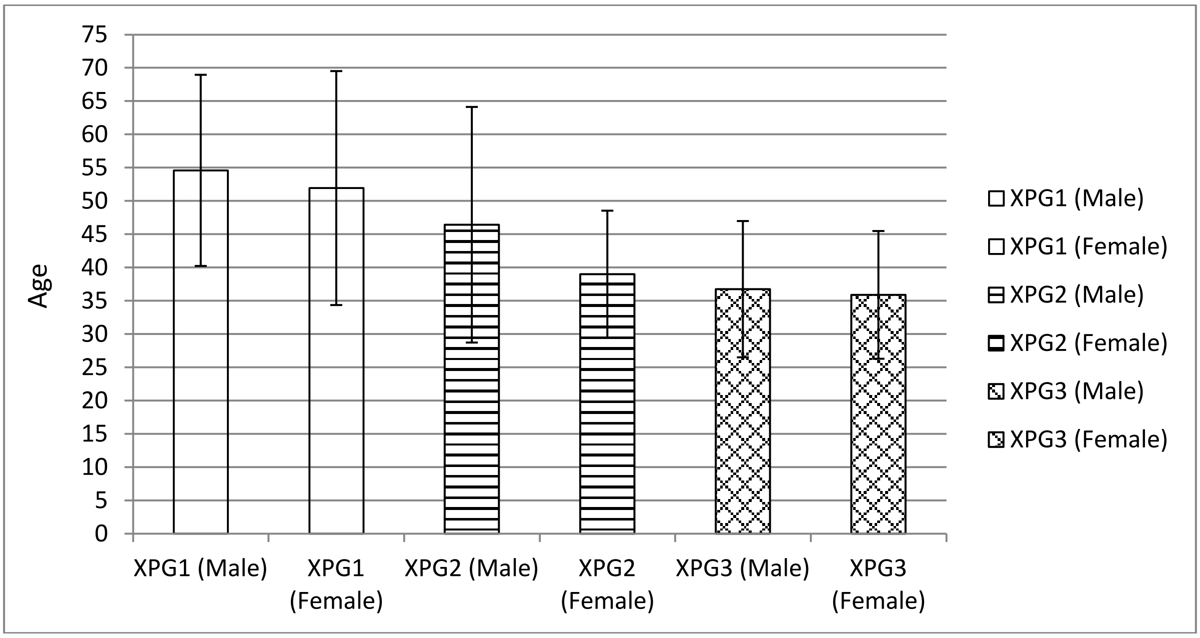


Figure 9 illustrates that participants' age decreased as a function of XPG, and that female (f) participants are, on average, younger than their male (m) counterparts in all XPGs. Furthermore, post-hoc analysis revealed that the significant mean differences manifested between XPG1 with XPGs 2 and 3 (Tukey's tests, P = 0.030 and $P \leq 0.0005$, respectively), but not between XPG2 and XPG3 (Tukey's test, P = 0.180).

5.1.2 Materials

The two-minute screening questionnaire was completed by all participants immediately before undertaking the CCTB. However, the five complementary SRMs (ESNS, DUS, BIMP, AES, and VVIQ) were completed by half (N = 39) of participants prior to the CCTB (Time 1) and by half of participants after completion of the CCTB (Time 2) in a fixed order. No significant SRM × Time interactions were revealed.

The primary equipment utilised was a Research Machines laptop with a 15.4” viewable screen, which contained preloaded Phase 2 (CCTB) software. The laptop was powered by a Pentium IV processor. The experimenter also required scoring forms plus a pen for the screening questionnaire and the NART in order to log participants’ responses.

5.2 Computerised cognitive test battery (CCTB) measures

5.2.1 Intelligence functioning: GCA (proxy IQ)

5.2.1.1 Procedure

Procedure 1: fluid/visuoconstructive intelligence (MR)

The matrix reasoning (MR) subtest of the Wechsler abbreviated scales of intelligence (WASI; Wechsler, 1999) consists of a series of 37 incomplete gridded patterns for each of which participants have to decide (by clicking in the appropriate checkbox) which one of five possible options completes the sequence. Each gridded pattern was centralised within a box measuring 660 x 480 pixels. Scores for the first five gridded patterns are discounted unless participants fail one or more after two trials; none did. In order to avoid guessing and/or rumination, once an answer was inserted (mouse click) the test automatically moved onto the next item.

Procedure 2: verbal intelligence (NART)

The National adult reading test (NART; Nelson, 1982) consists of 50 words decreasing in familiarity as the test progresses, for each of which participants must provide the correct pronunciation. Participants had as long as deemed necessary to compose themselves before forwarding an answer. Most participants made immediate responses; however, if no response was forthcoming after approximately 10secs participants were prompted to either provide an answer or hazard a guess and move quickly on to the next item (word). In order to move onto the next word participants had to press the SPACE BAR.

Following the “social causation hypothesis” of health inequalities (Acheson, 1998; Townsend, Davidson, & Whitehead, 1986)—where factors associated with socioeconomic status (SES) are seen to produce poorer health outcomes—the NART correction procedure, which controls for Age, Gender, and SES (Crawford et al., 1990; see also, Crawford, Cochrane, Besson, et al., 1990) was adopted. Utilising such a methodology derives a verbal IQ estimate that is superior to either demographic variables or the NART in isolation (Willshire, Kinsella, & Prior, 1991).

It was felt necessary to utilise the NART as opposed to the Vocabulary subtest of the WASI as although participants reported no previous or current psychopathology for Phase 1; after being screened for Phase 2 a total of six participants reported receiving treatment for various forms of psychopathology: two for clinical depression (unipolar), one for epilepsy, one for dyslexia/dyscalculia, one for migraine, and one for myalgic encephalomyelitis (ME). As such, due to the high resistance of the NART to neurological and/or psychiatric disorder (Bright, Jaldow, & Kopelman, 2002; Crawford, 1989) it is deemed an excellent choice for indexing premorbid verbal IQ in this particular sample.

Procedure 3 (GCA)

Following the experimental procedure of Edelstyn et al. (2007) a measure of GCA was produced by combining MR and NART results ([MR+NART]/2).

5.2.1.2 Caveat

One participant (PIN #7, member of XPG3) had a clinical diagnosis of 'moderate' dyslexia[41] and as such found the NART practically impossible. As such, it was decided in this case to administer the Quick Test (Ammons & Ammons, 1960), which involved matching a series of 50 spoken (by the experimenter) words to one of four pictorial scenes.

5.2.2 Sustained visual attention: The continuous performance test (CPT)

5.2.2.1 Procedure

The CPT was first introduced in order to measure sustained attention deficits in brain-injured patients (Rosvold, Mirsky, Sarason, et al., 1956; see also, Rosvold, 1959), and has been subsequently modified for utilisation in studies of schizophrenia (Nuechterlein, 1991). The CPT involves participants responding to a series of short-duration stimuli that appear at a rapid fixed rate. As such, CPT performance depends very much on the test format (Chen, Hsiao, Hsiao, et al., 1998). The CPT-

[41] Although the inclusion of a participant with dyslexia is purely coincidental, it is worth noting that individuals with a clinical diagnosis of dyslexia have been found to endorse significantly increased rates of positive schizotypal personality traits (Richardson & Gruzelier, 1994; Richardson & Stein, 1993; review: Richardson, 1997). Notwithstanding PIN #7 only just fulfilled the criteria for inclusion in XPG3.

X (single stimuli X [e.g., letter or number as target) is a simultaneous discrimination vigilance task, whereas the X-CPT-not-D (i.e., “f” unless preceded by “d”) involves a WM component and is a successive discrimination task. The X-CPT-not-D (Rosvold et al., 1956) was utilised for this experiment.

This version of the X-CPT-not-D task required participants to press the SPACE BAR every time the letter “f” was presented on screen and to ignore this rule if the letter “d” immediately preceded the letter “f”. The full complement of letters included “f” “d” “b” and “t.” The complementary letters comprising the full stimuli set possessed phonemic similarity with the to-be-ignored target (“d”), which, due to the rapid presentation rate adds a further aspect of task difficulty.

All stimuli throughout the test were of a uniform size (font size = 48 Sans Serif) as several sources suggest that visual attention is attuned to visual size; (e.g., Farell & Pelli, 1993). All four letters were presented in a fixed order, with equal opportunities for ‘hits’ ‘misses’ and ‘false alarms’. Stimulus durations were set to a constant of 750msecs and interstimulus durations were set to a constant of 200mses. After a 30secs practice session, when composed and confirming that they fully understood test requirements, participants engaged in the five-minute test period.

5.2.3 False (illusory) memory: Deese-Roediger-McDermott (DRM) paradigm

DRM Part 1: Encoding phase

Following Laws and Bhatt (2005), eight lists (critical lures: anger, black, bread, chair, cold, doctor, mountain, and needle) each containing 15 words, were drawn from the norm-referenced word lists bank of Stadler et al. (1999). Individual words were of a uniform size (font = 48 Sans Serif), and were presented at a rate of one word every 2.5secs (interstimulus = 36msecs, one screen refresh). Participants were requested to read each word aloud as it appeared on screen. At the end of each list of semantically-related words a button appeared on screen (NEXT LIST); when participants were ready they performed a simple mouse click to move onto the next list. The lists were completed in a fixed order. No clue as to a later recognition test was provided; instructions were simply to read aloud the total of 120 words.

DRM Part 2: Test phase

After undertaking approximately 20mins of distractor tasks (CCTB measures) participants were informed that they would be presented with 24 words relating to the earlier encoding phase. Each of the 24 words (eight critical lures, eight previously presented words, and eight nonpresented words) were individually presented with an accompanying check-box offering four options: was the word

“Old” (previously presented), “Probably old” (may have been previously presented), “Probably new” (may be a before unseen word), or “New” (an unseen word)? The 24 test items were presented in a counterbalanced manner.

5.2.4 Beads test (BT): Probability reasoning/jumping to conclusions (JTC)

5.2.4.1 Procedure

For all six variants (three graded estimates [GE]/three draws to conclusion [DTC]) the order of beads was preset with the opposing coloured bead (to the jar with the highest ratio) appearing four times in any given sequence of 20 (3rd, 5th, 9th, and 15th, respectively).

GE

This version of the BT is an assessment of participants’ confidence judgments when probability reasoning, to be analysed in terms of Bayes’s probability theory (Bayes, 1763). The procedure involved three conditions within which participants were presented with two jars each containing 100 coloured beads in opposite ratios (BLUE-RED 85:15/RED-BLUE 85:15—easy condition; GREEN-RED 70:30/RED-GREEN 70:30—medium condition; and GREEN-YELLOW 55:45/YELLOW-GREEN 55:45—hard condition). Participants were then presented with a series of, as far as they were concerned, “randomly computer-drawn” (although in truth pre-ordered, see above) series of coloured beads. For each bead they had to click on the jar they thought the bead was most likely (in their opinion) to have been drawn from, and then subsequently rate their confidence in that estimation on a ten-point linear scale (10–100, multiples of ten). The scale contained no zero option in order to make the test forced-choice. This procedure was completed twenty times for all three conditions.

DTC

The second variant, DTC, assessed participants’ propensity to jump-to-conclusions (JTC). That is, to base their decisions on scant evidence. The task involved presenting participants with the same ratios of beads as above but in differing colour combinations (BLUE-YELLOW 85:15/YELLOW-BLUE 85:15—easy condition; 70:30 BLUE-YELLOW/70:30 YELLOW-BLUE—medium condition; and 55:45 RED-BLUE/55:45 BLUE-RED—hard condition). However, rather than selecting a jar and then placing a confidence rating for each sequential bead, participants were presented with one bead and if they required further evidence (another bead/string of beads) before confirming a jar (i.e., being

100% sure that the bead and/or string of beads came from the chosen jar) then they could request it/them with a simple click of the mouse anywhere in the grey background. A maximum of nineteen additional beads could be requested, totalling twenty[42]. This procedure was completed for all three conditions.

For all variants, drawn beads were presented on a linear scale below the jars so as to discount a WM component. The order that the BT variants were presented is as follows: 1) GE 'medium 70:30'; 2) DTC 'easy 85:15'; 3) GE 'hard 55:54'; 4) DTC 'medium 70:30'; 5) GE 'easy 85:15'; and 6) DTC 'hard 55:45'.

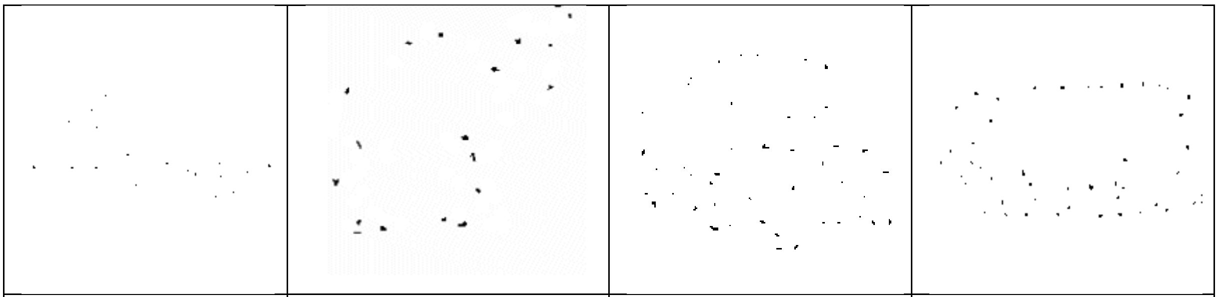
5.2.5 Object recognition (OR)

5.2.5.1 OR protocol

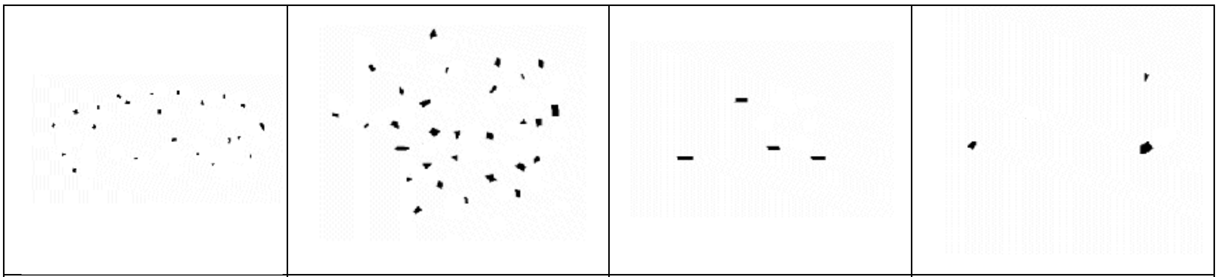
This test is based on the Gollin figures (Gollin, 1960), which was further refined by Bradbury, Stirling, and Cavill (2006) to assess OR performance in MS patients and healthy controls; it proved to be a resourceful measure, with significant OR results revealed between community-based MS patients and healthy controls, attaining an independent samples *t*-test result of 2.244 ($P = 0.032$, 1-tailed). The Gollin test (fragmented images) is primarily a test of image threshold, which reflects the processes of deciphering the signal from the noise. As such the Gollin test can be utilised as a tool for the diagnosis of differential cognitive-perceptual impairments (Chelepin, Chikhman, & Foreman, 2009). For this experiment the number of items (objects) has been expanded from six to eight, including an additional 'threshold' level of 2.5% of images. This has increased the levels of response from five to six. The eight items (objects) are drawn from norm-referenced object banks (Barry, Hirsch, Johnston, et al., 2001; Catling & Johnston, 2006), which, following Doniger et al. (2001), were, as far as possible, equated for familiarity and difficulty: easy = camel and pig; easy to moderate = truck and car; moderate to hard = violin and bicycle; hard = frog and aeroplane. Equating for familiarity may help in avoiding a distinctiveness (novelty) effect, whereby items are prioritised and allotted processing capacity, accordingly (Tulving & Kroll, 1995; see also, Kormi-Nouri, Nilsson, & Ohta, 2005); an effect that may also have repercussions with regard to RM performance (Aberg & Nilsson, 2001; Dobbins, Foley, Schacter, et al., 2002). The eight final black-and-white line drawings (see Figure 10 for level 1 [2.5%] of images presentation/Figure 11 for level 5 [50%] of images presentation) have been copied from the norm-referenced object battery of Snodgrass and Vanderwart (1980), which provided a heterogeneous images sample. Each object measured 200 x 200 pixels.

[42] Only one participant requested all nineteen available beads.

Figure 10: Eight OR test stimuli at the threshold (2.5%) level of images presentation



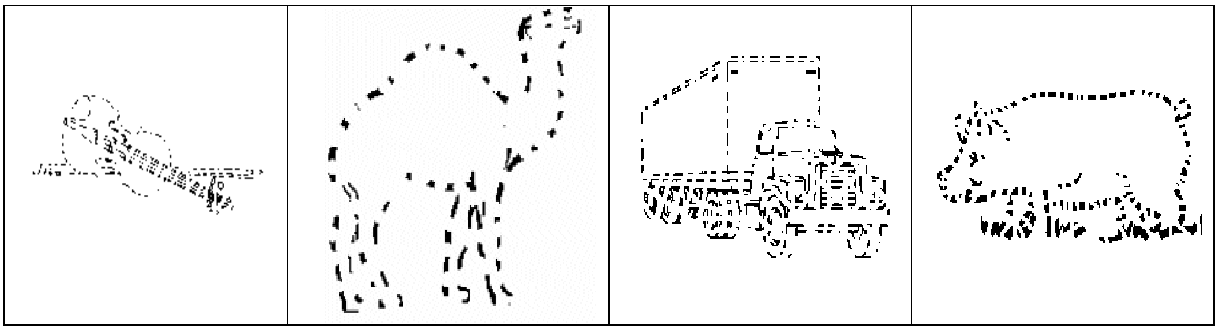
Violin (35.13)	Camel (7.31)	Truck (9.87)	Pig (9.68)



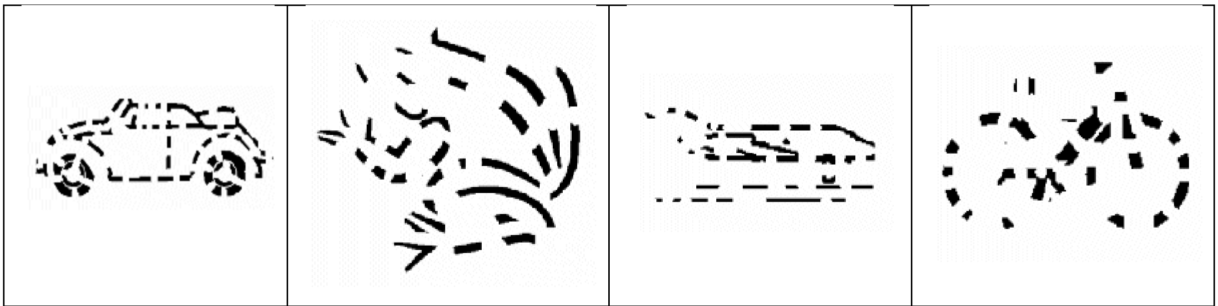
Car (13.78)	Frog (51.28)	Aeroplane (59.10)	Bicycle (27.69)

*Mean % image required to make an initial correct recognition (*N* = 78) in parentheses.

Figure 11: Eight OR test stimuli at the fifth (50%) level of images presentation



Violin (52.12)	Camel (21.09)	Truck (25.45)	Pig (21.28)



Car (28.27)	Frog (71.41)	Aeroplane (77.05)	Bicycle (53.78)

*Mean % image required to make a correct recognition with 100% confidence (*N* = 78) in parentheses[43].

[43] Two mean percentages (frog and aeroplane) are beyond the maximum images presentation range of 70% (level 6); this is because any participant who had not correctly recognised an image by level 6, was attributed a predecided recognition rate of 100%.

5.2.5.2 Procedure

Participants were advised that they would be presented with eight images of “familiar” objects in six levels of decreasing fragmentation. That is, each image would become progressively clearer with each subsequent level. Images for each level were presented in accordance with the ascending method of limits (ASTM, 1979) from level 1 (least clear) through level 6 (most clear). The exact degrees of degradation for each level of images presentation are as follows: level 1 = 2.5% visible image; level 2 = 5% visible image; level 3 = 15% visible image; level 4 = 30% visible image; level 5 = 50% visible image; and level 6 = 70% visible image. The inclusion of a 100% level of visible images was deemed unnecessary as previous research has found that participants, including those with organic CNS pathology—s.c., MS, a condition for which sufferers have been found to have an above chance liability for developing a psychotic disorder (Feinstein, 2004, 2007)—correctly recognised all images by 70% of images presentation (Bradbury et al., 2006).

For each image at each level participants were required to forward a written response (by typing in an adjoining box) coupled with a confidence judgment (by clicking the appropriate percentage from a drop-down check-box containing an 11-point linear scale; 0-100, multiples of ten). Correct responses were summated non-literally; that is, if a respondent, for example, applied the response “wagon” or “lorry” to the image of the truck, it was coded as correct as both recognitions are semantically valid. If participants were completely unsure as to what an image may be they were instructed to leave the response box blank and to insert no confidence rating.

5.2.6 Reality monitoring (RM)

5.2.6.1 Procedure

The test is based on the experimental protocol of Barnes et al. (2003) which evaluated RM in hallucinating and non-hallucinating individuals with Parkinson’s disease.

Encoding

This part of the test required participants to speak aloud 24 words and name 24 pictures (objects), which were presented in a counter-balanced order one item every 2.5secs (interstimulus duration = 36msecs, one screen refresh). Each word was presented in Sans Serif, 72-font, and each of the pictures (objects) measured 240 x 240 pixels.

Test phase

Akin to the DRM procedure, the test phase incorporated approximately 20-minutes of distractor tasks (i.e., CCTB tests) and required participants to identify (recognise) the previously encoded 48 items. However, this time 50% of the words and pictures (objects) had their 'Mode' of presentation switched (i.e., an item initially presented as a picture may now be presented as a word, and vice versa); additionally 24 distractor items (12 words and 12 pictures) were integrated into the test phase. The 12 pictures were again sourced from the object bank of Snodgrass and Vanderwart (1980) with care taken to ensure that no words or images duplicated those already utilised within the DRM or the OR paradigms, or within the Pictorial Distractor Task (see section 5.3). The test phase therefore had a total of 72 items for participants to discriminate between. By clicking in the appropriate check-box, for each of the 72 stimuli participants had three on-screen options from which to choose; 1) 'Word'; 2) 'Picture'; and 3) 'Not previously viewed'.

5.2.7 Self-monitoring (SM)

5.2.7.1 Procedure

This novel test, named the "Letters & Numbers Game" involved participants utilising the mouse to differentiate between visually-presented 'Letters' (left click) and 'Numbers' (right click). Stimuli (letter or number) were stretched to fit inside a box measuring 24 x 24 pixels. A total of 88 possible hits were available to each participant. Stimuli had an onscreen duration of 750msecs and an interstimulus duration of 750msecs. In order to add further difficulty stimuli appeared randomly at any point on the screen—as such, making this also a test of visual tracking—a technique facilitated by the bubble feature of Excel, which allocated a random mid-point for the box to appear in. Again, using the bubble technique, numbers were randomly sequenced with a one-in-four chance of being chosen (i.e., 22/88).

Although not the primary aim of this test, (smooth pursuit) visual tracking has been found to be compromised in those with a schizophrenia spectrum disorder (Matsui & Kurachi, 1995) and those with a liability for psychosis (Holahan & O'Driscoll, 2005; Lenzenweger & O'Driscoll, 2006; Nuechterlein, Asarnow, Subotnik, et al., 2002; O'Driscoll, Lenzenweger, & Holzman, 1998; van Kampen & Deijen, 2009). Notwithstanding, participants were advised that this test was a measure of their metacognitive (error-checking) abilities. As such, if participants made an error, for example by Left-clicking the mouse when a 'Number' was presented they were required, if the error has been noticed, to press the letter "c" on the keyboard to 'correct' the error.

Participants were advised that as this test was in essence a “game” and that the following criteria applied: if an error is made a 10% deduction to the total score for this test would be made, but if, however, they were to press the “c” key to correct the mistake then 5% would be reclaimed making that error worth only a 5% deduction. After a 30secs practice session, when composed and confirming that they fully understood test requirements, participants engaged in the five-minute test period.

5.2.7.2 The detection of alphanumeric figures

The SM test employed (Letters & Numbers Game) necessitates participants using left and right clicks of the mouse in response to a series of pseudorandom alphanumeric figures. It has been revealed that a category effect is present when ‘within-category’ decisions are to be made; however, this effect is diminished when participants are prevented from developing a ‘category set’ (Gleitman & Jonides, 1978). The detection via visual search of alphanumeric figures is, to a degree, category-specific (Hamilton, Mirkin, & Polk, 2006); however, it has been found that supplying participants with advance knowledge of to-be-presented stimuli (sc., a numeral) had no significant effect on scoring rates with regard to letter identification (Sperling, Budiansky, Spivak, et al., 1971).

5.3 Piloting of the CCTB

The CCTB was piloted on eight non-participants (four male and four female). Aside from the RM test, which displayed a ceiling effect, no floor or ceiling effects were identified for any of the other measures. As such, it was decided that once a Pictorial Distractor Task (see Appendix V) had been integrated to disrupt RM test performance[44] the testing of Phase 2 participants could then proceed.

5.4 General procedure

Some time prior to testing participants were presented with a Participant Information Form (see Appendix VI), which outlined the nature of the tests and their rights/obligations as participants. Two copies of the form were given to each participant, on one copy participants were asked to strike a line through any test/s they did not feel comfortable in completing and hand it back to the researcher before commencing Phase 2 testing. The other form was theirs to keep for personal reference.

[44] After the integration of the Pictorial Distractor Task, the CCTB was piloted on a further eight non-participants (four male/four female) and no further floor or ceiling effects were subsequently found with regard to the RM test.

Immediately before testing, participants were asked if appropriate visual (e.g., glasses, contact lenses) and aural (e.g., hearing aid) accoutrements were in place. Participants were also advised before testing that small monetary incentives were available in order to (hopefully) promote task engagement.

Once it was ascertained that participants were ready to proceed, they were sat at a comfortable viewing distance (approximately 50cms) in front of a Research Machines laptop computer with a 15.4" screen. Actual order of completion for the CCTB is as follows:

1. DRM Illusory Memory Test – Part 1 (Encoding).
2. IQ: Phase 1 (MR).
3. CPT: Sustained Visual Attention.
4. DRM: Illusory Memory – Part 2 (Recognition).
5. RM – Part 1 (Encoding)
6. Probability Judgment: (BT).
7. IQ: Phase 2 (NART).
8. OR (Gollin Figures).
9. SM (Letters & Numbers Game).
10. Pictorial Distractor Task.
11. RM – Part 2 (Recognition).

Full standard operating procedures (SOPs) were written and can be found in Appendix VII.

Chapter 6. Results

6.1 Statistical analyses

Data files were saved as plain American National Standards Institute (ANSI) text, with each item being separated by a comma, and each row separated by a hard return, providing individual comma-separated-variable (CSV) files—Excel (2007) can recognise this format. This procedure was utilised to simultaneously log participants' raw CCTB data into individual Excel spreadsheets. In order to transform the raw data into a useable format (e.g., *d*' for SDT analyses) test-specific data conversion equations (results template) had been pre-written. The subsequent "clean" data was transferred from the Excel files into SPSS v. 19 (2010) and, where appropriate, subjected to parametric analyses. A copy of the full data (raw, template, and SPSS) can be found on a CD contained on the inside cover. The raw data will be filed for five years in case of "matters arising".

a. Before subjecting any of the data to parametric analyses, a-priori homogeneity of variance (HOV; Levene's) tests will be conducted to assess for between groups variance. Where HOV has been violated data transformation procedures will be operationalised (i.e., square root, cube root, *z* score, log) in an attempt to normalise the data.
b. ANOVA and LTA will be employed to analyse mean differences between XPGs. Post-hoc tests (i.e., Tukey's) will be utilised to tease apart the direction of means scores. Furthermore, due to the disproportionate number of female participants with regard to Phase 2 testing (total: male = 32, female = 46), especially in XPG3 (male = 8, female = 18), two-way ANOVAs (XPG × Gender) will be conducted to reveal any partial confounds.
c. The set significance level for all analyses is $P \leq 0.05$ (2-tailed). For ease of statistical interpretation, with regard to graphical representation error bars depicting condition-specific standard deviations will be applied (i.e., 1.0 SD above/below the mean).
d. Following American Psychological Association guidelines (APA, 2001), tables containing variable descriptives (total *Ns*, means, and SDs) shall be presented. Within each table a final column denoting the effect size based on the ANOVA (η^2_p) plus the effect size based on the LTA (in parentheses) will be enumerated. The linear effect size is expressed as a proportion (%) of the condition effect (see, Furr, 2004).
e. Analysis of covariance (ANCOVA) will be employed to analyse the contribution of the covariate measures (i.e., GCA [proxy IQ] and the five accompanying SRMs) toward mean differences between XPGs.

f. Linear regression analyses will be utilised in order to assess the contribution (or not) of the covariate measures (i.e., SRMs and participants' Age) toward accounting for significant proportions of variations in CCTB measures' scores. It was decided that when enumerating the proportion of variations accounted for that the Adjusted R^2 statistic would be employed. This procedure, aside from being parsimonious, accommodates for any over-inflation of the *R* statistic due to small sample sizes (Coolican, 2004, p. 464).

g. Complete correlational and subsequent canonical discriminant analysis (CDA) will be utilised to identify those variables that best discriminate between XPGs and subsequently predict outcome (i.e., XPG membership).

h. In order to avoid multiple analyses, before analysing any of the CCTB (performance) measures it was decided, first, to identify which of the control (IQ) measures would be best suited for utilisation as a covariate in subsequent analyses (ANCOVAs). These analyses form the first section (section 6.2) of the results.

Statistical analyses of Phase 2 CCTB measures

6.2 Intelligence (IQ) functioning

With regard to the analysis of mean differences in IQ between XPGs, previous literature is unclear regarding the direction (if any) of IQ associations (i.e., visuoconstructive/verbal) with regard to positive schizotypy (e.g., Burch et al., 2005, 2004, 2006; Matheson & Langdon, 2008). As such, the recent protocol adopted of Edelstyn et al. (2007) will be employed. That is, two measures of performance IQ (visuoconstructive and verbal) will be combined to produce a proxy measure of general cognitive ability (GCA). Subsequent regression analyses will identify which of the resultant three measures of IQ is the best predictor of ANCOG.

6.2.1 Analysis of mean intelligence (IQ) differences between XPGs

6.2.1.1 Differences in mean scores between XPGs for Matrix Reasoning (MR): Visuoconstructive IQ

In confirmation of hypothesis 4, one-way ANOVA (MR × XPG) revealed significant mean differences between XPGs (F[2, 75] = 5.227, P = 0.007), and in further confirmation, LTA was also significant (F[1, 77] = 10.173, P = 0.002). See Table 7 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 0.602, P = 0.551).

6.2.1.2 Differences in mean scores between XPGs for the National Adult Reading Test (NART): Verbal IQ

In confirmation of hypothesis 5, one-way ANOVA (NART × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 4.007$, $P = 0.022$), and in further confirmation, LTA was also significant ($F[1, 77] = 7.706$, $P = 0.007$). See Table 7 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.503$, $P = 0.607$).

6.2.1.3 Differences in mean scores between XPGs for General Cognitive Ability (GCA) (combined MR and NART)

In confirmation of hypothesis 6, one-way ANOVA (GCA × XPG) revealed significant mean differences between XPGs in GCA performance ($F[2, 75] = 6.529$, $P = 0.002$), and in further confirmation, LTA was also significant ($F[1, 77] = 13.051$, $P = 0.001$). See Table 7 for descriptive statistics and effect size; see Figure 12 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.714$, $P = 0.493$).

6.2.1.4 Relationships between IQ measures

Correlational analyses revealed significant relationships between MR and GCA ($r_{78} = 0.78$, $P \leq 0.0005$) and between the NART and GCA ($r_{78} = 0.70$, $P \leq 0.0005$), but not between MR and NART ($r_{78} = 0.11$, $P = 0.357$). These results verify the utilisation of MR and the NART as a combined measure of proxy IQ as they possess no significant statistical relationship.

Table 7: Descriptive statistics and effect sizes for IQ measures

IQ variable	XPG	N	Mean	S.D.	ANOVA effect size [η^2_p]/(%)
	1	26	108.77	9.348	
MR	2	26	105.96	7.790	0.122/(97.31)
	3	26	100.88	9.501	
	1	26	113.76	6.454	
NART	2	26	110.38	7.666	0.097/(95.05)
	3	26	108.73	5.252	
	1	26	111.27	6.457	
GCA	2	26	108.17	6.520	0.148/(99.94)
	3	26	105.21	6.355	

Figure 12: Means plot for GCA

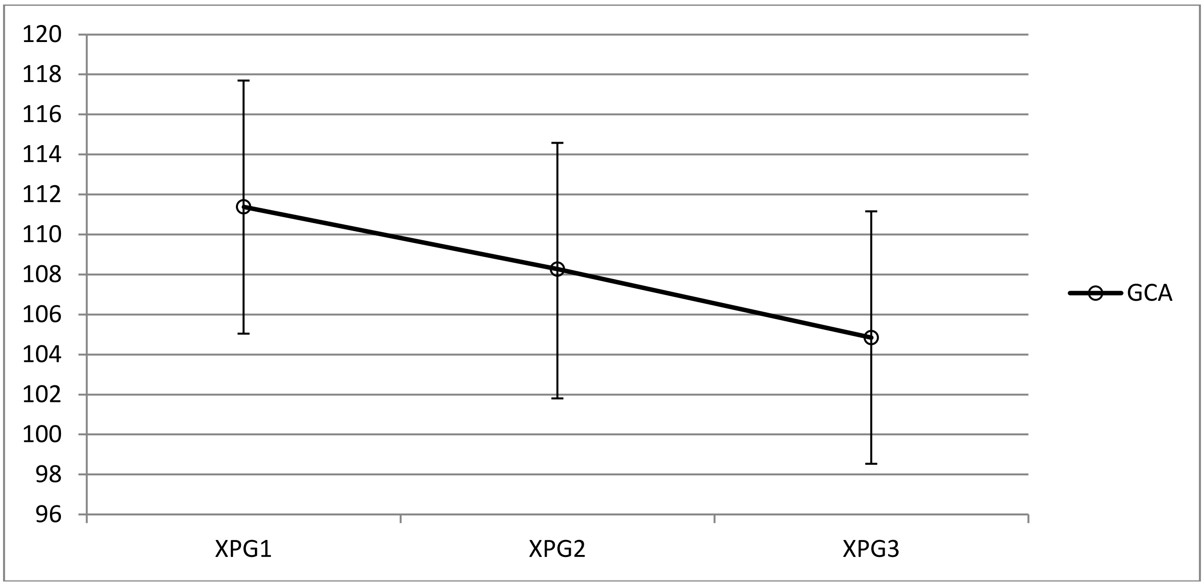


Figure 12 reveals a pattern of scoring as predicted; that is, an equitable rate of descent through XPGs. These observations are confirmed by post-hoc analyses, which reveal that for GCA the significant differences manifest only between XPG1 and XPG3 (Tukey's test, P = 0.002), but not between XPG2 and XPG3 (Tukey's test, P = 0.158) or between XPGs 1 and 2 (Tukey's test, P = 0.200).

6.2.2 Contribution of IQ measures toward variations in ANCOG scores

6.2.2.1 MR

Setting ANCOG as the DV, and entering MR as the IV the enter method of linear regression identified that MR independently predicted a significant proportion (11.7%) of variations in ANCOG scores (see Table 8).

Table 8: Regression model for ANCOG (MR)

Predictor variable (IQ measure)	*B*	*t*	*P*	R^2 *change*
MR	-0.359	-3.349	0.001	0.117
Adjusted R^2 = 0.117				

6.2.3.2 NART

Setting ANCOG as the DV, and entering NART as the IV the enter method of linear regression identified that the NART independently predicted a significant proportion (7.3%) of variations in ANCOG scores (see Table 9).

Table 9: Regression model for ANCOG (NART)

Predictor variable (IQ measure)	*B*	*t*	*P*	R^2 *change*
NART	-0.291	-2.655	0.010	0.073
Adjusted $R^2 = 0.073$				

6.2.2.3 GCA

In further confirmation of hypothesis 6, setting ANCOG as the DV, and entering GCA as the IV the enter method of linear regression identified that GCA independently predicted a significant proportion (13.9%) of variations in ANCOG scores (see Table 10).

Table 10: Regression model for ANCOG (GCA)

Predictor variable (IQ measure)	*B*	*t*	*P*	R^2 *change*
GCA	-0.388	-3.666	0.000	0.139
Adjusted $R^2 = 0.139$				

6.2.3 Association of participants' Age in accounting for mean differences in GCA

Univariate ANCOVA revealed that after accounting for participants' Age the significant mean differences between XPGs became nonsignificant ($F[2,74] = 0.423$, $P = 0.657$). In further confirmation of this finding, a significant XPG × Age interaction was revealed ($F[2,78] = 2.421$, $P = 0.029$, $\eta^2_p = 0.623$).

6.2.4 Summary of IQ (control measure) results

From the above analyses, and following Edelstyn et al. (2007), the combined measure of GCA ([MR + NART]/2) will be utilised with regard to further correlational and CDA analyses.

6.3 Sustained visual attention: Continuous Performance Test (CPT)

There are two components within the X-CPT-not-D procedure that are of statistical interest: 1) mean differences between XPGs for the overall discrimination of targets and nontargets as measured by SDT (*d'*)[45]; and 2) mean differences between XPGs in the number of In*R*.

6.3.1 Analysis of mean differences between XPGs for X-CPT-not-D performance

6.3.1.1 Mean differences in discrimination accuracy (d')

In rejection of hypothesis 7, one-way ANOVA (*d'* × XPG) revealed no significant mean differences between XPGs ($F[2, 75] = 1.552$, $P = 0.219$); and in further rejection, LTA was also nonsignificant ($F[1, 77] = 2.550$, $P = 0.114$). See Table 11 for descriptives and Figure 13 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.495$, $P = 0.612$).

6.3.1.2 Mean differences in random errors (In*R*)

In rejection of hypothesis 8, one-way ANOVA (In*R* × XPG) revealed no significant mean differences between XPGs ($F[2, 75] = 0.477$, $P = 0.623$); and in further rejection, LTA was also nonsignificant ($F[1, 77] = 0.689$, $P = 0.409$). See Table 11 for descriptives and Figure 14 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.611$, $P = 0.545$).

Table 11: Descriptive statistics and effect sizes for X-CPT-not-D variables

Variable	XPG	*N*	Mean	S.D.	Effect size [η^2_p]/(%)
	1	26	3.53	0.735	
d'	2	26	3.81	0.575	0.040/(82.21)
	3	26	3.84	0.782	
	1	26	7.23	8.520	
In*R*	2	26	5.04	10.475	0.013/(72.28)
	3	26	5.12	8.425	

[45] The *d'* statistic was calculated from the *z* of Hits (H; correct responses to the letter "f") minus the *z* of False Alarms (FA; responding to the letter "f" when preceded by the letter "d").

Figure 13: Means plot for X-CPT-not-D (d')

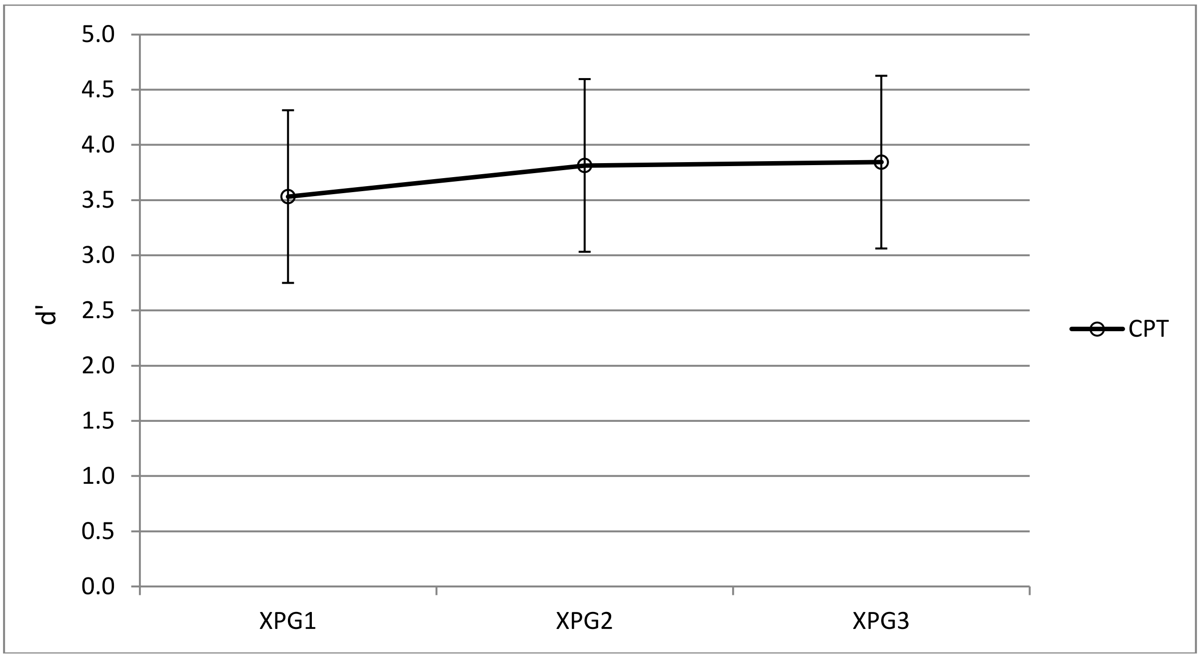
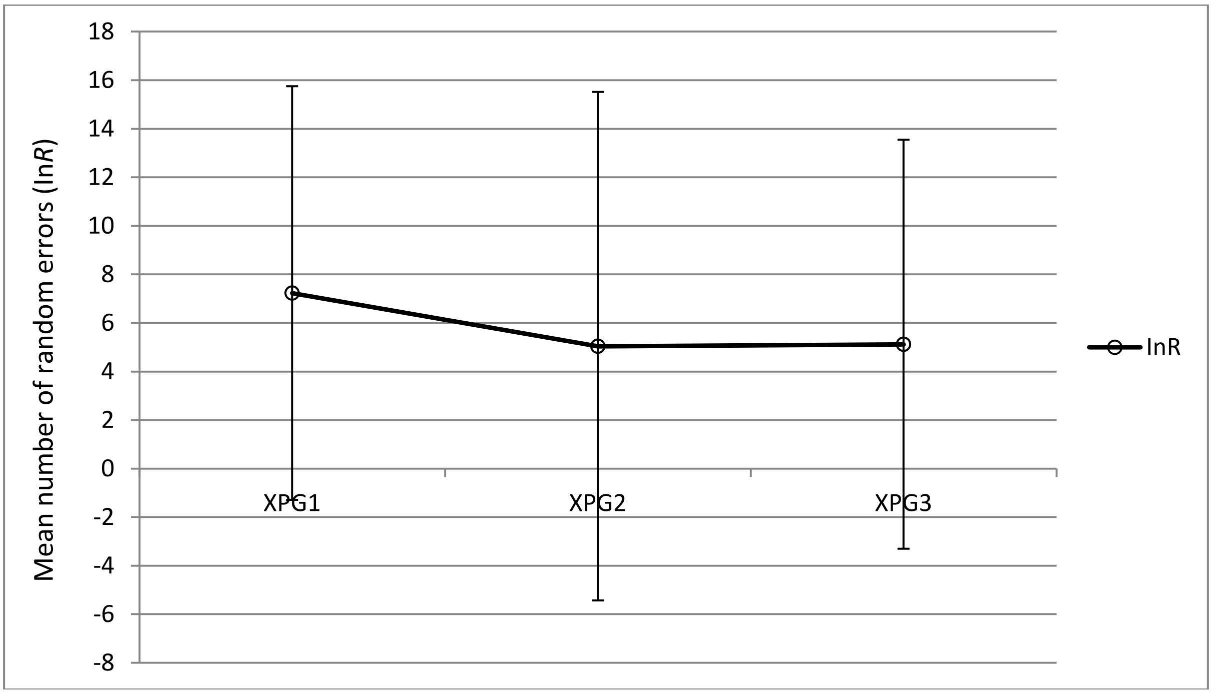


Figure 13 illustrates that XPGs 2 and 3 nonsignificantly outperformed XPG1 with regard to discrimination accuracy (*d'*). In confirmation of this pattern of overall CPT performance, XPG1 recorded a greater mean number of In*R* (Figure 14).

Figure 14: Means plot for In*R*



6.3.2 Summary of CPT results

No significant mean differences were revealed between XPGs for discrimination accuracy (*d'*) or for the mean number of In*R*. As such, neither of the two X-CPT-not-D variables will be taken forward into future correlational or CDA analyses.

6.4 Deese-Roediger-McDermott (DRM) false memory paradigm

There are three aspects of the DRM procedure that are of particular interest: 1) mean differences in overall DRM (True memory) performance as assessed by SDT (*d'*)[46]; 2) mean differences between XPGs in the number of critical lures (high associates) recognised; and 3) mean differences between XPGs in the number of new (not previously presented) words recognised.

6.4.1 Analysis of mean differences between XPGs

6.4.1.1 Mean differences in overall DRM 'True memory' performance (d')

In confirmation of hypothesis 9, one-way ANOVA (*d'* × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 4.948$, $P = 0.010$); and in further confirmation, LTA was also significant ($F[1, 77] = 8.692$, $P = 0.004$). For graphical representation see Figure 15; see Table 12 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.647$, $P = 0.526$).

6.4.1.2 Mean differences in the number of critical lure recognitions

In confirmation of hypothesis 10, one-way ANOVA (Lures × XPG) revealed significant mean differences between XPGs[47] ($F[2, 75] = 38.086$, $P \leq 0.0005$); and in further confirmation, LTA was also significant ($F[1, 77] = 54.881$, $P \leq 0.0005$). For graphical representation see Figure 16; see Table

[46] The *d'* statistic was calculated from the *z* of H (nonassociated words) minus the *z* of FA (recognition of new words, i.e. not previously presented).

[47] The original (raw) critical lure data possessed significant HOV (Levene's statistic [2, 75] = 5.928, $P = 0.004$) and as such raw scores were subjected to a cube root transformation. This procedure reduced the mean between groups differences to one of nonsignificance (Levene's statistic [2, 75] = 1.760, $P = 0.179$). A log transformation could not be applied because the data set contained values of zero. Notwithstanding, for graphical representation, the critical lure data is illustrated by the actual, as opposed to the transformed scores.

12 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 1.123, P = 0.331).

6.4.1.3 Mean differences in the number of New (not previously presented) words recognised

In confirmation of hypothesis 11, one-way ANOVA (New words × XPG) revealed significant mean differences between XPGs (F[2, 75] = 12.338, $P \leq 0.0005$); and in further confirmation, LTA was also significant (F[1, 77] = 24.351, $P \leq 0.0005$). For graphical representation see Figure 17; see Table 12 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 0.579, P = 0.563).

6.4.2 Counterbalancing effects

A series of Univariate ANCOVAs (XPG × List type [forward / backward]) revealed no significant list effect for DRM 'True memory' (F[2, 72] = 0.555, P = 0.576), for the number of critical lures recognised (F[2, 72] = 0.097, P = 0.908), or for the number of new words recognised (F[2, 72] = 1.686, P = 0.192). These results suggest that, in order to avoid a list-effect, the counterbalancing methodology was appropriate.

Table 12: Descriptive statistics and effect sizes for DRM variables

DRM variable	XPG	N	Mean	S.D.	Effect size [η^2_p]/(%)
	1	26	0.66	1.194	
DRM 'True memory'	2	26	0.73	1.282	0.117/(87.83)
	3	26	-1.04	1.388	
	1	26	1.35	1.018	
Critical lures[48]	2	26	1.35	1.093	0.504/(72.05)
	3	26	4.81	1.744	
	1	26	0.46	0.508	
New words	2	26	0.77	0.587	0.248/(98.68)
	3	26	1.23	0.587	

[48] Note that the original critical lure data was subjected to a cube root transformation and these statistics are reported in Table 12.

Figure 15: Means plot for DRM (True memory) performance

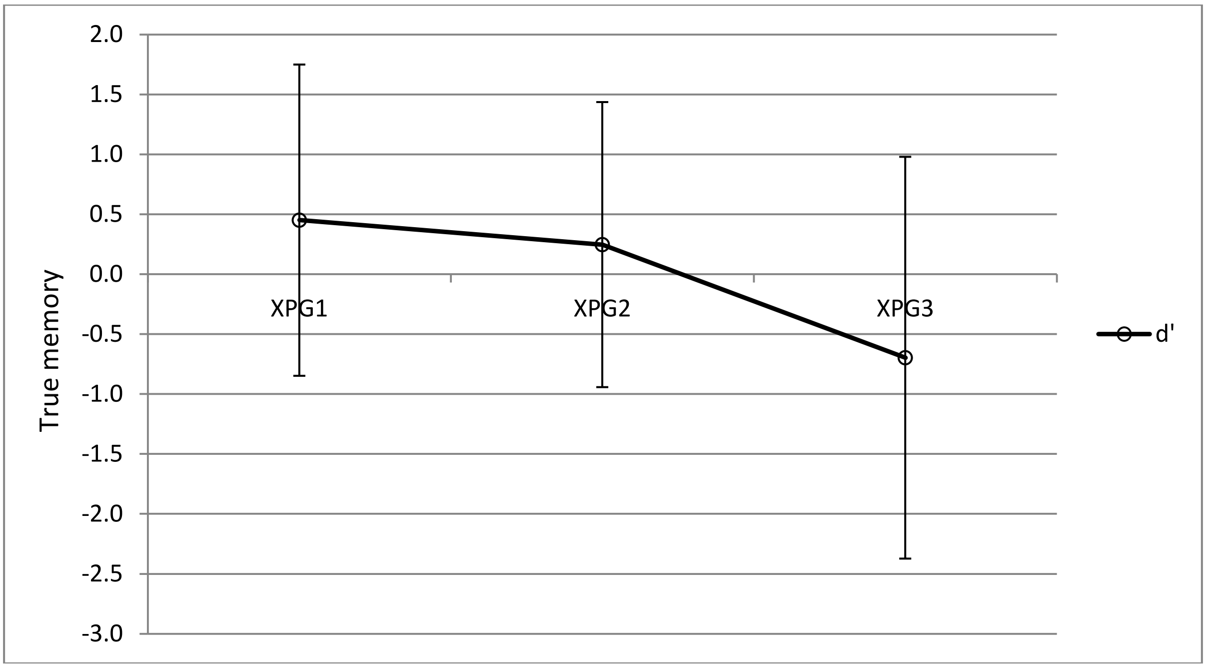


Figure 15 reveals that XPGs 1 and 2 performed at an equitable level with regard to DRM (*d'*) performance; whereas XPG3 displayed a pattern of performance that was significantly reduced. This observation is given further credence by post-hoc analyses, which reveal that the significant mean differences manifest between XPG1 and XPG3 (Tukey's test, P = 0.012) and between XPG2 and XPG3 (Tukey's test, P = 0.046) but not between XPG1 and XPG2 (Tukey's test, P = 0.860).

Figure 16 (see below) reveals that XPGs 1 and 2 performed at an equitable level with regard to the number of critical lures recognised, whereas XPG3 displayed a pattern of performance that is significantly elevated. These observations are given further credence by post-hoc analyses, which reveal that for the number of critical lures erroneously recognised the significant mean differences manifested between XPG1 and XPG3 (Tukey's test, $P \leq 0.0005$) and between XPG2 and XPG3 (Tukey's test, $P \leq 0.0005$) but not between XPG1 and XPG2 (Tukey's test, P = 0.954).

Figure 16: Means plot for the raw number of critical lures recognised

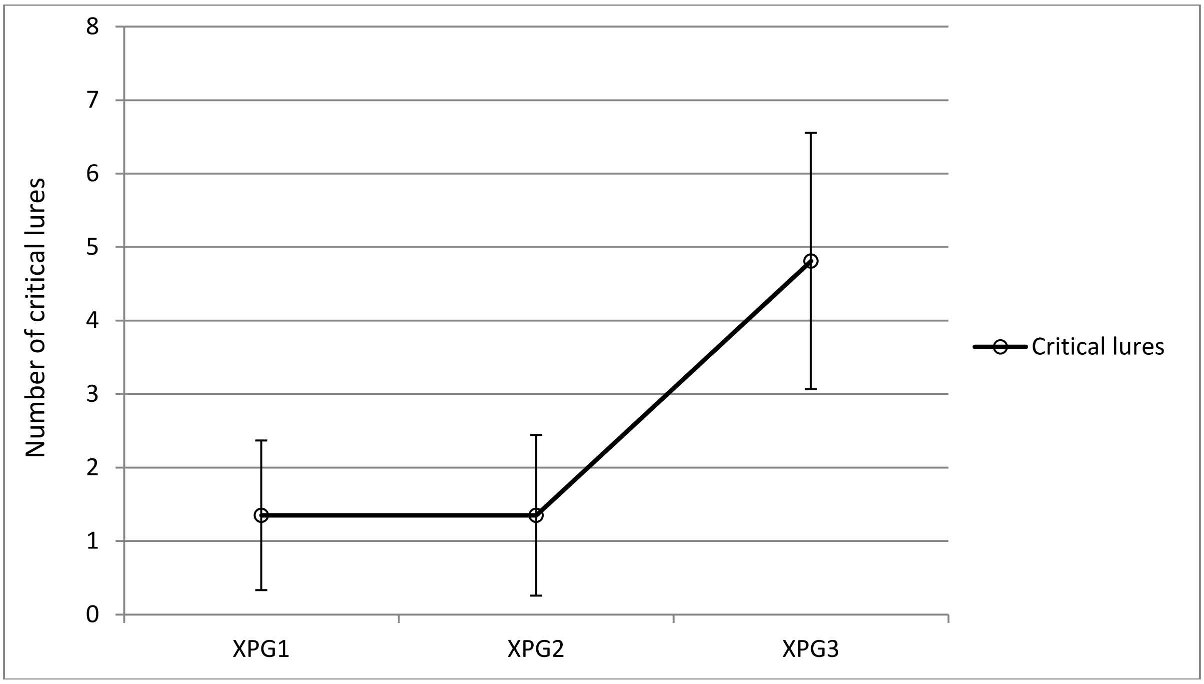


Figure 17: Means plot for the number of New words recognised

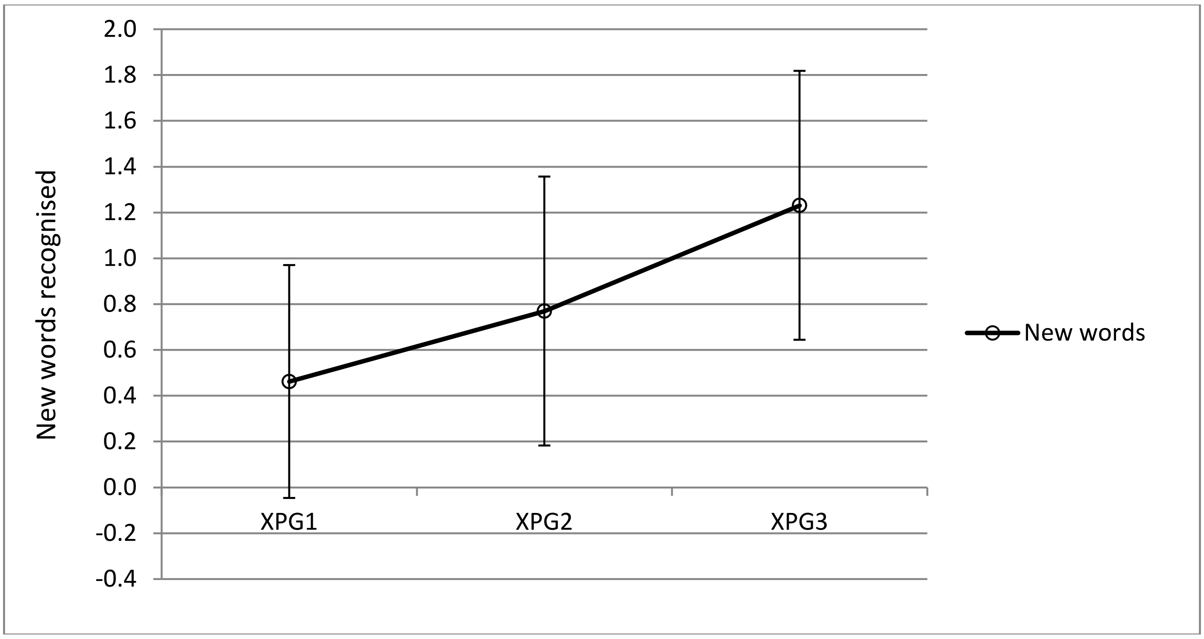


Figure 17 reveals a pattern of performance in the predicted direction; that is, a moderately steep ascent from XPGs 1 to XPG2 followed by an elevated ascent from XPG2 to XPG3. In confirmation of these observations, post-hoc analysis revealed that the significant mean differences in the number of new words erroneously recognised manifested between XPG1 and XPG3 (Tukey's test, $P \leq 0.0005$)

and between XPG2 and XPG3 (Tukey's test, $P = 0.011$) but not between XPG1 and XPG2 (Tukey's test, $P = 0.126$).

6.4.3 Contributions of GCA and SRMs toward accounting for mean differences (covariations) in DRM variables

6.4.3.1 DRM 'True memory'

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 2.867$, $P = 0.063$), the ESNS ($F[2, 74] = 2.474$, $P = 0.091$), and the BIMP ($F[2, 74] = 2.948$, $P = 0.059$) the significant mean differences between XPGs were reduced to ones of a trend toward significance; whereas, after accounting for the DUS ($F[2, 74] = 3.383$, $P = 0.039$), the AES ($F[2, 74] = 3.480$, $P = 0.036$), and the VVIQ ($F[2, 74] = 7.291$, $P = 0.001$) mean differences between XPGs retained significance.

6.4.3.2 Cube root of the number of critical lures

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 31.245$, $P \leq 0.0005$), the ESNS ($F[2, 74] = 29.260$, $P \leq 0.0005$), the DUS ($F[2, 74] = 34.086$, $P \leq 0.0005$), the BIMP ($F[2, 74] = 22.041$, $P \leq 0.0005$), the AES ($F[2, 74] = 29.677$, $P \leq 0.0005$), and the VVIQ ($F[2, 74] = 32.050$, $P \leq 0.0005$) none of the covariates made a substantial contribution toward reducing the significant mean differences between XPGs.

6.4.3.3 Number of new words

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 9.715$, $P \leq 0.0005$), the ESNS ($F[2, 74] = 9.132$, $P \leq 0.0005$), the DUS ($F[2, 74] = 8.576$, $P \leq 0.0005$), the BIMP ($F[2, 74] = 9.793$, $P \leq 0.0005$), the AES ($F[2, 74] = 11.609$, $P \leq 0.0005$), and the VVIQ ($F[2, 74] = 9.774$, $P \leq 0.0005$) none of the covariates made a substantial impact toward reducing the significant mean differences between XPGs.

6.4.4 Stepwise (forward) linear regression of DRM variables

6.4.4.1 DRM 'True memory'

Setting DRM 'True memory' as the DV and entering all SRMs (including participants' Age) as IVs the stepwise (forward) method of linear regression revealed that only the ESNS accounted for a significant proportion (10.4%) of variations in DRM 'True memory' scores (see Table 13).

Table 13: Regression model for DRM 'True memory'

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
ESNS	0.340	3.153	0.002	.104
Total Adjusted R^2 = .104				

6.4.4.2 Cube root of the number of critical lures

Setting critical lures as the DV and entering all SRMs (including participants' Age) as IVs the stepwise (forward) method of linear regression revealed that in combination the AES, the BIMP, and participants' Age accounted for a significant proportion (total = 33.3%) of variations in critical lures scores (see Table 14).

Table 14: Regression model for cube root of critical lures

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
AES	-0.366	-3.655	0.000	.203
BIMP	0.275	2.652	0.010	.090
Age	-0.230	-2.359	0.021	.040
Total Adjusted R^2 = .333				

6.4.4.3 Number of new words

Setting the number of new words as the DV and entering all SRMs (including participants' Age) as IVs the stepwise (forward) method of linear regression revealed that in combination the DUS and ESNS accounted for a significant proportion (total = 14.1%) of variations in new words scores (see Table 15).

Table 15: Regression model for new words

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
DUS	0.286	2.705	0.008	.081
ESNS	-0.266	-2.511	0.014	.060
Total Adjusted R^2 = .141				

6.4.5 Summary of DRM results

As expected, significant differences were revealed between XPGs for DRM 'True memory' and for the number of critical lures (cube root) and new words recognised[49]; no significant XPG × Gender interactions were revealed. The covariate measures (including participants' Age, the ESNS, the DUS, the BIMP, the AES and the VVIQ) made no impact upon the significant mean differences in variance with regard to the number of critical lures and new words recognised. However, GCA, the ESNS, and the BIMP reduced the significant mean differences in variance with regard to DRM 'True memory' scores to that of a trend. Linear regression analyses revealed that participants' Age, the ESNS, the DUS, the BIMP, and the AES differentially accounted for significant proportions of variations in DRM variables.

All three DRM variables: True memory, the number of critical lures and new words recognised will be included in further analyses (correlational and CDA).

6.5 Beads Test (BT): Probability reasoning/jumping to conclusions (JTC)

The BT consisted of two experimental conditions: 1) GE, a condition requiring sequential confidence judgments based on a series of predecided "draws" analysed in relation to Bayes's theorem of probability reasoning (Bayes, 1763)[50] (see Appendix IV); and 2) DTC, a condition requiring a final ("I'm 100% confident") judgment to be made at the participants' behest. Scores for the GE (probability reasoning) condition are based on deviations from the optimal response rates for each bead (1–20) in each condition ('easy 85:15,' 'medium 70:30,' and 'hard 55:45'): easy, total

[49] As a point of interest, it is worth noting that in accordance with previous research, except for the Laws and Bhatt (2005) study, no significant mean differences between XPGs were revealed for the correct recognition of previously presented words (F[2, 75] = 0.553, P = 0.577), and in further confirmation of this finding LTA was also nonsignificant (F[1, 77] = 0.040, P = 0.843).

[50] Put simply, Bayes's theorem allows one conditional probability to be inferred from the values of other probabilities. As such, tables were formulated to provide probability judgments (proportions), which were subsequently converted to percentages, for the three ratios of beads; from the derived theoretical probabilities, participants' input (confidence judgments) were subtracted—for all 20 beads (x 3)—to provide final values (see Appendix IV).

mean = 95.79%; medium, total mean = 92.90%; and hard, total mean = 77.31%. As such, based on Bayes’s theorem, individual scores can be either plus or minus.

6.5.1 Analysis of mean differences between XPGs for Graded Estimates (GE; probability reasoning) performance

6.5.1.1 GE ‘easy 85:15’

In rejection of hypothesis 12a, one-way ANOVA (GE ‘easy 85:15’ × XPG) revealed no significant mean differences between XPGs ($F[2, 75] = 1.770$, $P = 0.177$); however, LTA was a trend toward significance ($F[1, 77] = 3.403$, $P = 0.069$). See Table 16 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.252$, $P = 0.778$).

6.5.1.2 GE ‘medium 70:30’

In rejection of hypothesis 12b, one-way ANOVA (GE ‘medium 70:30’ × XPG) revealed no significant mean differences between XPGs ($F[2, 75] = 1.189$, $P = 0.310$); and in further confirmation, LTA was also nonsignificant ($F[1, 77] = 2.321$, $P = 0.132$). See Table 16 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.272$, $P = 0.762$).

6.5.1.3 GE ‘hard 55:45’

In confirmation of hypothesis 12c, one-way ANOVA (GE ‘hard 55:45’ × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 7.339$, $P = 0.001$); and in further confirmation, LTA was also significant ($F[1, 77] = 9.341$, $P = 0.003$). See Table 16 for descriptive statistics and effect size and Figures 18 and 19 for graphical representations. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 0.797$, $P = 0.455$).

Figure 18: Means plot for GE ‘hard 55:45’

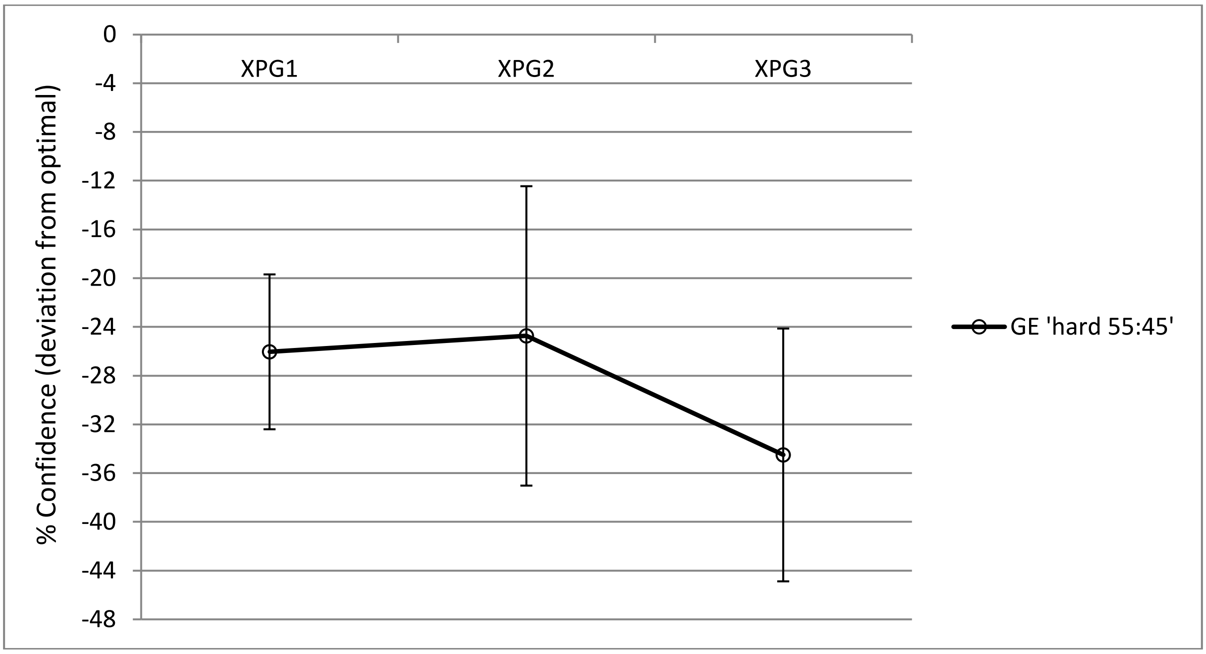
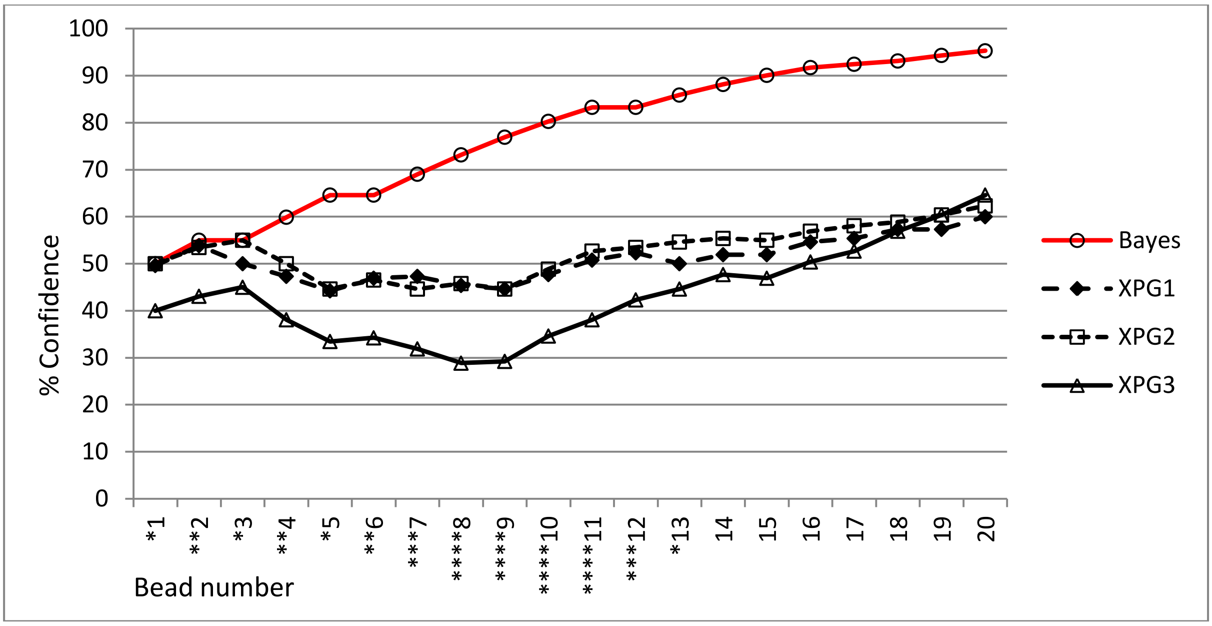


Figure 18 reveals a pattern of confidence judgments in line with prediction; that is, equitable performance from XPGs 1 and 2 followed by a reasonably steep decline from XPG2 to XPG3. These observations are borne out by post-hoc analysis, which reveals that the significant mean differences manifest between XPG1 and XPG3 (Tukey’s test, $P = 0.009$) and between XPG2 and XPG3 (Tukey’s test, $P = 0.002$) but not between XPG1 and XPG2 (Tukey’s test, $P = 0.884$).

Figure 19 (see below) illustrates that despite ANOVA for the GE ‘hard 55:45’ condition producing significant mean differences between XPGs, this did not hold for all beads. In fact, following the presentation of the 13th bead no significant mean differences were registered. It can also be seen that by the presentation of the 20th bead, the mean confidence (percentage) judgments of XPG3 were the highest (ns.). Moreover, increases in significant mean differences were revealed after presentations of the first three opposing (contrary) colour beads, i.e. third to fourth, fifth to sixth, and ninth to tenth, indicating that the confidence judgments, especially of XPG3, were significantly affected by disconfirmatory evidence.

Figure 19: Bayes probability comparisons—XPG means across all 20 draws ('hard 55:45')



*$P \leq 0.05$
**$P \leq 0.01$
***$P \leq 0.001$
**** $P \leq 0.0005$

6.5.2 Analysis of mean differences in draws to conclusion (DTC)

6.5.2.1 DTC 'easy 85:15'

In partial confirmation of hypothesis 13a, one-way ANOVA (DTC 'easy 85:15' × XPG) revealed a trend toward significant mean differences between XPGs (F[2, 75] = 2.806, P = 0.067); however, LTA was significant (F[1, 77] = 5.146, P = 0.026). See Table 16 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 0.317, P = 0.729)[51].

6.5.2.2 DTC 'medium 70:30'

In partial confirmation of hypothesis 13b, one-way ANOVA (DTC 'medium 70:30' × XPG) revealed a trend toward significant mean differences between XPGs (F[2, 75] = 2.475, P = 0.091); however, LTA was significant (F[1, 77] = 4.622, P = 0.035). See Table 16 for descriptive statistics

[51] A HOV test revealed a marginal trend toward significant between groups variance (Levene's statistic [2, 75] = 2.409, P = 0.097).

and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 1.176, P = 0.314)[52].

6.5.2.3 DTC 'hard 55:45'

In confirmation of hypothesis 13c, one-way ANOVA (DTC 'hard 55:45' × XPG) revealed significant mean differences between XPGs (F[2, 75] = 4.903, P = 0.010); and in partial confirmation, LTA revealed a trend toward significance (F[1, 77] = 3.816, P = 0.054). See Table 16 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 1.025, P = 0.364)[53].

6.5.2.4 DTC 'Global'

Considering the general significance of the HOV tests, it was decided to amalgamate the three DTC variants into a global measure: (easy + medium + hard)/3. A subsequent one-way ANOVA (DTC 'Global' × XPG) revealed significant mean differences between XPGs (F[2, 75] = 4.667, P = 0.012); and in further confirmation, LTA was also significant (F[1, 77] = 6.280, P = 0.014). However, a further HOV test again revealed significant between groups variance (Levene's statistic [2, 75] = 3.327, P = 0.041). As such, DTC 'Global' scores were subjected to a log transformation and this procedure reduced the HOV result to one of nonsignificance (Levene's statistic [2, 75] = 1.095, P = 0.340), and subsequent one-way ANOVA revealed significant mean differences between XPGs (F[2, 75] = 5.808, P = 0.005); and in further confirmation, LTA was also significant (F[1, 77] = 7.656, P = 0.007). See Figure 20 for graphical representation and Table 16 for descriptive statistics and effect size. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 0.198, P = 0.821).

[52] A HOV test revealed significant between groups variance (Levene's statistic [2, 75] = 4.696, P = 0.012).

[53] A HOV test revealed significant between groups variance (Levene's statistic [2, 75] = 10.624, $P \leq$ 0.0005).

Figure 20: Means plot for DTC 'Global'

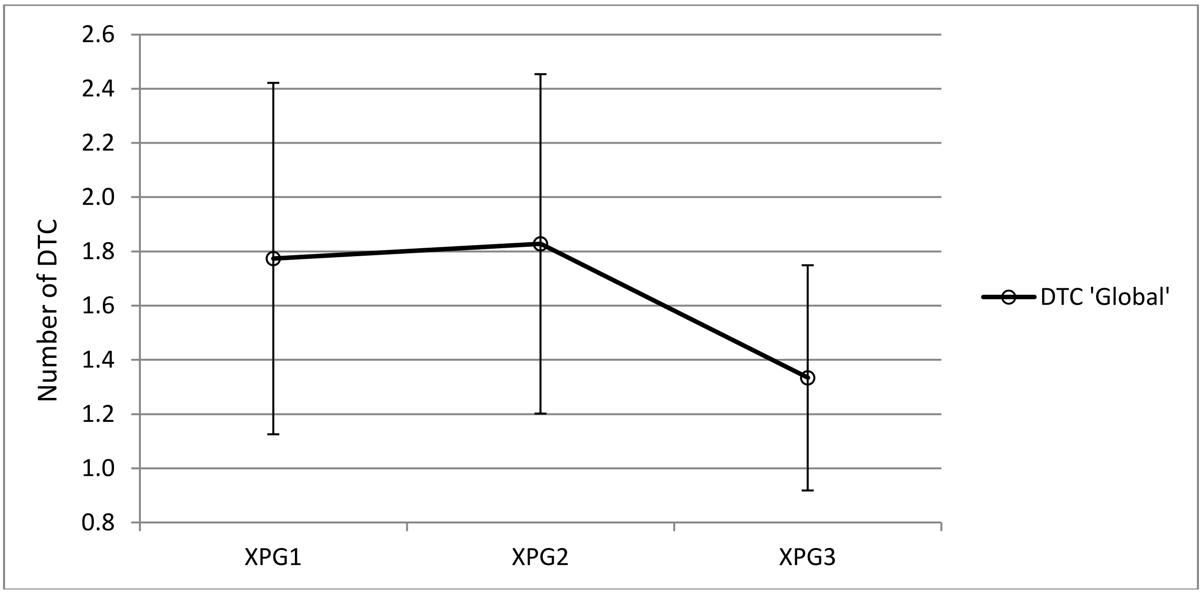


Figure 20 illustrates a pattern of responses as predicted. That is, equitable performance from XPGs 1 and 2 followed by a reasonably steep descent from XPG2 to XPG3. These observations are given further weight by post-hoc analysis, which highlighted that the significant mean differences manifested between XPG1 and XPG3 (Tukey's test, $P = 0.019$) and between XPG2 and XPG3 (Tukey's test, $P = 0.007$) but not between XPG1 and XPG2 (Tukey's test, $P = 0.938$).

6.5.3 Main effects and interactions

It is acknowledged that the DVs are not independent of each other. Although not considered for these particular analyses—for completion—a series of one-way ANOVAs have been conducted to ascertain main effects (DVs × IVs) and interactions (DV × XPG/IVs) for each of the six BT variants. Firstly, GE 'Global' scores were checked for HOV: Levene's statistic revealed no significant differences in the distribution of scores within XPGs (Levene's statistic = 2.094, $P = 0.130$).

Secondly, setting GE 'Global' as the DV, univariate ANCOVA revealed a significant main effect for GE 'easy 85:15' ($F[42, 35] = 5.046$, $P \leq 0.0005$, $\eta^2_p = 0.858$) and a trend toward a significant interaction between XPG and GE 'easy 85:15' ($F[18, 15] = 2.069$, $P = 0.080$, $\eta^2_p = 0.713$); for GE 'medium 70:30' univariate ANCOVA revealed a significant main effect for GE 'medium 70:30' ($F[49, 16] = 6.220$, $P \leq 0.0005$, $\eta^2_p = 0.916$) however no significant interaction was revealed between XPG and GE 'medium 70:30' ($F[10, 16] = 1.091$, $P = 0.423$, $\eta^2_p = 0.405$); for GE 'hard 55:45' univariate ANCOVA revealed a significant main effect for GE 'hard 55:45' ($F[48, 29] = 6.200$, $P \leq 0.0005$, $\eta^2_p = 0.911$) however no significant interaction was revealed between XPG and GE 'hard 55:45' ($F[16, 11] = 0.533$, $P = 0.877$, $\eta^2_p = 0.437$).

Thirdly, setting DTC ‘Global’ as the DV, univariate ANCOVA revealed a significant main effect for DTC ‘easy 85:15’ (F[10, 67] = 24.733, $P \leq 0.0005$, $\eta^2_p = 0.787$) however no significant interaction was found between XPG and DTC ‘easy 85:15’ (F[9, 56] = 1.288, $P = 0.264$, $\eta^2_p = 0.171$); for DTC ‘medium 70:30’ univariate ANCOVA revealed a significant main effect for DTC ‘medium 70:30’ (F[5, 72] = 27.437, $P \leq 0.0005$, $\eta^2_p = 0.656$) and a trend toward a significant interaction was revealed between XPG and DTC ‘medium 70:30’ (F[6, 64] = 1.930, $P = 0.089$, $\eta^2_p = 0.153$); for DTC ‘hard 55:45’ univariate ANCOVA revealed a significant main effect for DTC ‘hard 55:45’ (F[8, 69] = 42.552, $P \leq 0.0005$, $\eta^2_p = 0.831$) however no significant interaction was revealed between XPG and DT ‘hard 55:45’ (F[8, 59] = 0.732, $P = 0.663$, $\eta^2_p = 0.090$).

6.5.3.1 Interpretation of main effects and interactions

The two-way univariate ANCOVA results demonstrated significant main effects for all six BT variants on their respective DVs (GE ‘Global’ and DTC ‘Global’). Moreover, no significant interactions were observed between any of the six variants and XPG, aside from the GE ‘easy 85:15’ condition, which displayed a trend toward significance ($P = 0.080$).

Taken as a whole these supplementary analyses indicate that, with regard to the main effects of the IVs on the DVs, all six BT variants (IVs) significantly contributed to mean differences in the DVs (all $P \leq 0.0005$); a result that goes some way to validating test construction (IV inclusion and procedure [see Chapter 5, section 5.2.4.1]). With regard to the interactions between the IVs and XPG on the DVs, as all six analyses essentially produced nonsignificant results—GE ‘easy 85:15’ being the only exception (trend)—indicating that the DVs are free from any synergistic influence (interactions) generated between XPG and the IVs.

Table 16: Descriptives plus effect sizes for BT (GE and DTC variables)

BT variable	XPG	*N*	Mean	S.D.	Effect size [η^2_p]/(%)
GE 'easy 85:15'*	1	26	-17.56	8.431	0.045/(96.14)
	2	26	-20.73	9.478	
	3	26	-22.27	9.669	
GE 'medium 70:30'*	1	26	-29.50	8.511	0.031/(97.65)
	2	26	-32.40	11.393	
	3	26	-34.07	12.235	
GE 'hard 55:45'*	1	26	-26.04	6.349	0.164/(63.64)
	2	26	-24.73	12.286	
	3	26	-34.50	10.372	
DTC 'easy 85:15'	1	26	4.23	3.943	0.070/(91.68)
	2	26	3.81	2.281	
	3	26	2.46	1.726	
DTC 'medium 70:30'	1	26	2.38	2.562	0.062/(93.37)
	2	26	2.12	1.107	
	3	26	1.38	0.804	
DTC 'hard 55:45'	1	26	4.04	4.074	0.116/(63.64)
	2	26	5.23	4.537	
	3	26	2.00	2.298	
DTC 'Global'	1	26	1.03	0.675	0.145/(65.89)
	2	26	1.09	0.728	
	3	26	0.50	0.533	

*See also Figure 31 (Chapter 7, section *7.3.7.1*)

6.5.4 Contributions of GCA and SRMs toward accounting for mean differences (covariations) in BT scores

6.5.4.1 GE hard '55:45'

Univariate ANCOVA revealed that after accounting for GCA (F[2, 74] = 6.401, P = 0.003), the ESNS (F[2, 74] = 8.733, $P \leq 0.0005$), the DUS (F[2, 74] = 6.029, P = 0.004), the BIMP (F[2, 74] = 4.629, P = 0.013), the AES (F[2, 74] = 6.343, P = 0.003), and VVIQ scores (F[2, 74] = 3.808, P = 0.027) the significant mean differences between XPGs remained.

6.5.4.2 DTC 'Global'

Univariate ANCOVA revealed that after accounting for GCA (F[2, 74] = 4.959, P = 0.010), the ESNS (F[2, 74] = 4.175, P = 0.019), the DUS (F[2, 74] = 8.600, $P \leq 0.0005$), the AES (F[2, 74] = 4.795, P = 0.011), and VVIQ scores (F[2, 74] = 4.506, P = 0.014) the significant differences between

XPGs remained. However, after accounting for the BIMP the significant mean differences became a trend toward significance (F[2, 74] = 2.875, P = 0.063).

6.5.5 Stepwise (forward) linear regression of BT variables

6.5.5.1 GE 'hard 85:15'

Entering GE 'hard 55:45' as the DV and all SRMs plus participants' Age as IVs the stepwise (forward) method of linear regression revealed that only the VVIQ accounted for a significant proportion (4.8%) of variations in GE 'hard 55:45' scores (see Table 17).

Table 17: Regression model for GE 'hard 55:45'

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
VVIQ	-0.246	-2.212	0.030	.048
Total Adjusted $R^2 = 0.048$				

6.5.5.1 DTC 'Global'

Entering DTC 'Global' as the DV and all SRMs plus participants' Age as IVs the stepwise (forward) method of linear regression revealed that only the BIMP accounted for a significant proportion (6.1%) of variations in DTC 'Global' scores (see Table 18).

Table 18: Regression model for DTC 'Global'

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
BIMP	-0.271	-2.456	0.016	.061
Total Adjusted $R^2 = 0.061$				

6.5.6 Summary of BT results

Only the hard '55:45' variant of the GE procedure reached statistical significance between XPGs. This finding is unsurprising as any over- and/or under-confidence effects have been found to be reversed (and even in some instances negated) as the nature of the data (sc., percentages) becomes easier to manipulate (Lichtenstein & Fischoff, 1977). The three DTC variants all reached significance

(ANOVA/LTA); however, all three variants possessed significant HOV and as such were amalgamated into a global measure. After subjecting the global data to a log transformation the HOV statistic became nonsignificant, and subsequent ANOVA revealed significant mean differences between XPGs. Additionally, two-way ANOVAs revealed no significant XPG × Gender interactions for the GE 'hard 55:45' and DTC 'Global' variables. Supplementary two-way ANOVAs revealed significant main effects for the six IVs on the two DVs (Global' GE and DTC); however, no significant interactions were revealed between the six IVs and XPG with the two global measures of GE and DTC.

ANCOVA (including GCA, the ESNS, the DUS, the BIMP, the AES, and the VVIQ as covariates), revealed that for GE 'hard 55:45' none of the variables reduced the significant mean differences between XPGs to a level of nonsignificance; however, with regard to DTC 'Global' the BIMP reduced the significant mean differences between XPGs to the level of a trend toward significance.

Linear regression analyses (including participants' Age, the ESNS, the DUS, the BIMP, the AES, and the VVIQ as predictor variables) revealed that only the VVIQ accounted for a significant proportion of variations in GE 'hard 55:45,' and only the BIMP accounted for a significant proportion of variations in DTC 'Global' scores.

From the above analyses it is decided that GE 'hard 55:45' and DTC 'Global' variables will be taken forward for further correlational and CDA analyses.

6.6 Object recognition (OR)

There were three aspects of the OR procedure that were of interest: 1) mean differences between XPGs in the number of correct responses (NCRs) through all six levels of images presentation; 2) mean differences between XPGs in the point at which participants were prepared to forward an Initial recognition, irrespective of whether the response is correct or incorrect; and 3) mean differences between XPGs in confidence when responding under conditions of matched uncertainty ($Conf_{50:50}$).

6.6.1 Mean differences in OR performance

6.6.1.1 Mean differences in the NCRs (averaged from levels 1 through 6)

In confirmation of hypothesis 14, one-way ANOVA (NCRs × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 18.589$, $P \leq 0.0005$); and in further confirmation, LTA was also significant ($F[1, 77] = 26.636$, $P \leq 0.0005$). See Table 19 for descriptives and Figures 21 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2 ,74] = 0.695$, $P = 0.502$).

Figure 21: Bar chart for the mean NCRs attained through all levels of images presentation

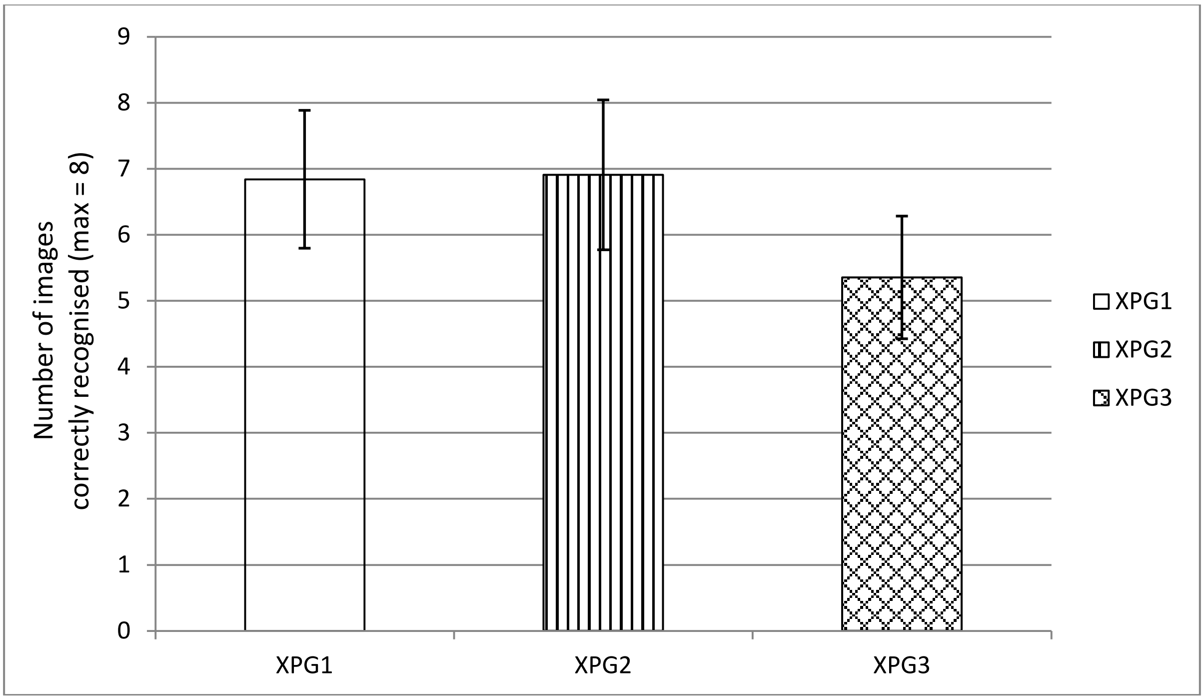


Figure 21 reveals a pattern of performance as predicted. That is, equitable performance from XPGs 1 and 2 followed by a pronounced descent from XPG2 to XPG3. This observation is given added weight by the post-hoc analyses, which reveal that the significant differences manifest between XPGs 1 and 2 with XPG3 (Tukey's test, $P \leq 0.0005$, respectively), but not between XPG1 and XPG2 (Tukey's test, $P = 0.971$).

6.6.1.2 Mean differences in the percent of images required to make an Initial recognition

In confirmation of hypothesis 15, one-way ANOVA (Initial recognition [%] × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 7.695$, $P = 0.001$); and in further confirmation, LTA was also significant ($F[1, 77]= 15.343$, $P \leq 0.0005$). See Table 19 for descriptive statistics and Figure 22 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 1.357$, $P = 0.264$).

Figure 22: Means plot for the percent of images required to make an Initial recognition

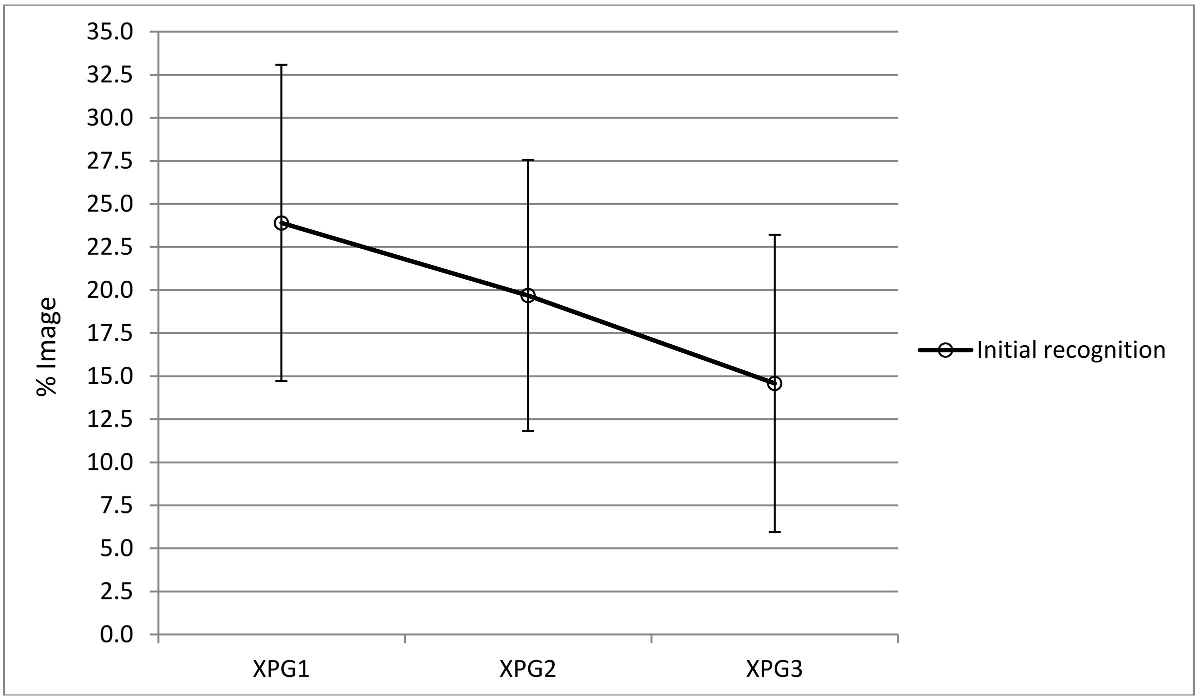


Figure 22 reveals a pattern of results as predicted. That is, a reasonably steep linear descent through XPGs. This observation is confirmed by the post-hoc analyses, which confirm that the significant differences manifest between XPG1 and XPG3 (Tukey's test, P = 0.001) coupled with a trend toward a significant mean difference between XPG2 and XPG3 (Tukey's test, P = 0.087), but no significant difference was revealed between XPGs 1 and 2 (Tukey's test, P = 0.187).

6.6.1.3 Mean differences in Confidence When Uncertain (Conf$_{50:50}$)

All eight images were drawn from a norm-referenced battery (Snodgrass & Vanderwart, 1980) furthermore the images were standardised for *familiarity* (Barry et al., 2001) and *difficulty* (Catling & Johnson, 2006). Therefore, it made sense to use the delineation points of each items' recognition difficulty. The eight images were graded as follows: easy = camel and pig; moderate = truck and car; hard = violin and bike; and very hard = frog and plane. After having gone through each individual participants' file, the point at which the vast majority of participants (N = 75 of 78) become unsure as to the identity of items is after they have recognised the four easy and moderate items. Therefore, mean confidence is calculated from immediately after the point at which each participant correctly recognised the four "easy" and "moderate" items, including any additional item/s. So, for example, if a participant recognises five items when first identifying the four more simplistic items they will receive a mean confidence (%) based on those five recognitions, etc. Such a procedure facilitates a more comprehensive recognition analysis because it does not discount any participant based on a failure to discern easy to moderate recognitions, whilst also incorporating those who are more adept at object recognition by not discounting any additional recognitions made at the point of identifying the four easier (more basic) items.

In confirmation of hypothesis 16, one-way ANOVA ($Conf_{50:50}$ × XPG) revealed significant mean differences between XPGs ($F[2, 75] = 19.533$, $P \leq 0.0005$); and in further confirmation, LTA was also significant ($F[1, 77] = 37.478$, $P \leq 0.0005$). See Table 19 for descriptive statistics and Figure 23 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction ($F[2, 74] = 1.300$, $P = 0.279$).

Figure 23: Means plot for $Conf_{50:50}$

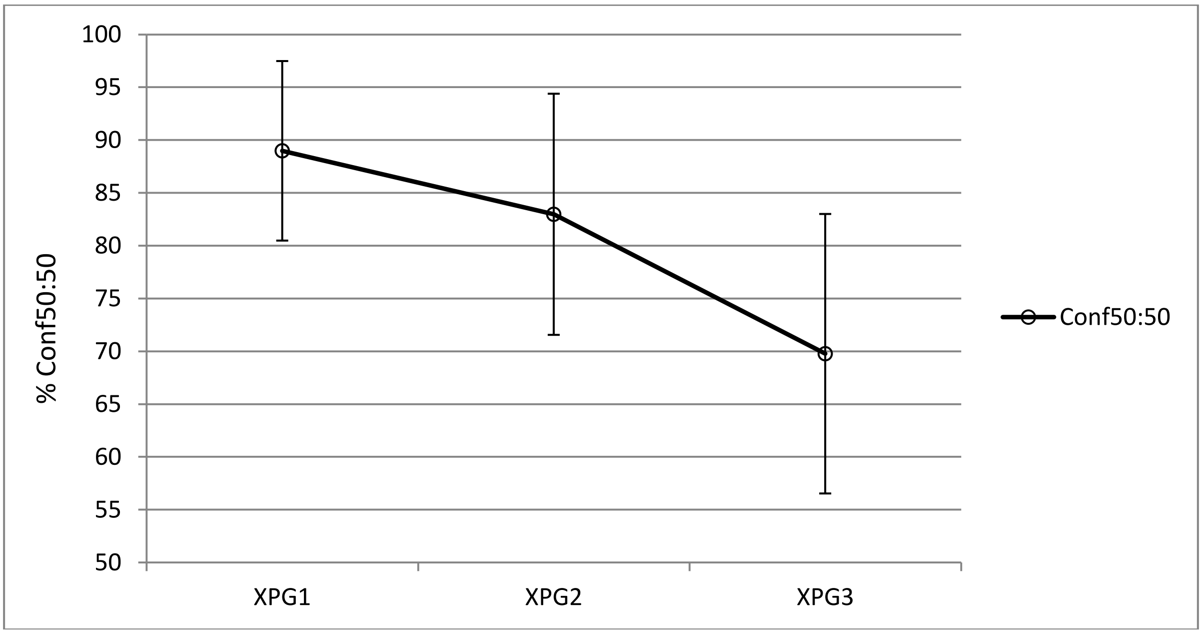
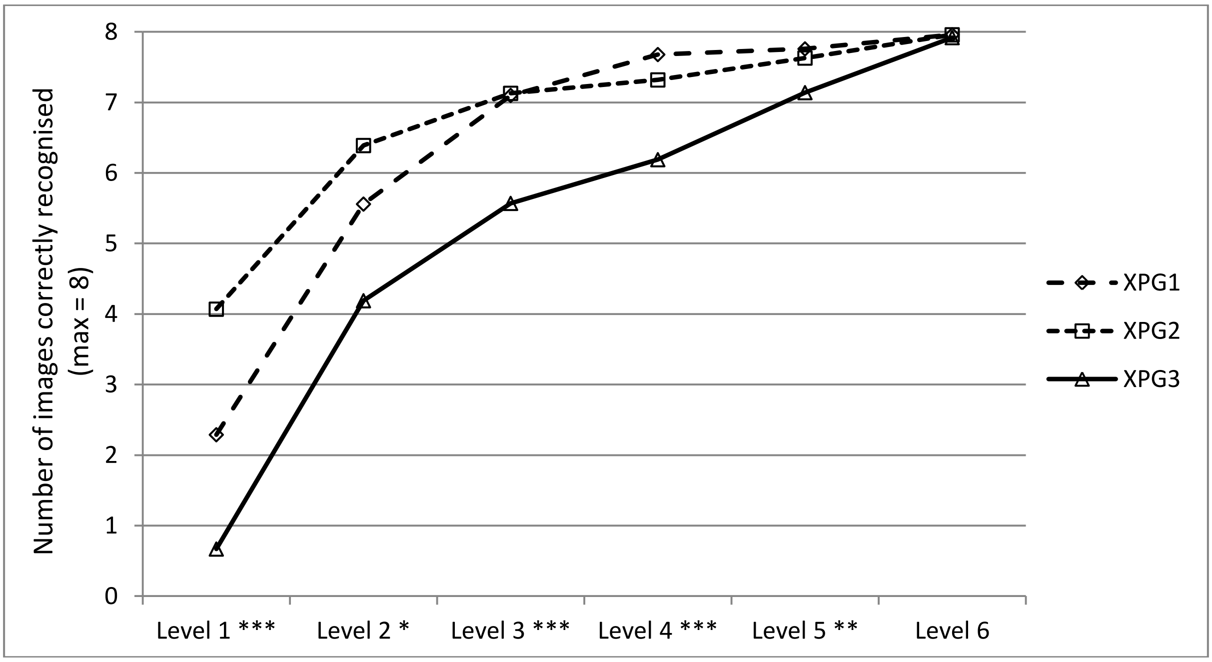


Figure 23 reveals a pattern of performance as predicted. That is, a reasonably steep descent through XPGs. These observations are given added weight by post-hoc analyses, which reveal that the significant mean differences manifested between XPGs 1 and 2 with XPG3 (Tukey's test, $P \leq 0.0005$), but not between XPG1 and XPG2 (Tukey's test, $P = 0.136$). Although the pattern of mean scores is in the predicted direction—that is, confidence decreasing as a function of XPG—the results actually demonstrate that XPG3 (~70%) are closer to the 50% ($Conf_{50:50}$) mark than either XPGs 1 (~89%) or 2 (~83%), who seemingly display mean *over*confidence (see Table 19). However, it must be borne in mind that despite XPGs 1 and 2 providing higher mean confidence judgments, they identified more objects correctly so the increased confidence of XPGs 1 and 2 was well placed.

6.6.1.3.1 Mean differences in the NCRs across six levels of images presentation

In order to gain a clearer picture of the pattern of recognition ability spanning the whole OR test, a series of six one-way ANOVAs were conducted in order to assess the mean NCRs at each level of images presentation. See Figure 24 for graphical representation. Figure 24 (see below) illustrates that the significant mean NCRs differences manifested through all levels of images presentation aside from, unsurprisingly, level 6.

Figure 24: Means plots for NCRs across six levels of images presentation



*$P \leq 0.05$
**$P \leq 0.01$
***$P \leq 0.0005$

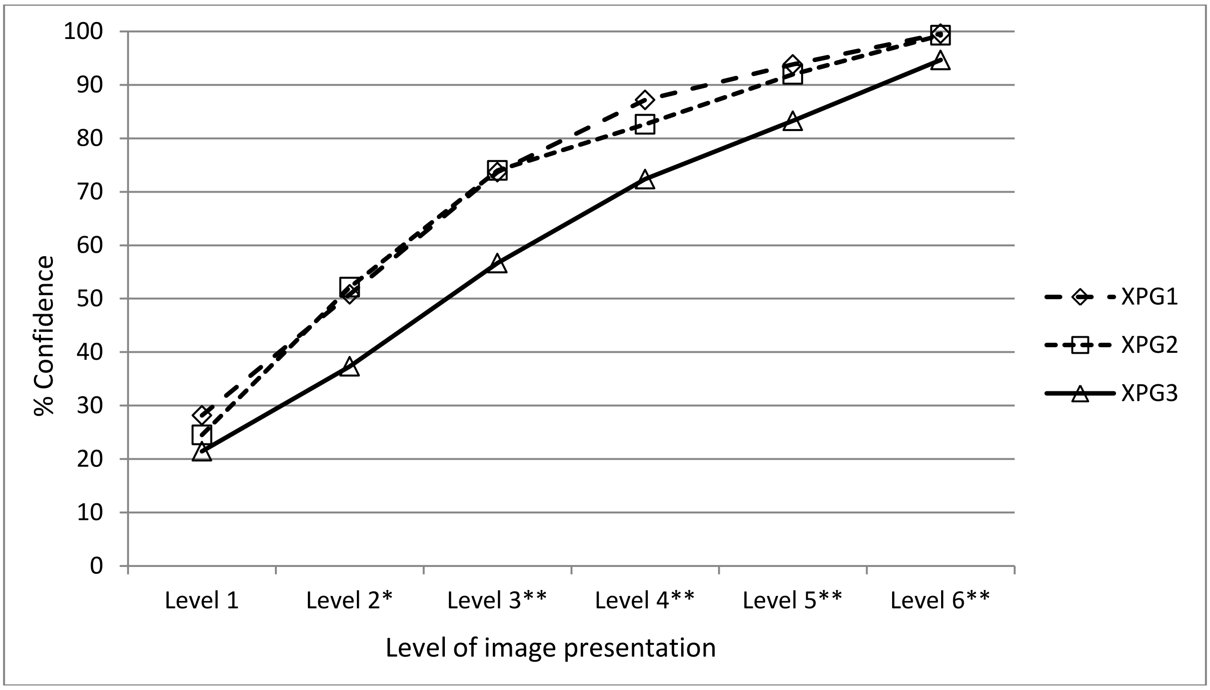
6.6.1.3.2 Mean differences in mean confidence across six levels of images presentation

In order to gain a clearer picture of the pattern of confidence judgments spanning the whole OR test, a series of six one-way ANOVAs were conducted in order to assess mean confidence at each level of images presentation. See Figure 25 for graphical representation.

Table 19: Descriptive statistics and effect sizes for OR variables

OR variable	XPG	*N*	Mean	S.D.	Effect size [η^2_p]/(%)
	1	26	6.84	1.044	
NCRs	2	26	6.91	1.136	0.331/(71.65)
	3	26	5.35	0.929	
	1	26	23.89	9.181	
Initial recognition	2	26	19.69	7.864	0.170/(99.69)
	3	26	14.58	8.627	
	1	26	75.88	17.616	
$Conf_{50:50}$	2	26	64.96	18.414	0.346/(95.94)
	3	26	52.52	12.299	

Figure 25: Means plots for confidence across six levels of images presentation



*$P \leq 0.01$
** $P \leq 0.0005$

Figure 25 illustrates that XPG3, except for the initial threshold (2.5%) level, reported significantly decreased confidence through all levels of images presentation.

6.6.2 Contributions of GCA and SRMs toward accounting for mean differences (covariations) in OR variables

6.6.2.1 NCRs

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 16.059$, $P \leq 0.0005$), the ESNS ($F[2, 74] = 13.545$, $P \leq 0.0005$), the DUS ($F[2, 74] = 18.141$, $P \leq 0.0005$), the BIMP ($F[2, 74] = 6.162$, $P = 0.003$), the AES ($F[2, 74] = 14.687$, $P \leq 0.0005$), and the VVIQ ($F[2, 74] = 10.863$, $P \leq 0.0005$) the significant mean differences between XPGs remained.

6.6.2.2 Initial recognition

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 5.820$, $P = 0.004$), the ESNS ($F[2, 74] = 6.265$, $P = 0.003$), the DUS ($F[2, 74] = 7.511$, $P = 0.001$), the AES ($F[2, 74] = 5.321$, $P = 0.007$), and the VVIQ ($F[2, 74] = 9.469$, $P \leq 0.0005$) the significant mean differences between XPGs remained. However, after accounting for the BIMP the significant mean differences between XPGs became a trend ($F[2, 74] = 2.934$, $P = 0.059$).

6.6.2.3 $Conf_{50:50}$

Univariate ANCOVA revealed that after accounting for GCA ($F[2, 74] = 17.886$, $P \leq 0.0005$), the ESNS ($F[2, 74] = 19.833$, $P \leq 0.0005$), the DUS ($F[2, 74] = 14.536$, $P \leq 0.0005$), the BIMP ($F[2, 74] = 12.031$, $P \leq 0.0005$), the AES ($F[2, 74] = 14.720$, $P \leq 0.0005$), and the VVIQ ($F[2, 74] = 19.020$, $P \leq 0.0005$) the significant mean differences between XPGs remained.

6.6.3 Stepwise (forward) linear regression of variations in OR variables

6.6.3.1 NCRs

Setting NCRs as the DV and entering all SRMs (including participants' Age) as IVs the stepwise (forward) method of linear regression revealed that only the BIMP accounted for a significant proportion (30.9%) of variations in NCRs scores (see Table 20).

Table 20: Regression model for the NCRs

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
BIMP	-0.564	-5.955	0.000	.309
Total Adjusted R^2 = 0.309				

6.6.3.2 Initial recognition

Setting Initial recognition as the DV and entering all SRMs (including participants' Age) as IVs the stepwise (forward) method of linear regression revealed that only the BIMP and the DUS accounted for significant proportions (total = 14.2%) of variations in Initial recognition scores (see Table 21).

Table 21: Regression model for Initial recognition

Predictor variable (SRM)	*B*	*t*	*P*	R^2
BIMP	-0.250	-2.171	0.033	.107
DUS	-0.234	-2.030	0.046	.035
Total Adjusted R^2 = 0.142				

6.6.3.3 Conf$_{50:50}$

Setting Conf$_{50:50}$ as the DV, and entering all SRMs (including participants' Age) as IVs, the stepwise (forward) method of linear regression identified that only the BIMP accounted for a significant proportion (16.5%) of variations in Conf$_{50:50}$ scores (see Table 22).

Table 22: Regression model for Conf$_{50:50}$

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
BIMP	-0.280	-2.513	0.014	.118
AES	0.242	2.167	0.033	.042
Total Adjusted R^2 = 0.160				

6.6.4 Summary of OR results

Significant mean differences were revealed between XPGs for all three OR variables, confirming the experimental hypotheses. No significant XPG × Gender interactions were revealed. ANCOVA revealed that the covariance measures (GCA, the ESNS, the DUS, the BIMP, the AES, and the VVIQ) made little impact on the significant mean differences between XPGs. Stepwise (forward) linear regression analyses revealed that only participants' BIMP, DUS, and AES scores differentially accounted for significant proportions of variations in OR variables.

The OR analyses had as their primary interest the potential differences in recognition ability and confidence judgment. As such, it was decided that all three variables would be taken forward for inclusion in future correlational and CDA analyses.

6.7 Reality monitoring (RM)

There were three independent aspects of the RM procedure which were of primary interest: 1) mean differences between XPGs in RM 'Memory' performance; 2) mean differences between XPGs in RM 'Mode' performance; and 3) that variations in RM 'Mode' scores will be significantly predicted by VVIQ scores. SDT was utilised to calculate both RM 'Memory and RM 'Mode' scores[54].

6.7.1 Analysis of mean differences between XPGs

6.7.1.1 Mean differences in RM 'Memory'

In confirmation of hypothesis 17, one-way ANOVA ('Memory' × XPG) revealed significant mean differences between XPGs (F[2, 75] = 3.116, P = 0.050); however, LTA was nonsignificant (F[1, 77] = 2.677, P = 0.106). See Table 23 for descriptive statistics and effect size; see Figure 26 for graphical representation. Additionally, two-way ANOVA revealed no significant XPG × Gender interaction (F[2, 74] = 1.051, P = 0.355).

[54] With regard to RM 'Memory', *d'* was calculated from the *z* of H (correct recollection of previously encoded target stimuli) minus the *z* of FA (incorrect recollection of new items). With regard to RM 'Mode', *d'* was calculated from the *z* of H (correct recollection of the mode of presentation of previously encoded target stimuli) minus the *z* of FA (incorrect recollection of the mode of presentation of test options).

6.7.1.2 Mean differences in RM 'Mode'

In confirmation of hypothesis 18, one-way ANOVA ('Mode' × XPG) revealed significant mean differences between XPGs (F[2, 75] = 5.162, P = 0.008); and in further confirmation, LTA was also significant (F[1, 77] = 7.817, P = 0.007). See Table 23 for descriptive statistics and effect size; see Figure 27 for graphical representation. Additionally, two-way ANOVA revealed a significant XPG × Gender interaction (F[2, 74] = 4.932, P = 0.010). Analysis of the mean XPG × Gender scores revealed that males outscored females in XPG1 (M_{Male} = 2.00, M_{Female} = 1.79) and XPG3 (M_{Male} = 1.61, M_{Female} = 1.53) but not in XPG2 (M_{Male} = 1.67, M_{Female} = 2.10).

Table 23: Descriptive statistics and effect sizes for RM variables

RM variable	XPG	*N*	Mean	S.D.	Effect size [η^2_p]/(%)
	1	26	2.57	0.642	
RM 'Memory'	2	26	2.71	0.620	0.077/(42.97)
	3	26	2.28	0.603	
	1	26	1.87	0.370	
RM 'Mode'	2	26	1.87	0.401	0.121/(75.73)
	3	26	1.56	0.438	

Figure 26: Means plot for RM 'Memory'

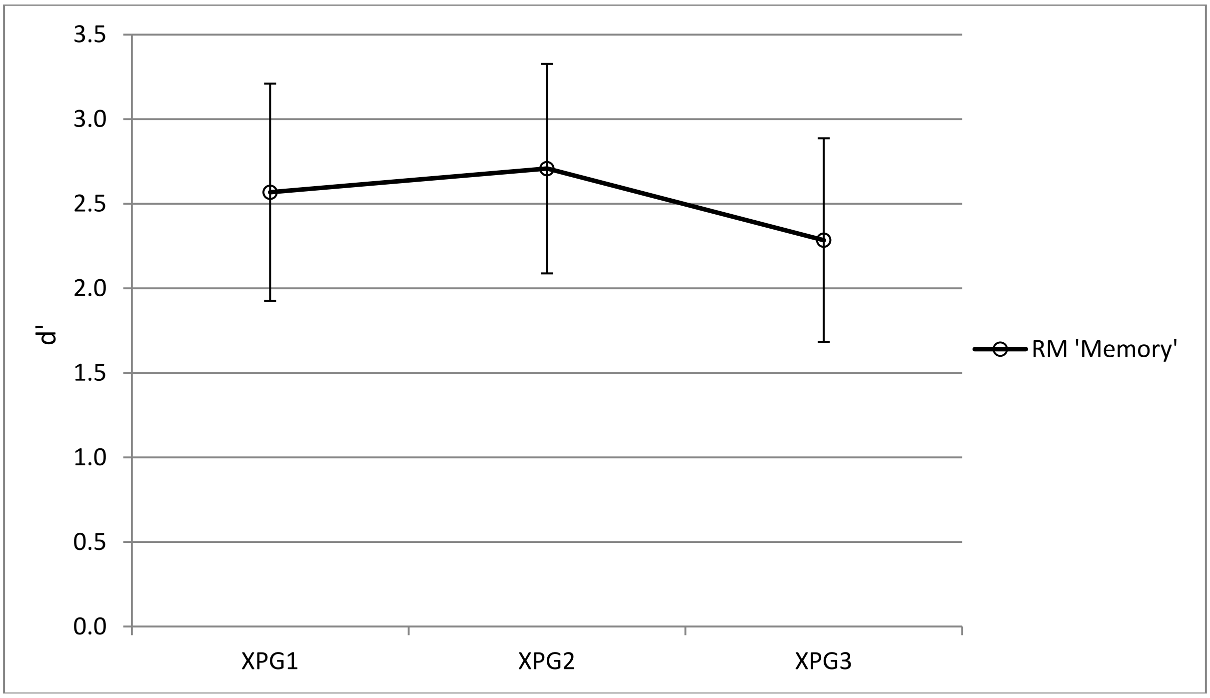
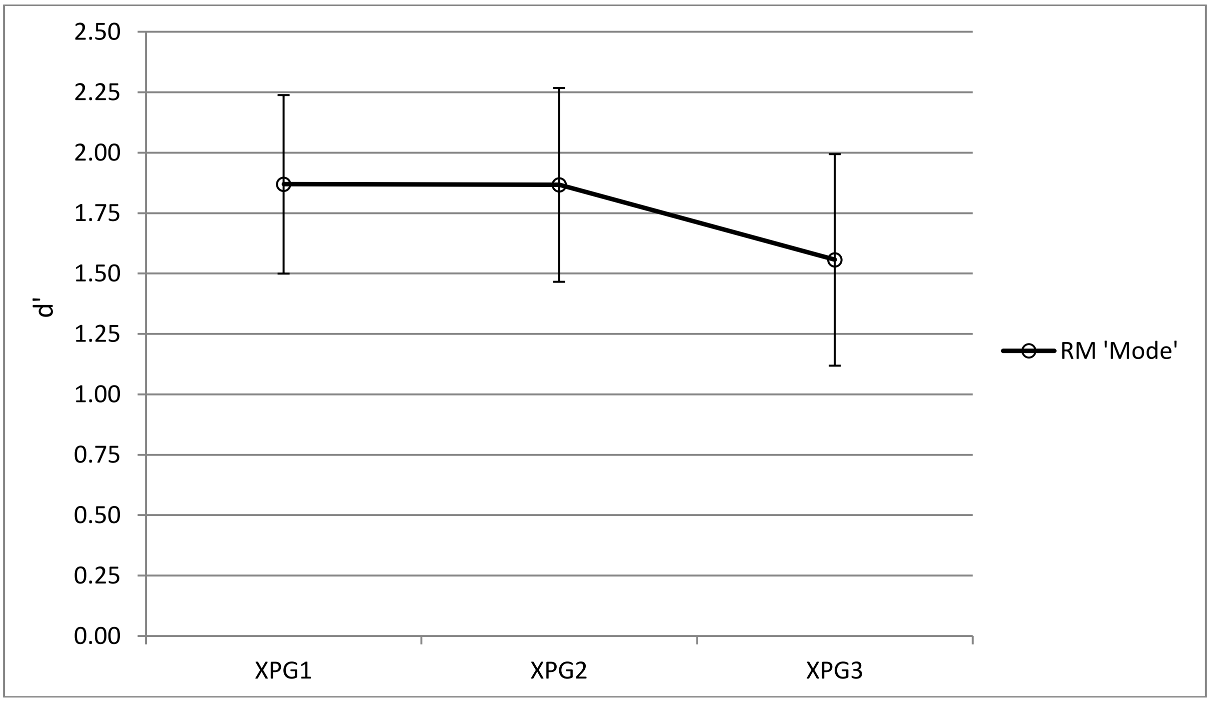


Figure 26 reveals a pattern of performance as predicted; that is, equitable performance from XPGs 1 and 2 followed by a slightly more pronounced descent from XPG2 to XPG3. These observations are given further credence by post-hoc analysis, which revealed that the significant differences only fell between XPG2 and XPG3 (Tukey's test, P = 0.043).

Figure 27 (see below) reveals a pattern of performance as predicted; that is, equivalent (almost exact) performance from XPGs 1 and 2 followed by a reasonably pronounced descent from XPG2 to XPG3. These observations are given further credence by post-hoc analysis, which revealed that the significant mean differences fell between XPGs 1 and 2 with XPG3 (Tukey's test, P = 0.018 and P = 0.019, respectively) but not between XPG1 and XPG2 (Tukey's test, P = 0.999).

Figure 27: Means plot for RM 'Mode'



6.7.2 Contributions of GCA and SRMs toward accounting for mean differences (covariations) in RM variables

6.7.2.1 RM 'Memory'

Univariate ANCOVA revealed that after accounting for GCA (F[2, 74] = 2.348, P = 0.103), the ESNS (F[2, 74] = 2.015, P = 0.141), the DUS (F[2, 74] = 2.077, P = 0.133), the BIMP (F[2, 74] = 1.336, P = 0.269), and AES scores (F[2, 74] = 2.120, P = 0.127) the significant mean differences between XPGs became nonsignificant. However, after accounting for participants' VVIQ scores (F[2, 74] = 2.573, P = 0.083) mean differences between XPGs became a trend toward significance.

6.7.2.2 RM 'Mode'

Univariate ANCOVA revealed that after accounting for GCA (F[2, 74] = 5.755, P = 0.005), the ESNS (F[2, 74] = 6.450, P = 0.003), and AES scores (F[2, 74] = 4.223, P = 0.018) mean differences between XPGs remained significant; however after accounting for the DUS (F[2, 74] = 3.049, P = 0.054) and BIMP scores (F[2, 74] = 2.475, P = 0.091) mean differences between XPGs became a trend toward significance. However, after accounting for VVIQ scores (F[2, 74] = 1.836, P = 0.167) mean differences between XPGs became nonsignificant.

6.7.3 Stepwise (forward) linear regression of variations in RM variables

6.7.3.1 RM 'Memory'

Setting RM 'Memory' as the DV, and entering all the other SRMs (including participants' Age) as IVs, the stepwise (forward) method of linear regression identified that only the BIMP accounted for a significant proportion (6.2%) of variations in RM 'Memory' scores (see Table 24).

Table 24: Regression model for RM 'Memory'

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
BIMP	-0.272	-2.460	0.016	.062
Total Adjusted R^2 = 0.062				

6.7.3.2 RM 'Mode'

Setting RM 'Mode' as the DV, and entering all the other SRMs (including participants' Age) as IVs, the stepwise (forward) method of linear regression identified that only the VVIQ accounted for a significant proportion (10.1%) of variations in RM 'Mode' scores (see Table 25). This finding confirms hypothesis 19.

Table 25: Regression model for RM 'Mode'

Predictor variable (SRM)	*B*	*t*	*P*	R^2 *change*
VVIQ	-0.336	-3.105	0.003	.101
Total Adjusted R^2 = 0.101				

6.7.4 Summary of RM results

ANOVA revealed significant mean differences between XPGs for RM 'Memory' and 'Mode.' Two-way ANOVA revealed a significant XPG × Gender interaction for RM 'Mode'.

ANCOVA (incorporating GCA, the ESNS, the DUS, the BIMP, the AES, and the VVIQ as covariance variables) revealed that for RM 'Memory' all variables aside from VVIQ (trend) reduced the significant differences between XPGs to nonsignificance. With regard to RM 'Mode', after accounting for the covariance of VVIQ scores the significant mean differences between XPGs became nonsignificant; the variables of the DUS and the BIMP reduced the level of significance to a trend.

Linear regression analyses (including participants' Age, the ESNS, the DUS, the BIMP, the AES, and the VVIQ as predictor variables) revealed that only the BIMP accounted for a significant proportion of variations in RM 'Memory' scores; whereas, in line with prediction, only the VVIQ accounted for a significant proportion of variations in RM 'Mode' scores.

These analyses reveal that XPGs 1 and 2 outperform XPG3 with regard RM 'Memory' and 'Mode', indicating that not only can they recall items more accurately but that they can also, to a significant degree, attribute the correct source (mode) of those recollections.

From the RM analyses both variables ('Memory' and 'Mode') will be taken forward for further correlational and CDA analyses.

6.8 Self-monitoring (SM)

The primary aspect of the SM paradigm is participants' ability to monitor performance (an on-line metacognitive process) during the test. More specifically, this test was introduced to participants as the "Letters & Numbers Game"; as such, if a mistake (error) is made (-10%) participants are required to correct that error (+5%). Analysis of this experimental variable will be called the Proportion of Errors Corrected (PEC).

6.8.1 Analysis of mean differences between XPGs

6.8.1.1 Mean differences in SM 'PEC'

Due to a ceiling effect being observed with a large majority of participants (41/78, 52.6%) displaying perfect performance (i.e., scoring 100%, with no errors and no need for corrections) the resultant data was unsuitable for parametric analysis (hypothesis 20 void). This observation was confirmed by a HOV test (Levene's statistic = 11.032, $P \leq 0.0005$). As such, the raw data was subjected to non-parametric, Chi-square analysis. Results revealed a significant difference in the number of participants from each XPG making errors ($\chi^2 = 21.28$, df = 2, $P < 0.001$): XPGs 1 and 2 contained nine and 10 participants, respectively; whereas XPG3 contained 18 participants. Results for both the total (all 78 participants) and subsamples are tabulated (Table 26) and portrayed (Figure 28) based on mean percentage scores to provide easily interpretable indications of this trend. Table 26 and Figure 28 are provided for illustrative purposes only.

Table 26: Descriptive statistics for SM 'PEC'

Variable	XPG	*N*	Mean	SD
SM 'PEC'	1	26 (9)	96.92 (91.11)	5.114 (4.859)
	2	26 (10)	95.26 (87.67)	8.428 (9.660)
	3	26 (18)	85.96 (79.72)	14.766 (13.663)

*Subsamples in parentheses

6.8.2 Summary of SM results

The SM data possessed inadequate variance for parametric analyses. Chi-square revealed a significant difference in the distribution of participants making errors between XPGs with a significantly lesser number of participants from XPGs 1 and 2 making errors requiring correction than participants from XPG3. As such, SM 'PEC' scores will not be forwarded for further analyses (correlational and CDA).

Figure 28: Means plots for SM ‘PEC’

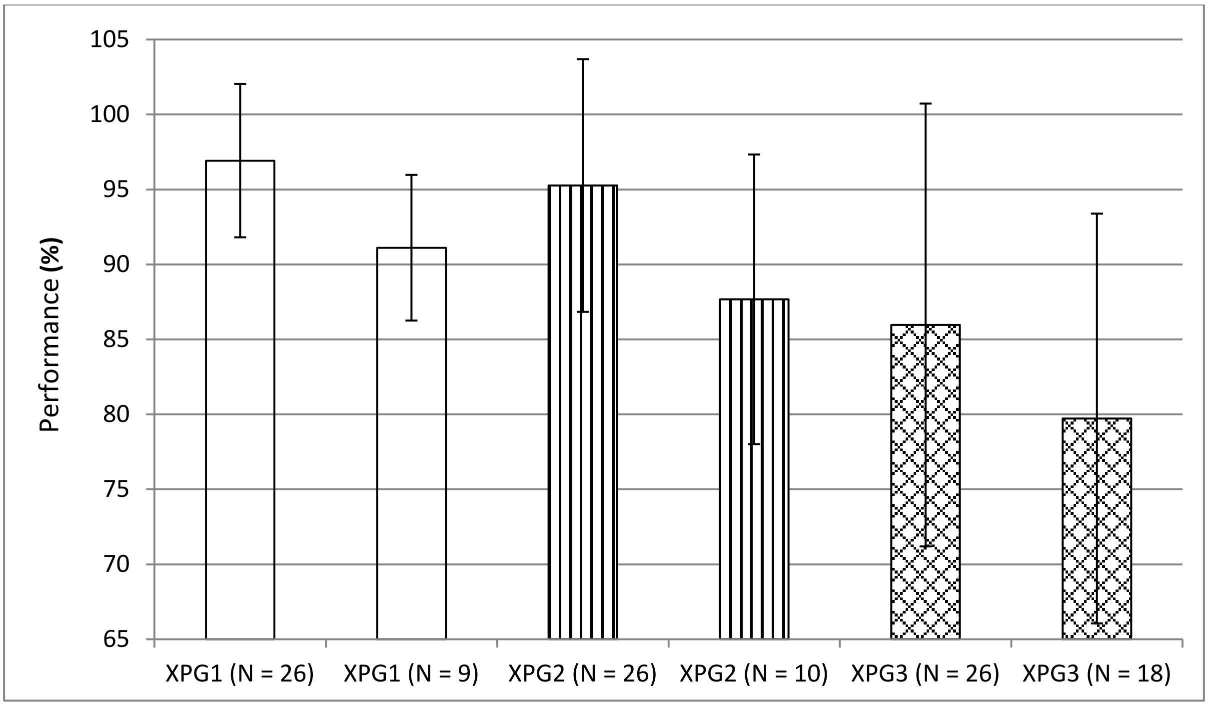


Figure 28 reveals patterns of performance as predicted. That is, for the total sample (*N* = 78) equitable performances from XPGs 1 and 2 followed by a marked decrease in performance from XPG2 to XPG3. Additionally, the distribution of condition-specific SD lines indicates that XPG scores for the error-making subsamples fell within the maximum range of 100%. However, due to irrevocable HOV violation, the data were unfortunately, inappropriate for parametric analysis. Although not appropriate for CDA analysis, due to uneven XPG membership and the aforementioned HOV violation, the subsample data do provide an indication that the distribution of error-correcting behaviour differs as a function of XPG.

6.9 A note on statistical power

6.9.1 Why an emphasis on power?

One of the targets of psychopathological research is identifying complex abilities and basic psychological processes that occur in mental disorders (e.g., attention deficits in schizophrenia) with a view to developing theoretical insights and therapeutic interventions (Strauss, 2001). As such, the procurement of robust statistical power for the experimental assessment of psychological variables is of great import to this study as some of the measures are not standardised (see, Woods, Rippeth, Conover, et al., 2006). Moreover, utilising standardised neuropsychological tests provides increased power to detect even a small effect size, whereas the utilisation of novel assessment methods can prove statistically problematic, no moreso than in the assessment of clinical populations (Woods et al., 2006). It is acknowledged that computing observed (retrospective) power is a tautological exercise when determining why a particular measure has *not* reached a set significance level; however, observed power can be helpful to guide future research (Hoenig & Heisey, 2001) and for presentation purposes (O'Keefe, 2007).

6.9.2 Power analyses of Phase 2 variables

Given the above considerations, and due to the novelty of some of the experimental measures (e.g., OR and SM paradigms), it seems appropriate to consider the effectiveness of the CCTB measures to detect any observed effects. The initial power for the study comes directly from the delineation of respondents from Phase 1 into three distinct XPGs. Such a methodology immediately provides power on the basis of psychometric distinctiveness. The observed power for each of the 21 CCTB variables plus the five supplementary SRMs are presented in Table 28[55] (p. 179).

The results in Table 28 indicate that, aside from DRM 'True memory' (borderline) and RM 'Memory', all Phase 2 variables possessed sufficient power ($\geq$ 0.80) to detect mean differences between XPGs (Cohen, 1992). Notwithstanding, the reasons for the high power values are primarily because the DVs are based on designed tasks, most of which are distilled from a range of carefully collected data and because the sample was recruited with considerable effort (stratified quota sample delineated by primary factor scores), including large numbers for cognitive laboratory work in extreme groups.

6.10 Correlational and canonical discriminant analyses (CDA) of the computerised cognitive test battery (CCTB) results

6.10.1 Correlational analysis

In order to gain an overview of the relationships between Phase 2 experimental variables a complete correlational analysis was conducted (see Table 29, p. 180). It can be seen that the majority of CCTB variables possessed statistically significant intercorrelations, notable exceptions being GCA, DRM 'True memory', and RM 'Mode'. The correlational matrix will only be briefly reviewed; more important to these analyses are the forthcoming CDAs, which will highlight the ability of the CCTB to discriminate between XPGs (i.e., by predicting XPG membership).

[55] Only those variables reaching statistical significance between XPGs will be entered into the forthcoming CDA analyses (see section 6.9.2).

Of special note, ANCOG possessed significant correlations with all CCTB measures with the exception of RM ‘Memory’, supporting the inclusion of these cognitive measures. The most prominent relationships (≥ 0.32; Tabachnik & Fidell, 2006) were with GCA (-0.39), GE ’55:45 hard’ (0.33); DRM ‘True memory’ (-0.37), ‘Critical lures’ (0.63), and ‘New items’ (0.48); and with OR ‘NCRs’ (-0.47), ‘Initial recognition’ (-0.41), and ‘$\text{Conf}_{50:50}$’ (-0.59), which suggests that the CDA may be primarily modeled around the DRM and OR tests.

Adding confirmatory weight to its inclusion as a covariate measure, GCA was only found to possess significant relationships with those variables pertaining to memory functioning, i.e. a negative relationship with DRM ‘Lures’ (-0.31) and a positive relationship with DRM ‘True memory’ (0.28). These results suggest that the ability to consciously avoid semantic relations between highly associated words (critical lures) is moderately associated with intelligence functioning; that is, possessing higher GCA would appear to be, to a limited extent, a protective cognitive mechanism shielding an individual from making erroneous recognitions (misattributions) from memory. DRM ‘True memory’ ability is weakly associated with GCA, suggesting that the more global aspects of memory functioning increase as GCA increases, which validates the previous suggestion of a protective mechanism.

6.10.1.1 Correlational analysis: Implications for CCTB efficacy

The results of the correlational analysis would appear to have two major implications with regard to the efficacy of evaluating cognitive performance: 1) the most pronounced correlations (≥ 0.32) are found within tests (e.g., the strong correlations between OR variables), which indicates that the cognitive domains are performing relatively independently of one another; and 2) that those test variables that do significantly intercorrelate possess some form of memory (e.g. DRM ‘Critical lures’ and ‘RM ‘Memory’ [-0.41]) or decision making component (e.g., OR ‘$\text{Conf}_{50:50}$’ and GE ‘hard 55:45’ [0.51]), which suggests that non-cognitive (e.g., psychopathological or behavioural) factors such as depression, test anxiety, and instruction comprehension (behavioural “noise”) may to a certain extent be influencing test performance (see, Moutoussis, Bentall, El-Deredy, et al., 2011, for a specific example).

Table 28: Observed power for the 21 CCTB variables and five accompanying SRMs

	Experimental variable/SRM	Observed power[56]
1.	**MR: Fluid/visuoconstructive IQ**	**0.817**
2.	**NART: Verbal IQ**	**0.700**
3.	GCA	0.897
4.	**CPT (*d'*)**	**0.320**
5.	**CPT (In*R*)**	**0.125**
6.	DRM: 'True memory'	0.794
7.	DRM 'Critical lures'	1.000
8.	DRM 'New words'	0.995
9.	**BT: GE 'easy 85:15'**	**0.360**
10.	**BT: GE 'medium 70:30'**	**0.253**
11.	BT: GE 'hard 55:45'	0.889
12.	**BT: DTC 'easy 85:15'**	**0.536**
13.	**BT: DTC 'medium 70:30'**	**0.483**
14.	**BT: DTC 'hard 55:45'**	**0.790**
15.	BT: DTC 'Global'	0.930
16.	OR: 'NCRs'	1.000
17.	OR 'Initial recognition'	0.941
18.	OR '$\text{Conf}_{50:50}$'	1.000
19.	RM: 'Memory'	0.583
20.	RM 'Mode'	0.812
21.	**SM: 'PEC'**	**0.963**
22.	ESNS	0.844
23.	DUS	0.925
24.	BIMP	1.000
25.	AES	0.816
26.	VVIQ	1.000

*All power analyses were conducted using alpha 0.05. Emboldened variables have been excluded from further analyses and are included for illustrative purposes, only.

[56] It is acknowledged that perfect power (i.e., 1.0) is impossible; the statistics reported here are the observed power outputs, correct to three decimal places, from SPSS (v. 19).

Table 29: Correlational matrix enumerating the relationships between the principal factor (ANCOG) and CCTB measures

	Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.	ANCOG	–	-0.39****	-0.37***	0.63****	0.33**	-0.33**	-0.24*	-0.47****	-0.41****	-0.59****	-0.20	-0.28*
2.	GCA		–	0.28*	-0.31**	0.07	0.14	0.18	0.20	0.21	0.17	0.18	0.01
3.	DRM 'True memory'			–	-0.32**	-0.43****	-0.06	-0.03	0.31**	0.18	0.03	0.11	-0.10
4.	DRM 'Lures'				–	0.15	-0.14	-0.40****	-0.52****	-0.20	-0.34**	-0.41****	-0.38***
5.	DRM 'New words'					–	0.04	-0.03	0.19	0.24*	-0.22*	0.01	-0.05
6.	GE 'hard 55:45'						–	-0.10	0.14	0.23*	0.51****	-0.01	0.09
7.	DTC 'Global'							–	0.48****	0.16	0.10	0.38***	0.29*
8.	OR 'NCRs'								–	0.39****	0.17	0.38***	0.37***
9.	OR 'Initial recog'									–	0.46****	-0.04	0.07
10	OR 'Conf$_{50:50}$'										–	0.05	0.22
11.	RM 'Memory'											–	0.47****
12.	RM 'Mode'												–

*$P \leq 0.05$
** $P \leq 0.01$
*** $P \leq 0.001$
**** $P \leq 0.0005$

6.10.2 Canonical Discriminant Analysis (CDA)

Based on the fact that the majority of mean differences (ANOVA/LTA) fell between XPGs 1 and 2 with XPG3, before proceeding with the classification procedures, it was decided to collapse XPGs 1 and 2 into one XPG (N = 52). Two discriminant analyses were performed. First, the 11 experimental cognitive variables: setting XPG as the DV and entering GCA, DRM 'True memory', DRM 'Critical lures', DRM 'New items', GE 'hard 55:45', DTC 'Global', OR 'NCRs', OR 'Initial recognition', OR '$\text{Conf}_{50:50}$', RM 'Memory', and RM 'Mode' as predictor variables—a total of 78 cases were analysed. A series of one-way ANOVAs revealed that XPGs 1–2 and 3 differed significantly on all 11 predictor variables. One discriminant function was calculated and the value of the function was highly significant, $\chi^2 = 86.493$, df = 10, $P \leq 0.0005$, which indicates that it makes a significant contribution to group affiliation. The EV associated with the function indicated that Function 1 (EV = 2.381; 100.0% of total variance) possessed strong discriminatory power between XPGs; and in further confirmation, the canonical relationship (0.84) indicated that Function 1 discriminated well between XPGs.

Wilks' lambda statistics (Function 1 = 0.296, $P \leq 0.0005$) revealed that when utilising Function 1, a highly significant result is produced, confirming that XPG means significantly differ. As Wilks' lambda provides a test of the null hypothesis (i.e., that the variables entered into the discriminant analysis do not predict XPG membership); because of the high significance of Function 1 the null hypothesis can thus be rejected.

Using the interpretational procedure adopted by Gavilán and García-Albea (2011)—whereby only those correlations reaching ≥ 0.32 might be considered of statistical importance (Tabachnik & Fidell, 2006)—with regard to these analyses, the correlations between predictor variables and Function 1 revealed that the experimental variables of DRM 'Lures', OR 'NCRs', and OR '$\text{Conf}_{50:50}$' (rs ≥ 0.32) were the three variables that best predicted XPG membership (see Table 30). The remaining variables made only minor (r = 0.15–0.20) to modest (r = 0.21–0.31) contributions toward XPG membership.

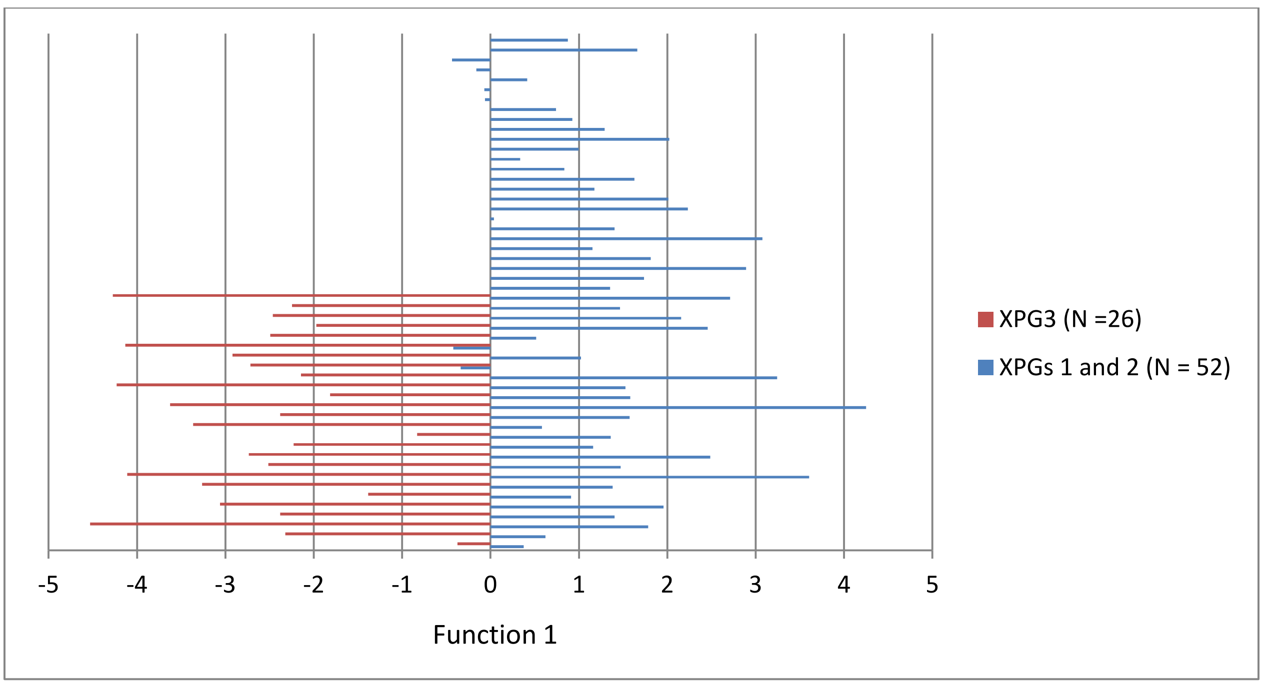
In view that the assumption of homocedasticity was not violated (Box' M = 69.166, df1 = 55, df2 = 8,598.334, P = 0.381) the option of "combined groups" covariance was used in classification. The usefulness of the equation in discriminating correctly between XPGs was confirmed by the classification procedure. Results showed that 94.9% of participants were correctly classified. Overall, the discriminant Function successfully predicted outcome (XPG membership) for 94.2% of XPG1–2 and 96.2% of XPG3. Because these results exceed the value of classification as expected based on chance (50%), the first discriminant analysis provides initial evidence for the efficacy of certain aspects of the CCTB to discriminate between individuals completing psychometric indices investigating ostensibly ANCOG (see Figure 29).

Table 30: Structure matrix for correlations between discriminant function and predictor variables

	Function 1
DRM 'Lures-trans'	-0.60
OR 'NCRs'	0.42
OR '$Conf_{50:50}$'	0.42
DRM 'New words'	-0.31
GE 'hard 55:45'	0.26
OR 'Initial recognition'	0.24
DTC 'Global-trans'	0.23
RM 'Mode'	0.22
GCA	0.21
DRM 'True memory'	0.21
RM 'Memory'	0.16

*Largest absolute correlation between each variable and any discriminant function; those correlations reaching the demarcation level expounded by Tabachnik and Fidell (2006) have been emboldened.

Figure 29: Canonical discriminant function (experimental CCTB measures)



Despite SPSS producing no graphical representation for a single-function solution, extracting the correlation coefficients (raw data) from SPSS and importing it into Excel allowed for the generation of a visual illustration of the results. Figure 29 illustrates that the discriminant function (0 = delineation point) clearly segregates XPG3 (–) from XPGs 1–2 (+). The classification procedure verified this observation with two participants from XPG1–2 being wrongly classified; that is, being assigned to XPG3 and one participant from XPG3 being erroneously assigned to XPG1–2.

A second discriminant analysis was performed, this time including the five accompanying SRMs. A series of one-way ANOVAs revealed that all three XPGs differed significantly on all 16 predictor variables. One discriminant function was calculated and the value of this function was significant, χ^2 = 108.593, df = 16, $P \leq 0.0005$, which indicates that it makes a significant contribution to group affiliation. The EV associated with the function indicated that Function 1 (EV = 3.938; total variance = 100.0%) possessed strong discriminatory power between XPGs; and in further confirmation, the canonical relationship (correlation = 0.89) indicated that Function 1 discriminated well between XPGs.

Wilks' lambda statistics (Function 1 = 0.203, $P \leq 0.0005$) revealed that when utilising Functions 1 a highly significant result is produced, confirming that XPG means significantly differ. As Wilks' lambda provides a test of the null hypothesis (i.e., that the variables entered into the discriminant analysis do not predict XPG membership); because of the high significance of Function 1-through-2 the null hypothesis can thus be rejected.

The correlations between predictor variables and Function 1 revealed that DRM 'Lures', the BIMP, OR 'NCRs', OR 'Conf$_{50:50}$', and the VVIQ (rs $\geq$ 0.32) are the five variables that best predict XPG membership (see Table 31).

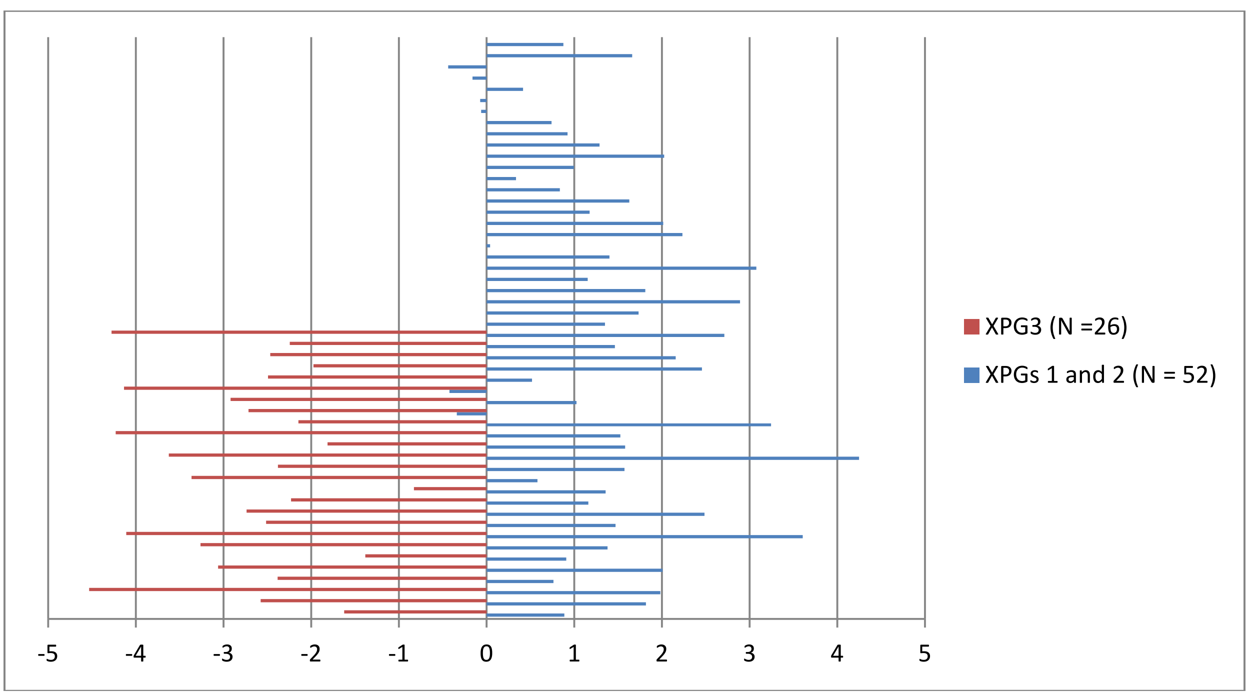
In view that the assumption of homocedasticity was violated (Box' M = 229.133, df1 = 136, df2 = 8,259.821, $P = 0.038$) the option of "separate groups" covariance was used in classification. The usefulness of the equation in discriminating correctly between XPGs was confirmed by the classification procedure. Results show that 100% of participants were correctly classified. Because these results exceed the value of classification as expected based on chance (50.0%), the second discriminant analysis provided further evidence for the efficacy of certain aspects of the CCTB (plus two of the accompanying SRMs) to reliably discriminate between individuals completing psychometric indices investigating ostensibly ANCOG (see Figure 30).

Table 31: Structure matrix for correlations between discriminant functions and predictor variables

	Function 1
DRM ‘Lures-trans’	-0.51
BIMP	-0.37
OR ‘NCRs’	0.35
OR ‘Conf$_{50:50}$’	0.35
VVIQ	-0.32
DRM ‘New words’	-0.26
GE ‘hard 55:45’	0.22
DUS	-0.22
OR ‘Initial recognition’	0.20
DTC ‘Global-trans’	0.20
ESNS	0.19
RM ‘Mode’	0.19
GCA	0.18
DRM ‘True memory’	0.18
AES	0.18
RM ‘Memory’	0.14

*Largest absolute correlation between each variable and any discriminant function; those correlations reaching the demarcation level expounded by Tabachnik and Fidell (2006) have been emboldened.

Figure 30: CDA function, including five accompanying SRMs



As with Figure 29, Figure 30 clearly illustrates succinct relationships between XPG membership and discriminant functions. Both discriminant analyses confirm a set of predictor variables that reliably discriminate between XPGs. Finally, the second CDA completely predicted overall XPG membership (100%), an increase on the first CDA of 5.1%.

6.11 Summary of results

The results reveal that of the 21 experimental variables considered (i.e., three IQ[57], two CPT, three DRM, seven BT, three OR, two RM, and one SM), 11 experimental variables provided statistically significant mean differences between XPGs. This meant discarding the two variables pertaining to sustained visual attention (CPT), two of the three GE variants plus three of the four DTC variants[58] from the BT, and the SM variable. Of the 11 remaining variables, all bar one (RM 'Memory'), retained significance between XPGs after accounting for participants' Age and Gender[59].

Considering the aforementioned differences in XPG membership with regard to the unequal distribution of males and females (see Table 6), a series of two-way ANOVAs only revealed a significant XPG × Gender interaction for RM 'Mode' (see section *6.6.1.2*).

With regard to the correlational analysis of relationships between the primary factor (ANCOG) and CCTB variables, significant relationships were revealed between ANCOG and all 11 of the experimental variables, with the noted exception of RM 'Memory'.

From the above analyses it was determined that the 11 CCTB variables and the five accompanying SRMs would be entered into the culmination of the results section—the second CDA. The first CDA included only the 11 CCTB measures and results revealed that the best predictors of XPG membership (total percent of cases correctly classified = 94.9%) were the number of critical lures recognised on the DRM paradigm plus two aspects of the OR test. The second CDA, which included 16 predictor variables (11 experimental variables plus five SRMs) revealed that for Function 1, DRM 'Lures' and the two OR variables (NCRs and $Conf_{50:50}$) were the best cognitive predictors of XPG membership along with the SRMs addressing comorbid psychopathology (BIMP) and the vividness of mental imagery (VVIQ): total

[57] Note: the two measures of IQ (MR and NART) were amalgamated into a single measure of GCA (proxy IQ).

[58] Note: the three original DTC variables were amalgamated into a global measure (DTC 'Global').

[59] RM 'Memory' was the only CCTB variable to be effected by participants' Age and Gender. ANCOVAs confirmed that after accounting for these covariates the significant mean differences between XPGs in RM 'Memory' became trends toward significance. However, due to the marginal impact upon this single variable, for the sake of brevity, it was decided to exclude these findings from the RM results (section 6.6). Notwithstanding, for completion, ANCOVA results are as follows: Age ($F[2, 74] = 2.635$, $P = 0.078$) and Gender ($F[2, 72] = 2.414$, $P = 0.097$).

percent of cases correctly classified = 100%. Therefore, due to the inclusion of the covariance SRMs it was decided that the second CDA provided a more parsimonious model.

In combination, these results provide preliminary evidence for the efficacy of certain aspects of the CCTB and two of the accompanying SRMs to reliably differentiate between those reporting, especially high rates of ANCOG, including disorganised and positive schizotypal phenomena.

Chapter 7. General Discussion

7.1 Reassertion of primary aims and general findings

Consistent with recent psychosocial/sociocognitive models of schizophrenia spectrum disorders, symptoms such as delusions, hallucinations, thought and communication disorders in normal populations may be seen as a product of environmental factors impinging on neurobiological factors, rather than being solely endogenous in nature (Moutoussis, Williams, Dayan, et al., 2007; van Os et al., 2009; van der Gaag, 2006; Lysaker, Buck, & Lysaker, 2012; Lysaker & Lysaker, 2010). To this end, cognitive deficits, where manifested, should be accurately investigated and subsequently portrayed so that effective psychological intervention strategies can be operationalised (e.g., cognitive-behavioural therapy) before any potential misdiagnosis (Davies, 2007; Murphy et al., 2012a). In confirmation of this viewpoint, it has been suggested that variations in the characterisation of anomalous cognitions (ANCOG) are influenced by pre-existing beliefs and affective factors such as alexithymia[60] (Polito, Langdon, & Brown, 2010). As such, this two-Phase research aimed firstly to assess the distribution of the psychometric correlates of positive schizotypal personality traits within a quota sample of the general population stratified by Age and Gender (Phase 1); and secondly to determine which of the cognitive measures highlighted in Chapter 4 are the best predictors of XPG membership (Phase 2).

Unsurprisingly, the primary factor (component) as identified from Phase 1 was interpreted as a psychological bias toward reporting anomalous experiences and beliefs (ANCOG) and accounted for over 40% of variance in the data set. The six variables making independent contributions to the primary factor in descending order of magnitude were: 1) the disorganised thought dimension of the SPQ-B; 2) the cognitive-perceptual (positive) dimension of the SPQ-B; 3) dissociative experiences as measured by the DES; 4) traumatic (stressful) experiences as measured by the SLESQ; 5) transliminality as measured by the RTS; and 6) delusional ideation as measured by the PDI-trans. The results of Phase 1 are in accordance with previous research (e.g., Johns & van Os, 2001; Kelleher & Cannon, 2011; Stefanis, Hanssen, Smirnis, et al., 2002; van Os et al., 2009), which suggests that the distribution of subclinical PLEs is widespread in the general population.

[60] Alexithymia is defined as "[A] disruption in both *affective* and *cognitive* processes . . . not treated as a 'true' psychiatric syndrome but rather as a general characterization of a number of traits which are often seen together in a variety of disorders, including those with psychosomatic origins and some addiction and drug-dependency disorders" (Reber & Reber, 2001, p. 24). Moreover, alexithymia has been linked to the reporting of positive schizotypal personality traits (e.g., Larøi, Van der Linden, & Aleman, 2008; van 't Wout, Aleman, Kessels, et al., 2004; see also, Seghers, McCleery, & Docherty, 2011).

Using the cognitive performance measures and criterion groups, Phase 2 revealed that the psychometric tests do influence performance and are not just paper measures of opinion or attitude. To this end, correlational and canonical discriminant analyses identified that of the 11 experimental (cognitive) variables reaching statistical significance between XPGs (ANOVA and/or LTA), the number of critical lures recognised from the DRM paradigm, the NCRs achieved from the OR task, and participants' confidence when uncertain ($Conf_{50:50}$) on the OR task were the best predictors of XPG membership. A second CDA revealed that when the five supplementary SRMs were entered—DRM (Lures), the BIMP (Bedford & Deary, 2006), OR (NCRs and $Conf_{50:50}$), and the VVIQ (Marks, 1973) provided a succinct five-variable model.

7.1.1 Expanded interpretation of the link between ANCOG and the adoption of a LVS (lifeview system; Phase 1)

Although the primary factor of ANCOG accounted for the greatest proportion of variance in the data set (>40%), it is worthwhile further enunciating the relationship between ostensibly psychosis-like cognitions (experiences and beliefs) and ostensibly religio-spiritual cognitions. To this end, the secondary factor, which was interpreted as representing a LVS[61] was found to possess a mild yet significant correlation with the primary factor (see Chapter 2, section 2.5.4).

As this thesis will be primarily read by academics (plus interested participants), it is worthwhile discussing recent research, which has attempted to identify the relationship between schizotypal personality traits (ANCOG), transliminality (ANCOG), and religious belief (LVS) with respect to scientific involvement (i.e., MacPherson & Kelley, 2011)[62]. It has been suggested that between 40–50% of scientists report a religious orientation (Stark & Finke, 2000; Wuthnow, 1985) and MacPherson and Kelly (2011) suggest two personality traits that may help *faithful* scientists reconcile their scientific and religious viewpoints: creativity and positive schizotypy. The authors argue that the pursuit of science depends on being committed to empiricism, which means that scientists are not usually prone to believe anything without good evidence. The author's assumption is that religious and scientific ways of knowing are basically at odds (Dennett, 2007; see, Dennett & Plantinga, 2011, for an interesting philosophical discussion), competing for explanatory space in people's minds. According to this model, the more committed one is to an empirical explanatory system, the less convincing religious explanations for

[61] Reminder: the secondary factor (LVS) contained independent loadings from the measures of religiosity (AUIE) and TRB subscale of the RPBS, with joint loadings from hallucinations as indexed by the LSHS-R and global paranormal beliefs (RPBS).

[62] Due to the expansive nature of the Phase 1 discussion, the findings of McPherson and Kelly (2011), for brevity, were omitted at that point.

various phenomena will seem, and vice versa. Testing has confirmed this hypothesis, with research subjects primed under one explanatory system finding the other less appealing (sc., Preston & Epley, 2009). But working scientists, roughly half of whom profess belief in religious or spiritual entities, seem to challenge that model. And so a conundrum arises: how does someone who spends their working day dealing empirically with the world embrace religio-spiritual beliefs?[63] MacPherson and Kelly suggest that, in fact, such scientists *do* encounter evidence for their religious beliefs, often in the form of unusual experiences (see also, Sperry, 1988).

Thus, paradoxically, scientists who believe in God may in fact have good reasons for doing so, at least in accordance with their own experience and logic. Such experiences are associated with schizotypy (Farias et al., 2005), which is also characterised by magical thinking, general nonconformity, and the propensity for dissociated, disorganised thinking (see Chapter 2, section *2.1.2.7*). Positive schizotypy refers to an emphasis on the "positive" aspects of this trait, such as subjectively pleasant "flow" states and absorption in creative work (Nelson & Rawlings, 2010)—a trait that scientists tend to have in more abundance than the general population (MacPherson & Kelley, 2011; see, Kaufman & Beghetto, 2009, for an informative discussion of a creativity typology)—possibly due to organisational and/or institutional (employment-related) necessity (Heinze, Shapira, Rogers, et al., 2009; see also, Hammond, Neff, Farr, et al., 2011).

Since scientists have been trained to encounter the world empirically, experiential evidence would presumably be more important for their faith than it would be for the religious convictions of a scientific layperson. Hypothesising that scientists with high schizotypy and creativity scores would be more likely to be religious, MacPherson and Kelly surveyed more than 220 working scientists and 190 nonscientist control respondents to determine the connections between schizotypy, creativity, and religious belief. Their international sample was composed of—for example—biologists, physicists and psychologists, ensuring that they had a well-rounded representation of scientists in different fields. The authors also hypothesised that nonscientists would show little to no connection between schizotypy and religious belief/orientation (e.g., see Chapter 2, Table 3). The study's results confirmed both of the author's hypotheses, showing that religious scientists were more likely to score highly on measures of schizotypy and creativity than their unbelieving peers. Among scientists, the effect of creativity on religiosity was partially mediated by schizotypy, but not entirely. In other words, both schizotypy and creativity had

[63] Referring back to the General Introduction (Chapter 1, section 1.1), this brief analysis of the MacPherson and Kelly (2011) article is by no means meant to invalidate a religio-spiritual worldview; rather, such ideology has had a major impact on a variety of human experiences for time immemorial, e.g. music, literature, architecture, and the arts (Carroll, 2012; Fontana, 2003; Wuthnow, 2006).

strong positive effects on scientist's levels of religious belief—but not on the beliefs of laypeople. In fact, neither schizotypy nor creativity predicted religiosity among laypersons[64].

MacPherson and Kelly concluded that, since someone with a creative, schizotypal personality is more likely to have unusual sensory experiences such as seeing shapes in shadows or feeling an invisible presence in a room, scientists who have such experiences may be much more likely to think of them as evidence for religious or spiritual entities. Since scientists are trained to rely on evidence for their beliefs, this neatly explains the difference between many believing and non-believing scientists: one group tends to have unusual experiences that lend credibility to religious ideas, while the other does not.

MacPherson and Kelly went one step further and suggested that schizotypy is associated with transliminality, in which sensory and cognitive data become intertwined (see Chapter 2, section *2.1.2.6*). In individuals reporting high transliminality, these data pass easily over the borders of conscious awareness and unconscious automatic processing, leading to more associative (Thalbourne, Crawley, & Houran, 2003) and intuitive (Lange & Houran, 2010) modes of thinking. This type of cognitive style may lead to more insightful and creative solutions to scientific problems, but it also means that data from one part of the brain might unexpectedly come into awareness in another (Mahowald, 2003; McCreery, 1997; Watson, 2001, 2003)—leading to the types of odd sensory experiences associated with positive schizotypy (Fleck et al., 2008).

The portrait of believing scientists that emerges from MacPherson and Kelly's study is intriguing: more creative and, perhaps, more intuitive than their peers, such scientists may be prone to seeing connections between seemingly disparate concepts. At the same time, their cognitive style may make them more likely to have the kinds of unusual, even bizarre, sensory and emotional experiences that have been recorded in the annals of mystics and religious seekers for millennia (Hunt, 2007), which have been interpreted as also contributing greatly to creative human experiences (see footnote 63). What's more, it seems that many of them are interpreting those experiences in exactly the same way as the great religious writers before them—as signs, tangible and credible, of a spiritual dimension to reality (MacPherson & Kelly, 2011). While this doesn't necessarily mean that these scientists should be taken at their word regarding spiritual matters, it does imply that the conflict between scientific and religious ways of thinking could be rooted as firmly in the personality styles of individual scientists as it is in the logical arguments they wield, which may also be culturally-specific (e.g., Bhawuk, 2003).

[64] Addendum: in this study positive schizotypy independently accounted for a significant (P = 0.017), yet small, proportion of variations in religiosity (AUIE) scores (Adjusted R^2 = 3.6%); and a highly significant ($P \leq 0.0005$), and substantial, proportion of variations in TRB scores (Adjusted R^2 = 14.6%).

7.2 Discussion of Phase 2 results

The series of experiments reviewed in Chapter 4, aimed to assess potential mean differences between XPGs with regard to cognitive functioning and to identify the best measure, or combination of measures, for use as a covariate in future analyses (proxy IQ). Therefore, the following sections will place the experimental variables into a (rudimentary) hierarchical bottom-up cognitive framework. Starting with GCA (proxy IQ) as a fundamental requirement, followed by sustained visual attention as measured by the continuous performance test (CPT), basic perceptual ability (OR), through memory functioning as assessed with the DRM paradigm and the memory (delayed recall) component of the RM test, continuing with the modal aspect of the RM test, then SM, and ending with higher-order reasoning and decision making processes (BT and confidence judgments [$\text{Conf}_{50:50}$] from the OR procedure).

7.2.1 Intelligence functioning (IQ) results

The two measures of IQ when recoded into a proxy measure of GCA ([MR+NART]/2) produced significant mean differences between XPGs. Considering the inconclusive findings regarding the relationship between psychometric schizotypy and IQ—most likely due to the differing measures used to assess schizotypy and IQ—the results reported here are generally in line with previous research (e.g., Burch et al., 2006; Burch et al., 2004; Matheson & Langdon, 2008) inasmuch as ANCOG, which contain high factor loadings of the CP and DT dimensions of the SPQ-B, produced significant mean differences between XPGs when assessed in respect of intellectual functioning. As such, GCA provided a statistically sensitive covariate for subsequently evaluating CCTB scores. Linear regression analyses revealed that of the three measures of IQ, GCA independently accounted for the greatest proportion of variations in ANCOG scores (Adjusted R^2 = 13.9%). ANCOVA revealed that after accounting for participants' Age the significant mean differences between XPGs in GCA became nonsignificant; and despite the large effect size for XPG × Age, it was deemed appropriate to utilise GCA as a covariate in future analyses as subclinical ANCOG are more commonly reported by younger adults (e.g., Scott, Welham, Martin, et al., 2008; Spauwen, Krabbendam, Lieb, et al., 2003; see also Chapter 2, Table 5)[65].

[65] Possessing lower intelligence has been suggested to be a risk factor for the development of schizophrenia (e.g., David, Malmberg, Brandt, et al., 1997; Mortensen, Sørensen, Jensen, et al., 2005).

7.2.2. Sustained visual attention: Continuous performance test (CPT) results

Contrary to previous research (Chen et al., 1998; Gooding et al., 2006; Rawlings & Goldberg, 2001) ANOVA revealed no significant mean differences in discrimination accuracy (*d'*). One immediate reason for the nonsignificance of the *d'* result is that the ANCOG factor may not be specific enough to reliably detect such differences. Further validating this line of reasoning is the fact that Chen et al.'s (1998) results, which as well as employing the PAS—which revealed significant results for the three variables in question (*d'*, response bias, and In*R*)—also assessed CPT performance in light of the SPQ, which was included as a general indicator of schizotypal personality traits: the SPQ elucidated borderline (trends toward significant) results for the CPT variables. The *d'* finding might also be explained by four other possibilities: 1) utilising a psychometric measure of schizotypy, in isolation, as opposed to the composite measure of ANCOG may have brought any potential mean differences to the fore; 2) the X-CPT-not-D version may not have been of sufficient difficulty to discriminate between ostensibly "psychologically healthy" community-based participants; 3) it can be reasonably argued that XPG3 due to increased exposure to trauma may adopt, by default, increased vigilance, which when coupled with greater anxiety-related psychopathology[66] may unwittingly promote performance on this test; and 4) the nonsignificance may be due to the nonaffective (neutral) nature of the stimuli; for example, a recent study incorporating 34 normal volounteers (Helton, Dorahy, & Russell, 2011) revealed that subclinical dissociation—as assessed by the DES—correlated with a greater vigilance decrement for negatively valenced stimuli but not for positively valenced or neutral stimuli.

Although In*R* have been posited as a fruitful index of sustained visual attention in community samples, beyond those offered by *d'* and response bias (Bergida & Lenzenweger, 2006), no significant mean differences were revealed between XPGs in this study. Again, one possible reason for this is that the X-CPT-not-D procedure was simply not of sufficient difficulty to differentiate between XPGs.

7.2.3 Object recognition (OR) results

Utilising an expanded version of the Bradbury et al. (2006; see also, Gollin, 1960) procedure, this experiment aimed to assess potential mean differences in OR ability, with regard to *accuracy* and *confidence*. The design of the experiment (i.e., ascending method of limits) allowed for a comprehensive recognition assessment. The added advantage of this OR procedure is that it incorporated an immediate

[66] One possible psychological mechanism by which anxiety-related psychopathology may be upheld in this particular experiment is through participants' embarrassment regarding test failure and the negative self-appraisal such cognitions might incur (Fowler, 2000).

decision making component (confidence judgments), which allowed for the analysis of participants' OR ability in light of reported confidence in those recognitions.

The first perceptual analysis concerned the NCRs; results revealed that XPG3 made a significantly lesser NCRs, which ties in with the findings of Blackmore and Moore (1994) and Doniger et al. (2002, 2001) in their work with high scoring paranormal believers and individuals with chronic schizophrenia, respectively. The mean amount of images required for participants to make Initial recognitions (whether correct or incorrect) significantly differed as a function of XPG, with XPG3 requiring significantly less perceptual data (mean = 14.58%) to make initial recognitions (cf., Blackmore & Moore, 1994). This finding seems likely to tie in with a JTC style of cognition (Moritz & Woodward, 2006a); however, no significant correlational relationship was found (see Table 29, and Orones et al., 2009). A significant relationship was, however, noted between DTC 'Global' and OR 'NCRs' (see Table 29), suggesting that a JTC bias was indeed present when assessed in terms of response bias as opposed to the amount of perceptual data required to make an initial recognition. The perceptual results indicate that XPG3 are significantly more impaired in detecting the signal (image) from the noise, a cognitive style that may result in perceptual misidentifications under suboptimal viewing conditions (e.g., dim light), and are more likely to forward (incorrect) responses given limited amounts of perceptual data. Neither of the two OR variables was substantially influenced by the covariate measures.

OR scores were in the main predicted by the BIMP (NCRs = exclusively [30.9%] and Initial recognition in conjunction with the DUS [total = 14.2%]). In sum, these results suggest that comorbid subclinical psychopathology (including, elevated substance use) influences OR ability. Comorbid psychopathology has been found to compromise OR ability (e.g., depression [Ramponi, Murphy, Calder, et al., 2010] and OCD [Irak & Flament, 2009]), and, although previous research is mixed (meta-analysis: Grant, Gonzales, Carey, et al., 2003), substance use (sc., cannabis), especially during adolescence, has been found to impact upon neurocognition, including aspects of recognition memory functioning (Miller, McFarland, Cornett et al., 1977; Rubino & Parolaro, 2008; Schweinsburg, Brown, & Tapert, 2008).

One possible explanation for these results could be due to the absence of time restrictions, participants, especially from XPG3, were allowed time to cogitate (ruminate), and in lieu of generating any immediate correct response felt *safe* in forwarding an incorrect one. Such a tactic was not adopted by XPG1 or XPG2, who, in the main, only forwarded a response when they were in possession of sufficient perceptual data to be almost sure as to what the object/s might be. It is suggested that the apparent hastiness of XPG3 to forward (incorrect) responses given limited amounts of perceptual data reflects the internal (endogenous) encoding style findings of Valérie, Belayachi, and Van der Linden (2011; see also section 7.3.4).

7.2.4 Deese-Roediger-McDermott (DRM; illusory memory) and reality monitoring (RM) 'Memory' results

Although assessing two independent components of memory functioning, the DRM (semantic) and RM 'Memory' (recognition) variables will be discussed together as both experiments aimed to assess potential mean differences in the ability to accurately remember stimuli presented in lists; in the case of the DRM (words), to not misremember nonpresented (semantically) highly-associated critical lures and nonassociated (nonpresented) words; and in the case of RM 'Memory' (words and pictures) to accurately recall all stimuli irrespective of presentation mode (word or picture) or semantic association.

In line with expectations, significant mean differences between XPGs were revealed for the three DRM performance variables. Of these three variables, the recognition of critical lures was the greatest differentiating variable. This finding is unsurprising considering that subclinical delusional ideation (Laws & Bhatt, 2005) and dissociative experiences (Dehon et al., 2008; Hyman, & Billings, 1998), both of which are independent contributors to the ANCOG factor, have been associated with significant differences in false memory production. Moreover, the propensity to report anomalous experiences per se is also associated with deleterious DRM performance (Clancey et al., 2002; French et al., 2008; Meyersburg et al., 2009).

With regard to psychometric schizotypy, these findings are at odds with those reported in Chapter 4 (section 4.3.4) inasmuch as previous research (i.e., Dagnall & Parker, 2009) found reduced recognition of critical lures for high scoring positive schizotypals utilising the CP dimension of the SPQ-B, which provided the second greatest factor loading for ANCOG. However, it has been reported that utilising the unusual experiences (UnEx; positive) dimension of the O-LIFE revealed high scoring positive schizotypals to make a greater number of false recognitions, and Saunders, Randell, and Reed (2012) suggest that this disparity might be explained by differences in scale construction (see Chapter 1, section 1.6).

Significant mean differences were also revealed for the memory (delayed recall) component of the RM test, although this significance was borderline (P = 0.050), suggesting that the surprise recall of previously encoded material may not be a valid experimental variable for psychosis-proneness research. The recall results are comparable to those of Peters et al. (2007), who showed delayed recall for previously encoded stimuli (actions and imaginings) to significantly differentiate (P < 0.05) between low- and high-scoring schizotypals (STA). Interestingly, the study of Lenzenweger and Gold (2000), which assessed positive schizotypy with the PAS, provided explicit instructions that a recall test was forthcoming, whereas the study of Peters et al. (2007), as with the present research, did not; suggesting that prior knowledge of to-be-recalled items promotes recall memory. To this end, the results reported in

Chapter 6 (section 6.7) partially complement the findings of Barnes et al. (2003)—which assessed source (reality) monitoring in hallucinating and non-hallucinating individuals with Parkinson's disease and healthy controls—insofar as mean differences in correct recognition (recall) between the three groups were nonsignificant. The above findings suggest that explicit recall (and recognition) instructions may promote comparable memory functioning (e.g., Newstead & Newstead, 1998).

The DRM performance measures gave insights into a cognitive style (bias) that is also reflected in some of the psychometric measures. Including GCA, the ESNS, and the BIMP in the regression analysis reduced the significant mean differences in DRM 'True memory' performance to that of a trend; which indicates an association between intelligence (proxy IQ), a more secure support network (ESNS), and reduced comorbid psychopathology (BIMP) with memory functioning, including the exclusion of irrelevant material from memory. All but one of the covariance measures displayed an association with RM 'Memory' scores, i.e. they became nonsignificant; and the VVIQ reduced the significance level to that of a trend, suggesting that the vividness of visual imagery exerts a lesser effect than the other covariate measures when accounting for mean differences in RM 'Memory' (delayed surprise recall).

DRM 'True memory' performance as assessed by d' was found to be significantly predicted by the ESNS (10.4%), which may have accounted for variations in scores by providing individuals with a supportive arena in which to express their thoughts and as such more readily organise memories into a veridical representation of what *actually* occurred (Stiller & Dunbar, 2007).

The recognition of highly associated critical lures was significantly predicted by the AES, the BIMP, and participants' Age (total = 33.3%). Apathy may have been a deleterious factor promoting the partial encoding of items leaving only a trace (gist) of the items identities, which may have subsequently facilitated false recognitions (Brainerd & Reyna, 1998, 2002)—more specifically, apathy has been linked to attentional difficulties in the prodromal phase of psychosis (e.g., Tan & Ang, 2001), which may have reduced XPG3 participants' attention to list structure and the derivation of gist representations. Comorbid psychopathology as assessed by the BIMP includes depressive symptomatology, which has been found to increase the recognition of nonpresented neutral and negatively valenced words but not positively valenced words (e.g., Howe & Malone, 2011; Yeh & Hua, 2009; cf., Joormann, Teachman, & Gotlib, 2009). The illusory (false) memory effect has been found to differentially vary with age (Watson, McDermott, & Balota, 2004; see also, Norman & Schacter, 1997; cf., Hashtroudi, Johnson, & Chrosniak, 1989), with younger adults reporting less critical lures than older adults "reflecting the influence of indistinct encoding of events and the use of lenient criteria during retrieval" (Schacter, Koutstaal & Norman, 1997, p. 229), possibly due to failure in source monitoring[67] (Dehon & Brédart, 2004; Winograd,

[67] The source monitoring framework may well prove beneficial in aiding understanding of false memory phenomena (Lindsay & Johnson, 2000).

Peluso, & Glover, 1998): such a finding was not confirmed in this study. Alternatively, a list-length effect may have been activated, i.e. previous research has found that longer lists are more likely to increase the recognition of critical lures for both younger and older adults (Sugrue, Strange, & Hayne, 2009). One other possible reason for this seemingly spurious finding is that the contributory components of ANGOG (e.g., schizotypal and delusion cognitions) are, indeed, exerting a real effect—perhaps, by increasing associative processing—with regard to memory functioning, and the finding may not, therefore, be attributable to non-psychopathological origins, i.e. be purely an artifact of *normal* individual differences in memory functioning. Alternatively, cognitive processes such as feature-binding[68] may be exerting an effect (see, Lyle, Bloise, & Johnson, 2006).

A reasonable proportion of new (nonassociated) words was significantly predicted by the DUS and ESNS (total = 14.1%). Substance use, especially the use of cannabis has profound effects on neuropsychological functioning (Heather, 2001; Solowij & Michie, 2007). More specifically, with regard to the DRM, cannabis use has been found to reduce the amount of studied words correctly identified although, interestingly, no difference was revealed between the cannabis or amphetamine groups and a placebo (no substance) group[69] with regard to false memory, although amphetamine was found to increase false memory relative to cannabis (Ballard et al., 2012). Notwithstanding, in a study incorporating 10 casual cannabis smokers and utilising *d'* as a measure of discrimination accuracy, cannabis use was found to be significantly associated with the recognition of newly (but not previously) presented words (Ilan, Smith, & Gevins, 2004). Such an effect has also been noted in the visual domain with a disruption to the ordered recall of objects (but not word associations or recall) suggesting that marijuana "appears to affect the temporal ordering of information" (Pekala, Kumar, & Marcano, 1995, p. 113). The ESNS will act in a similar fashion as outlined above.

Interestingly, according to Roberts (2002), subjects with more vivid imagery and those who are stronger visualisers had higher rates of false memory creation. Wilkinson and Hyman (1998) also found that individuals who used more imagery were more likely to create false memories. They more often falsely recognised critical lures during the DRM paradigm than individuals that used less imagery. It was, however (surprisingly) found that visual imagery as assessed by the VVIQ did not predict a significant amount of variations in any of the DRM variables scores. One possible reason for this spurious finding is that imagery vividness as assessed by the VVIQ may be more related to a source (reality) monitoring deficit than to the creation of false memories (McNally, Clancy, Barrett, et al., 2005; Meyersburg et al.,

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[68] Feature-binding refers to a process of image completion whereby the separate features of objects of similar structural composition (e.g., lollipop [imagined] and magnifying glass [seen]) are integrated in correct combinations facilitating correct recall (Treisman, 1998).

[69] All participants in the Ballard et al. (2012) study were only eligible for inclusion if they reported using cannabis less than ten times in their lifetime.

2009; see also section 7.3.5). To this end, a small, yet significant, proportion (Adjusted R^2 = 6.2%) of RM 'Memory' scores was predicted by the VVIQ.

7.2.5 Reality monitoring (RM) 'Mode' results

This experiment aimed to assess potential mean differences in the ability to discriminate between internally- and externally-generated words and pictures. Significant mean differences were revealed between XPGs for both the *memory* (see above) and *mode* components of the RM paradigm. Although the memory aspect just reached significance, the mode aspect of the test produced highly significant mean differences between XPGs. The results indicate that mean differences in basic memory (delayed surprise recall) for real and imagined stimuli (words and pictures), reach a marginally significant level—that is, there are effects, but this study barely reveals them—however, when participants attempt to provide the mode of presentation for their recollections difficulty ensued (cf., Dobson & Markham, 1993). This indicates that participants from XPG3 may be more biased toward the attribution of externally-generated items to the self (e.g., Debanné, Van der Linden, Glaser, et al., 2010)[70]. This finding agrees with the studies of Aleman et al. (2000) and Peters et al. (2007) inasmuch as hypothetically psychosis-prone subjects (as indexed by the LSHS and STA, respectively) were found to possess statistically decreased discrimination accuracy between internally- and externally-generated items (see Chapter 4, section 4.6.3). Conversely, Ruiz-Vargas, Cuevas, and López-Frutos (1999) interpret their findings as evidence for similarities in encoding and retrieval processes between individuals prone to hallucinations and non-hallucinating controls, with both groups making correct attributions from memory when evaluating the source (internal/external) of words and pictures. The disparity between the studies may lie with the nature of the encoded stimuli (words/pictures vs. action/imagination). That is, it is feasible that the study of Ruiz-Vargas et al. (words/pictures) may be seen as a typical RM paradigm, whereas the study of Peters et al. (actions/imaginings) may also be viewed as an SM paradigm, with participants having to monitor the source (internal/external) of their actions and imaginings.

Four of the covariance measures (GCA, the ESNS, the DUS, and the AES) possessed no association with RM 'Mode' scores, i.e. they remained significant; however, after accounting for the BIMP mean differences became a trend, and after accounting for VVIQ scores mean differences between XPGs became nonsignificant.

As predicted, the VVIQ accounted for the greatest proportion of variations in RM 'Mode' scores (Adjusted R^2 = 10.1%); one possible mechanism by which visual imagery may impinge upon Mode

[70] Such misattributions are hypothesised to increase vulnerability along the psychosis continuum (Debanné et al., 2010).

differentiations, may be due to the abundant and longstanding imagery emanating from intrusive memories (Steel, Fowler, & Holmes, 2005). Steel et al. (2005) expand on this position by suggesting that high schizotypy is associated with the poor integration of contextual information during stressful events[71]; and that, in addition, "there may be a failure to recognise triggers for images, and a failure to associate images with an index event [and] this could clearly cause distress, and contribute to the positive symptoms of psychosis" (Hackmann & Holmes, 2004, p. 394). These findings agree with previous research suggestive of the vividness of visual imagery as being a trait marker across the schizophrenia spectrum (Oertel, Rotarska-Jagiela, van de Ven, et al., 2009; Sack, van de Ven, Etschenberg, et al., 2005; cf., Bell & Halligan, 2010). Indeed, the correlation between RM 'Mode' and VVIQ scores revealed an inverse (moderate) relationship (r_{78} = -0.34, P = 0.003), indicating that as VVIQ scores increase RM 'Mode' scores decrease.

7.2.6 Self-monitoring (SM): Proportion of errors corrected (PEC) results

Although possessing insufficient variance for parametric analysis, Chi-square analysis revealed significant differences in the number of participants making errors between XPGs, with XPG3 possessing the greatest number of participants (N = 18). The results are in agreement with the SOA dysfunction evinced in positive schizotypals (see Chapter 3, section 3.1.4), suggesting that the monitoring (metarepresentational) aspects of SM are somehow disturbed, and the attribution of, in this instance, a physical action (error correction) might be erroneously transferred to an outside agent. Such reasoning, although theoretically appealing, is difficult to reconcile in this sample of the general population, and, as such, might be better conceptualised as an output monitoring failure (see section 7.3.6). An alternative explanation might be that the dual-task nature of the SM test—discrimination between alphanumeric figures/performance (error) monitoring—might have left certain participants without the necessary cognitive resources to successfully complete the test. Such dual-task (cognitive) depletives have been revealed in SPD patients with regard to the necessary allocation of attention (CPT visual/auditory; Moriarty, Harvey, Mitroupolou, et al., 2003) and impairment of information processing (digit span/box checking; Harvey, Reichenberg, Romero, et al., 2006). The latter findings seem plausible as the SM differences between XPGs were due to a few low-scoring (non-corrected errors) participants from all XPGs, especially XPG3 (see also section 7.3.6). Alternatively, increased apathy (amotivation) has been found to decrease attention to errors on a WM task (Bengtsson et al., 2009) and the primary mechanism by which motivation can enhance error correction performance is hypothesised by Bengtsson et al. to

[71] Note: a highly significant positive correlation between the CP dimension of the SPQ-B and stressful life events as indexed by the SLESQ was found in this study (see Chapter 2, Table 3).

involve the commission of errors as being detrimental to an individual's self-image (esteem), perceptions that may be abnormal in individuals reporting subclinical schizotypal phenomena (e.g., persecutory ideation; Martin & Penn, 2001). Furthermore, comorbid psychopathology, especially depressive and anxiety-related symptomatology has been related to the expression of SM dysfunction in adolescents reporting positive schizotypal symptoms (e.g., hallucinations; Debanné et al., 2009). Further, the research of Versmissen et al. (2007) revealed that such action SM dysfunction is positively associated with the level of psychosis risk, especially for delusional ideation (see also, Chapter 4, section 4.7.3). As such, despite the unusable SM data generated in this study, the investigation of SM functioning in putatively psychosis-prone individuals requires detailed and comprehensive analysis (see section 7.3.6).

7.2.7 Beads test (BT) and OR confidence when uncertain ($Conf_{50:50}$) results

With regard to the BT, this series of experiments aimed to assess potential mean differences in probability reasoning under two different conditions: 1) confidence ratings (GE); and 2) the amount of evidence required before forwarding a definite response (DTC). No significant mean differences were revealed for the 'easy 85:15' and 'medium 70:30' probability reasoning (GE) variants; however, significant mean differences between XPGs were revealed for the measure of GE 'hard 55:45', which is at odds with the data reported in the review conducted by Fine et al. (2007; see also, White & Mansell, 2009), which suggested that delusion-prone individual's probability reasoning is comparable to non-delusion-prone controls. This disparity may be explained by differing test constructions (e.g., procedures, analyses). Significant mean differences between XPGs were revealed for the DTC 'easy 85:15' and 'medium 70:30' variants (LTA) and for the 'hard 55:45' variant (ANOVA); however, all DTC variants were found to possess significant HOV and as such were subjected to log transformation and amalgamated into DTC 'Global', which, in line with prediction, produced significant mean differences between XPGs. The latter finding complements the previous research into a JTC bias evinced in individuals scoring high on measures of, for example, delusion-proneness (e.g., Colbert & Peters, 2002), and has also been extrapolated to delusion-relevant real life social scenarios with regard to paranoid ideation and social anxiety (Lincoln, Salzmann, Ziegler, et al., 2011; see also, Freeman et al., 2008). With regard to the OR test, analyses of participants' confidence when uncertain ($Conf_{50:50}$) revealed that XPG3 were significantly less confident in perceptual (visual) recognitions when unsure of the items identity. This finding ties-in with the GE data, which revealed that XPG3 forwarded decreased confidence judgments (significantly so in the hard '55:45' condition) as the ambiguity of the presented data increased (see Table 29). In combination, these two findings imply that respondents reporting high levels of ANCOG report significantly less confidence on cognitive tests in the perceptual and reasoning domains;

as such, decreased confidence may be a global feature of such a personality disposition. The confidence data results are unsurprising as comorbid depression and anxiety have been found to be significant factors in respondents scoring high for psychometric schizotypy (e.g., Lewandowski et al., 2006; Rey, Jouvent, & Dubal, 2009) and such associated psychopathology has undoubted ramifications with regard to individuals' confidence (Horan et al., 2008).

None of the covariance measures displayed an association with GE 'hard 55:45' and OR '$Conf_{50:50}$' scores. However, the BIMP in isolation reduced the significant mean differences between XPGs in DTC 'Global' scores to a trend level, suggesting that comorbid psychopathology may mildly impact upon decision making strategies. This line of reasoning is not supported by the research of Rodier, Prévost, Renoult, et al. (2011), which found that in a sample of 80 healthy participants utilising the BT that subclinical depressive symptoms independently predicted individuals' delusional ideation but not their reasoning (decision making) style.

The VVIQ accounted for a small yet significant proportion of variations in GE 'hard 55:45' scores (4.8%). It has been suggested that the medial occipital cortex (Brodmann's area [BA] 17; Kosslyn, Pascual-Leone, Felician, et al., 1999; see also, Parsons & Osherson, 2001) is activated during probabilistic reasoning tasks and may represent the greater use of visual imagery during the completion (formation, maintenance, and comparison) of two competing probabilistic hypotheses as compared to reasoning processes involved with two completely specified data types (Blackwood, ffytche, Simmons, et al., 2004). The results of Blackwood et al. confirm the earlier findings of Knauff, Mulack, Kassunek, et al. (2002), who utilised a spatial-relational (visual) paradigm (24 tests of relational inferences) to assess reasoning processes in the absence of any correlated visual input; fMRI results indicated that during tasks completion, cerebral activation occurred in an occipitoparietal-frontal network, including parts of the prefrontal cortex (BA 6, 9), the cingulate gyrus (BA 32), the superior and inferior parietal cortex (BA 7, 40), the precuneus (BA 7), and, most interestingly, the visual associative cortex (BA 19) but not the primary visual cortex (BA 17). The results of the two studies suggest that the visual associative cortex, amongst other brain regions, is activated when involved with inferential (Blackwood et al., 2004) and spatial-relational (Knauff et al, 2002) reasoning tasks. With these neuroimaging findings in mind, activation of the visual associative cortex possibly occurs because when deciding under conditions of uncertainty decision makers must evoke (visualise) relevant information (Brase & Barbey, 2006; Browne, Curley, & Benson, 1997) aiding the implementation of viable *minds-eye* solutions (Cifarelli, 1998; Koenig & Griggs, 2001).

The BIMP, which accounts for comorbid psychopathology including psychological distress (depression and anxiety) accounted for a small yet significant proportion of variations in DTC 'Global' scores (6.1%) and a substantial proportion of OR '$Conf_{50:50}$' scores in conjunction with the AES (total =

21.8%). These findings are unsurprising as comorbid psychopathology, especially depressive symptomatology has been found to have a significant relationship with the onset and maintenance of subclinical PLEs (Binbay, Drukker, Elbi, et al., 2012; Fonseca-Pedrero, Paino, Lemos-Giráldez, et al., 2011; Krabbendam, Myin-Germeys, & van Os, 2004; Murphy et al., 2012a). Further, these findings sit easily alongside data suggestive of maladaptive reasoning strategies being integral to the onset and maintenance of PLEs (Van Dael et al., 2006). With regard to apathy, the aforementioned comorbid psychopathology may promote indifference to task parameters (van Reekum, Stuss, & Ostrander, 2005), possibly resulting in low confidence (Horan et al., 2008).

7.3 Study limitations and future research directions

7.3.1 Intelligence functioning (IQ)

In line with previous research, the results revealed significant mean differences in intellectual functioning (both fluid and verbal) between those scoring low, mid, and high for ANCOG. The immediate limitation of the IQ protocol is that, due to time restrictions, only certain aspects of intelligence functioning (i.e., performance IQ) could be assessed. Although significant mean differences were noted for all IQ indices, such findings must be observed in light of research supporting the idea that certain facets of schizotypy, especially unusual experiences and cognitive disorganisation, seem to be related to enhanced creativity and academic achievement (Jackson, 1997; Fisher, Mohanty, Herrington, et al., 2004; Karimi, Windmann, Güntürkün, et al., 2007; MacPherson & Kelly, 2011; Nettle, 2006; Schuldberg, French, Stone, et al., 1988; cf., Miller & Tal, 2007; Stoneham & Coughtrey, 2009). These findings imply that high levels of schizotypy can, in some contexts, be adaptive. Indeed, as the MR subtest of the WASI (Wechsler, 1999) and NART (Nelson, 1982) are essentially measures of performance IQ, different aspects of intelligence may well prove beneficial when evaluating cognitive performance. For example, emotional intelligence may have deleterious effects with regard to high scoring schizotypals social functioning (Aguirre, Sergi, & Levy, 2008) and as such may be well suited, in conjunction with established measures of performance IQ, to evaluate data suggestive of differences on neuropsychological measures assessing sociocognitive factors (Kerns, 2006)[72].

[72] In addition to *performance* and *emotional* intelligence, a third aspect of intelligence functioning has been suggested to be that of *spiritual* intelligence, which "makes it possible for us to do creative, insightful, rule-making, [and] rule-breaking thinking" (Zohar & Marshall, 2001, p. 39). In essence, it facilitates the reforming and transformation of previous thinking.

7.3.2 Sustained visual attention (CPT)

As already suggested, the composition (contributory components) of the ANCOG factor may not have possessed sufficient specificity to detect deficits in X-CPT-not-D performance. For example, the two main contributory components to ANCOG are the CP and DT dimensions of the SPQ-B, which, in this study, do not possess a weak enough correlational relationship (see Chapter 2, Table 3 and Figure 3) to make independent contributions toward teasing-apart mean differences in CPT performance. That is, a low correlation ($r \leq 0.20$) between these two schizotypal dimensions would have been preferable. In further confirmation of this line of reasoning, Chen et al. (1998) found that only disorganisation features as measured by the SPQ were associated with decreased *d'* in their student sample. However, the exact makeup of the cognitive disorganisation feature is unclear as it was described by Chen et al. (1998) as possessing 'social anxiety' and 'attentional anomalies', which may better represent the negative factor of schizotypy (Venables & Rector, 2000). Further, Rawlings and Goldberg (2001) found significant mean differences in CPT performance between low- and high-scoring "cognitive disorganised" and "unusual experiences" schizotypal subjects utilising the O-LIFE, which is a measure of schizotypal personality features that was designed in such a way so as to avoid the "pathological feel and content of some other scales" (Mason et al., 1997, p. 33). Conversely, the SPQ-B, although forwarded as a measure intended for use with the general population was directly derived from the SPQ, which was designed specifically to address clinical SPD features. As such, utilising the O-LIFE as opposed to the SPQ-B may have facilitated the detection of mean differences between XPGs.

Due to the results revealing no significant mean differences between XPGs, utilising the independent-pairs (Cornblatt et al., 1988) version of the CPT, which incorporates a greater cognitive load (increased WM component), or using degraded stimuli may go some way to establishing the exact nature of any potential visual sustained attentional differences with regard to ANCOG. For example, the degraded stimuli (DS-CPT) version of the test due to its increased perceptual burden without any increase in WM demands is one viable option[73]. In fact, the DS-CPT is incorporated as part of six endophenotypic tests within the Consortium on the Genetics of Schizophrenia (COGS) ongoing research project (Calkins, Dobie, Cadenhead, et al., 2007). Another possibility to increase cognitive load would be to decrease stimulus and interstimulus presentation times. Such a procedure may aid in teasing-apart performance differences between schizotypal personality dimensions (Lencz, Raine, Benishay, et al., 1995), and aid in accentuating potential differences in, for example, In*R*.

[73] Assuming a continuum of psychosis (Claridge, 1997), in hindsight, employing the DS-CPT would have been preferable as it may have complemented the OR (fragmented images) test, potentially highlighting the effects of sustained visual attention on recognition processes (e.g., Clementz, Wang, & Keil, 2008; Itti & Koch, 2001: Pilz, Braun, Altpeter, et al., 2006; Sponheim, McGuire, & Stanwyck, 2006).

7.3.3 OR performance

The main findings of the OR task are that: 1) XPG3 provided a significantly decreased NCRs; 2) XPG3 were more likely to report recognition of an object given significantly less perceptual data; and 3) that XPG3 reported significantly reduced confidence in their OR recognitions when deciding under conditions of uncertainty ($Conf_{50:50}$). As such, the utilisation of an OR task incorporating fragmented black-and-white line drawings, as with previous research assessing OR in individuals with chronic schizophrenia and in individuals reporting paranormal beliefs, proved beneficial in elucidating significant mean differences between XPGs in perceptual (OR) performance. Furthermore, the inclusion of confidence rating scales allowed for the analysis of decision making (confidence judgment) capacities, which produced highly significant mean differences between XPGs (see section *7.3.7.2*). The findings in this study agree with previous research (e.g., O'Donnell, Bismark, Hetrick, et al., 2006) inasmuch as participants scoring highly for ANCOG (which contains high CP and DT schizotypal factor loadings) display comparable performance on a test of PC[74]. That is, the research of O'Donnell et al. (2006) is suggestive of intact visual processing in SPD subjects, a clinical condition far closer to clinically diagnosed schizophrenia than psychometric schizotypy, which by definition is only a propensity (liability) for developing schizophrenic symptoms. This line of reasoning suggests that it may not be the schizotypal personality traits that underlie the XPG3 performance biases; rather some other aspect of ANCOG (e.g., transliminality), may be exerting greater effects than the CP and DT schizotypal dimensions. Notwithstanding, the ANCOG factor provided a powerful tool for assessing mean XPG differences in OR perceptual and decision making performance. To this end, the OR findings complement Blackmore and Moore's (1994) findings with regard to paranormal belief inasmuch as XPG3 are more liable to forward a greater number of responses, incorrect responses (see also, Blackmore et al., 1994), and an overall perceptual bias in deciphering the signal (image) from the noise. Interestingly, the results do not fully complement the findings of Doniger et al. (2002, 2001) as XPG3 recorded NCRs biases primarily through the low-to-mid (2–5, i.e., 5–50%) levels of images presentation (see Chapter 6, Figure 24), suggesting that XPG3 may be more impulsive[75] than Doniger et al's (2002, 2001) samples with chronic schizophrenia.

[74] Although not reported in the results (Chapter 6), for brevity, the point of initial correct recognition (mean % images) was found to be comparable between XPGs ($F[2, 75] = 1.929$, $P = 0.152$).

[75] Impulsivity is a schizotypal dimension not covered by the SPQ-B but one that is incorporated in the O-LIFE.

The significant NCRs results, although on first inspection are suggestive of an OR bias (attributable to XPG3), were nullified after accounting for the total number of responses (guesses?)[76]. One possible way to combat guessing would be to allow participants one response per image—when they are "certain" what the image may be. It may also have been beneficial to assess differences in object categories. For example, in this test participants were presented with three natural objects (camel, pig, and frog) and five (manmade) artifacts (violin, truck, car, aeroplane, and bicycle). Differentiation between categories of objects has been shown to play an important role in the ability to recognise an object (Humphreys, 1996). Moreover, it has been suggested that individual differences in the ability to correctly recognise 'natural' and 'artificial' (manmade) categories of objects may be beneficial in informing any potential differences in OR performance (Gerlach, 2009). To this end, it has been proposed that categories of natural objects (e.g., animals) as opposed to artifacts (e.g., vehicles) may be harder to recognise because of their lack of structural uniformity (Iqbal & Aggarwal, 2002; Kahlaoui, Baccino, Joanette, et al., 2007).

It may also have been beneficial to have followed the experimental protocols of Blackmore and Moore (1994) and Doniger et al. (2002, 2001) by presenting images for brief time periods. Such a procedure may have elevated the point of Initial recognition, especially for XPG3 by not allowing time for reflection (rumination). Indeed, it has been suggested that increasing stimulus exposure times may aid in normalising the performance of high scoring psychometric schizotypes, especially high scoring positive schizotypal subjects (see, Randell, May, Jones, et al., 2011; Bressan & Kramer, 2013, for recent examples). With direct relevance to psychometric schizotypy as assessed by the SPQ, Koychev et al. (2010) suggested that short stimulus duration times may impinge on early visual processing by disrupting higher-order cognitive processes, which are, for example, involved with memory searching and subsequent stimulus naming. Moreover, as reported previously, the manipulation of stimulus and interstimulus duration (exposure) times may help tease apart the differential effects of schizotypal personality dimensions with regard to task performance. Additionally, utilisation of the Doniger et al. (2001) priming procedures (i.e., pre-exposure to the objects and/or valid word prompts) may have further validated the eventual finding that XPG3 are not significantly impaired in OR; rather, they are more prone to forward recognitions given limited perceptual data (Blackmore, 1992; Blackmore & Moore, 1994). As a final note, the inclusion of, for example, a more ecologically valid single-item questionnaire item (e.g., "I have had the experience of acknowledging someone on the street and then realising that they were a stranger") may provide valuable information regarding instances of realworld false recognition (Blackmore & Moore, 1994, p. 94).

[76] Although not reported in the results (Chapter 6), for brevity, after accounting for the total number of responses the significant mean NCR differences between XPGs became a trend ($F[2, 74] = 2.694$, $P = 0.074$).

7.3.4 False (illusory) memory functioning (DRM)

The DRM paradigm proved efficacious in eliciting significant mean differences between XPGs for DRM 'True memory' performance as assessed by SDT, the recognition of critical lures, and the recognition of new (not previously presented) words. However, concerns have been raised as to the ecological validity of using false memory paradigms to elicit memory depletives with respect to ANCOG (e.g., French, 2003; cf., Gallo, 2010), because of the use of deliberately manipulated stimuli. Notwithstanding, future research into autobiographical and recovered memories may shed invaluable light on how we understand false memory processes and the associated errors, thereof (Wade, Sharman, Garry, et al., 2007). Further, it has been proposed that, congruent to individuals with schizophrenia and individuals scoring high on measures of delusional ideation, such corruptions in memory, which are held with high confidence, are congruous with a JTC bias (Moritz & Woodward, 2006a). Such a relationship was found in this study with the number of critical lures recognised increasing as the number of beads required to confirm a jar decreased being significantly related ($r_{78} = -0.40$, $P \leq 0.0005$)[77].

During encoding, stimuli (word) duration time was fixed in this study at 2.5secs; however, it has been found that decreasing stimuli durations can drastically affect subsequent performance (McDermott & Watson, 2001; Thapar & McDermott, 2001). To this end, reducing stimuli duration times to, for example ≤ 500msecs, may have eradicated the deleterious performance of XPG3 by discouraging, for example, conscious activation of critical lures (Seamon, Luo, & Gallo, 1998) although there is also evidence to the contrary (Seamon, Goodkind, Dumey, et al., 2003). Notwithstanding, in general, using longer stimuli duration times (e.g., ≥ 2.0secs) have been reported to normalise the scores of schizotypal individuals with regard to social cognitive measures (e.g., recognition and judgment of facial stimuli; Toomey & Schuldberg, 1995). Additionally, the presentation style of items (e.g., pictorial, auditory) has also been found to differentially affect recall and recognition rates. Indeed, a study utilising visually presented pictorial stimuli, which attempted to relate the distinctiveness heuristic to metacognition, found that false recognition rates were reduced by presenting participants with pictorial stimuli at test, and that the distinctiveness heuristic can be turned on and off dependent upon participants' expectations regarding its usefulness for task completion (Dodson & Schacter, 2002). Considering the OR biases evinced by participants from XPG3, undertaking a DRM methodology that employs both written and pictorial stimuli may help shed light upon the recognition processes underlying the false memory performance of schizotypal individuals.

Utilising emotionally charged words and/or pictures may also have been beneficial as those reporting PLEs generally do so against a background of emotional turmoil (e.g., Murphy et al., 2012a). Previous

[77] Note: a lower JTC score equates to hasty decision making.

studies have found that the recall and recognition of emotionally valenced (sc., negative) critical lures is greater than that for neutral words (e.g., Pesta, Murphy, & Sanders, 2001) and this effect has been found to be true in both younger and older adults (Kensinger & Corkin, 2004). Indeed, false recall and recognition rates for emotionally valenced stimuli follow a weighted path with the greatest number of false recollections attributed to negatively valenced stimuli, followed by neutral stimuli, and the least number of false recollections being made for positively valenced stimuli (Brainerd, Stein, Silveira, et al., 2008), a finding that may be due to the influence of emotional memory on encoding and retrieval processes (El Sharkawy, Groth, Vetter, et al., 2008). Conversely, it has been suggested that including items with substantial emotional content may not be a reliable indicator of memory accuracy, whether the memories are true or false (Laney & Loftus, 2008).

One experimentally interesting technique, which was recently used in respect to eye-witness testimony, was to have participants recall visually presented stimuli (sc., an argument) with their eyes closed. This procedure increased the percentage of correct recollections of useful visual information by 37.6% and recollections containing high detail by 23.8% (Vredeveldt & Penrod, *article in press*). The authors concluded that the eyes-shut procedure, in a laboratory setting, facilitated recreations of the original context in the mind's eye. However, such recollections were not facilitated in the real world suggesting that the effects of distraction were significant. In the DRM procedure, post-hoc analysis of the covariation data suggests that the eyes-closed portion of the VVIQ did not account for the significant variations between XPGs in DRM 'True memory' or for the number of critical lures identified but it did, however, reduce the number of New Words erroneously identified to a trend level ($P = 0.052$), suggesting that the eyes closed condition of visual imagery may aid in the veridical recollection of new (non-associated) material from memory. This finding concurs with previous research (e.g., Parker & Dagnall, 2007), which suggests that, under certain circumstances, the false (illusory) effect can be attenuated.

Finally, it may have been beneficial to take account of participants' encoding style, as recent research has shown individual differences in how pre-existing schemata (internal vs. external) affect encoding (Dehon, Larøi, & Van der Linden, 2011). Dehon et al. showed that encoding style as assessed by the Encoding Style Questionnaire (Lewicki, 2005) influenced the generation of false memories. More specifically, as compared to external encoders, internal encoders generated a greater number of false memories whilst monitoring less critical lures. In relation to this study, Valérie et al. (2011) found a significant correlation between an internal (hasty) as opposed to an external (conservative) encoding style for respondents ($N = 184$) utilising the SPQ-B. Valérie et al. concluded that a hasty encoding style is robustly linked to psychometric schizotypy, especially the CP (positive) dimension. These findings seem plausible as psychopathological symptoms such as paranoia, anxiety, and depression may be partly dependent on an internal coding style (Hill, Lewicki, & Neubauer, 1991). Furthermore, due to time restrictions, it was decided not to undertake a recall phase for the DRM paradigm, although the inclusion of such a protocol may have shed valuable light on the, for example, relationship between false memory production and RM biases.

By reducing the number of lists (eight in this study) false recall recognitions may have been reduced as the cognitive effort required to keep 120 items (words) on-line, although not explicitly requested, has been found to have differential effects with regard to correct recall and, more specifically, false recognition rates (see, e.g., Hicks & Marsh, 1999). Such experiential confusion—misattributing the source of experiences—has been psychometrically explored in two samples of undergraduate students (N = 85 and 255, respectively) scoring high and low on the DES and Creative Experiences Questionnaire. The authors concluded that a nontrivial minority of respondents (11.8% and 25.9%, respectively) reported difficulties in distinguishing between dreams and reality, and that such experiential confusion was related to dissociative experiences and fantasy proneness (Rassin, Merckelbach, & Spaan, 2001; see, Henkel, Franklin, & Johnson, 2000, for an experimental cognitive example) both of which are analogues of absorption and, by association, positive schizotypy (see also Chapter 1, section 1.5.1, final paragraph).

7.3.5 RM functioning

The RM procedure, which was adapted from Barnes et al. (2003), proved to be a resourceful experimental measure for elucidating RM deficits with regard to basic memory performance (delayed recall) but, moreover, with regard to the mode of presentation of previously encoded stimuli. The obvious limitation with the RM protocol was the use of emotionally-neutral words and pictures as discrimination stimuli (cf., Kerns, 2005; Kerns & Becker, 2008). That is, utilising more ecologically valid stimuli (e.g., emotionally-valenced faces) might provide greater insight into how RM deficits might manifest and further complement research into the sociocognitive underpinnings of positive schizotypal phenomena (see, e.g., Brown & Cohen, 2010; Hoshi, Scoales, Mason, et al., 2011). To this end, memory for emotional items may be less prone to memory distortions, such as RM errors (Kensinger & Schacter, 2005) dependent on attention processes designated during encoding. To this end, contrary findings suggest that the heightened attention paid to emotionally valenced items during encoding disrupts the binding of contextual details into memory (Cook, Hicks, & Marsh, 2007), decreasing monitoring performance. As such, utilising video footage of realworld scenarios may aid in identifying the memory (and attention) components compromised during reality (source) monitoring processing (Dobson & Markham, 1993).

Further, in relation to both false memory (DRM) and RM, Wilkinson and Hyman (1998) noted that the tendency to change a source judgment for an autobiographical memory was not related to the number of errors on a word list task. As such, future studies should include autobiographical measures for a more comprehensive (and realworld) assessment. For example, it has been ascertained that memory illusions (inventions) are reported within seconds of exposure to video footage—participants (N = 58) reported experiencing (seeing) a protagonist kick a ball when, in fact, they did not (Strickland & Keil, 2011), suggesting that, in line with the OR results, certain people may insert false information to verify (complete) a nonexistent causal relationship.

7.3.6 SM functioning

Participants who made mistakes were asked if they had noticed and duly corrected them at the end of the test. Interestingly, participants from all XPGs reported that when mistake/s were made, correction/s had been duly made (by pressing the letter "c" on the keyboard); however, as all participants, especially those from XPG3 reported making correction/s when few if any were in fact initialised, suggests dysfunction of two possible cognitive mechanisms. Firstly, WM may have been compromised and participants may have simply not remembered that they were supposed to correct errors[78]; and secondly, participants from XPG3 may have presumed that they had made error correction/s when none in fact were made, suggesting dysfunction in the metarepresentational aspects of intentions, a failure in the SOA over intended actions (see Chapter 3, section 3.1.3). As already suggested in section 7.2.6, this implication seems to contradict previous research into the SOA in positive schizotypals (e.g., Asai & Tanno, 2007, 2008; Asai et al., 2008), which suggested that SOA dysfunction manifests by attributing self-generated actions to an external source. As such, considering that participants claimed to have "monitored" task performance, yet made little or no corrections, suggests an output monitoring effect[79]. Notwithstanding, whatever the reason, a greater number of participants from XPG3, than XPGs 1 or 2, were clearly deficient at monitoring performance[80].

In order to increase variance in the range of scoring—more specifically, to eradicate the ceiling effect—numerous variations on the SM procedure could have been adopted, including: 1) a decrease in the ratio of letters and numbers from 3:1 to, for example, 3:2, which may decrease test performance by

[78] Considering the observation made in Chapter 6 (section 6.10.1) regarding the protective effect on memory functioning of intelligence, fluid reasoning as assessed by the Raven's Progressive Matrices (cf., MR) is posited to be mediated by a composite of WM systems (Prabhakaran, Smith, Desmond, et al., 1997).

[79] In this instance, an error in output monitoring refers to the omission of a planned action, which is one of the processes by which people distinguish what or what was not done (Koriat & Ben-Zur, 1988); in essence it is a memory relating to past performance (Sugimori & Kusumi, 2008).

[80] Another viable explanation for the—"If I made a mistake, I corrected it" claim—is an unwitting experimenter effect.

manipulation of the sensory-response function (see, Loftus & Ruthruff, 1994): 2) a decrease in stimulus duration time from 750msecs in this study to approximately 100mecs (Bloch's law) which is the hypothesised cut-off point for the perfect trade-off between intensity and performance with regard to threshold detection (Bloch & Nassar, 2006; see, Coull, Nazarian, & Vidal, 2008, for a neurophysiological example); and 3) to increase the number of trials, from the one in this study (two if the 30secs practice trial is included) to four: trial 1 as a 30secs practice; trials 2–4 as experimental trials from which early, middle, and late phases could be analysed separately. Moreover, adopting the experimental protocols of Asai et al. (2008) and Versmissen et al. (2007)—i.e., deciding whether the movements of a computer-generated index were synchronous (analogous) to participants' own movements—would seem more pertinent in extracting any potential differences in SM ability, which could then be directly linked back to the theoretical literature regarding SOA dysfunction evinced in the schizophrenia spectrum (e.g., David et al., 2008; Frith et al., 2000a,b; Gallagher, 2004; Frith, 1992, 2005; Teufel et al., 2010).

7.3.7 Reasoning and decision making functioning

7.3.7.1 Beads tasks (GE and DTC)

One obvious limitation of the BT protocol was that variants were presented in a serial, fixed order (see Chapter 5, section *5.2.4.1*). By adopting such a protocol, participants may well have become disinterested. Further, the majority of participants (from all XPGs) could not "see the point" of the test, and engagement, as such, was necessarily compromised (see, e.g., Balzan, Delfabbro, Galletly, et al., 2012). Such disengagement may also have resulted from the incomprehension of task directives leading to illogical responses, an experimental confound that has been found to significantly affect performance on the BT (Balzan, Delfabbro, & Galletly, 2012). Compounding this *incomprehension effect* none of the participants had any prior experience with dealing with probability judgments in an artificial (laboratory) setting (Fox, Rogers, & Tversky, 1996). Notwithstanding, significant mean differences were revealed for two of the variables analysed (GE 'hard 55:45' and DTC 'Global'). As the majority of participants appeared to take a percentage (numerical) reasoning approach, with mean total percentages in the GE variants following a downwardly weighted path for such a strategy (see Figure 31)[81] suggests that statistically-naïve participants were, on some level, involved with one viable probability reasoning strategy; a reasoning (decision making) style that was independent of classic Bayesian reasoning (Johnson-Laird, Legrenzi, Girotto, et al., 1999). Complementing this line of reasoning, when making

[81] Graphical illustration of mean percentages were excluded from the Results (Chapter 6) for brevity.

decisions humans have been suggested to be “predictably irrational” and tend to adopt a middle-ground (relativistic)[82] approach when making decisions under uncertainty (Ariely, 2008, p. 8).

Figure 31: Probability confidence means for BT GE variants, including a global representation (cf., DTC ‘Global’; Figure 20)

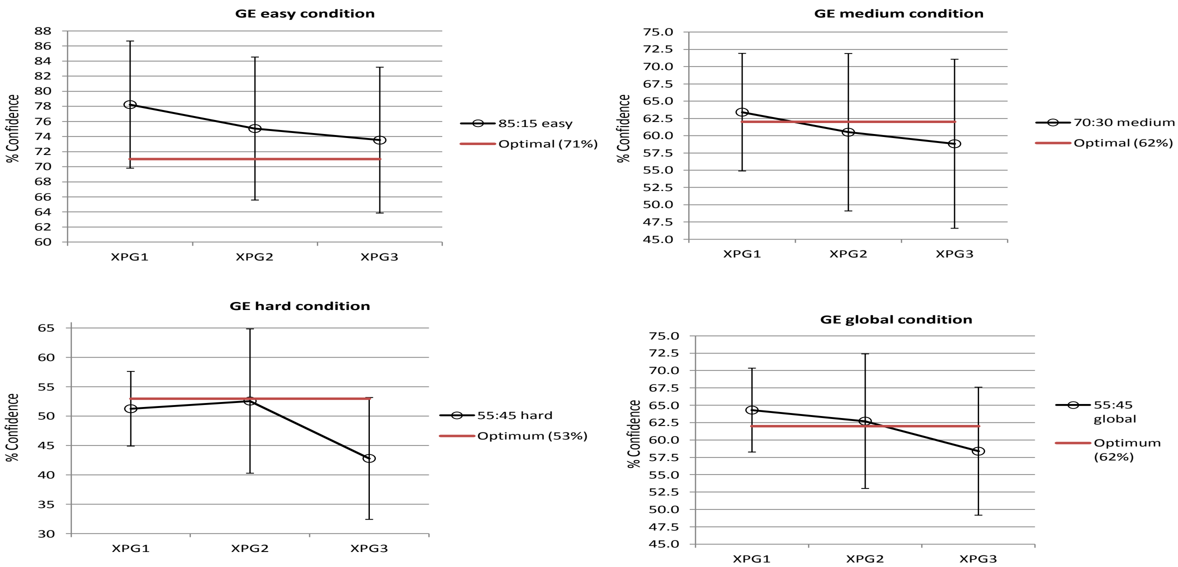

Figure 31 neatly illustrates two observations: 1) if participants were indeed using an arithmetically-based reasoning strategy then they were using the percentage data in a far more liberal manner for the easiest (85:15) condition and became more cautious as the ambiguity of the presented data increased; and 2) the disparities between XPGs were greatest for the third (GE ‘hard 55:45’) variant of the procedure suggesting that the novelty and/or task comprehension effects, if evinced, only manifested as the presentation of experimental stimuli increased in ambiguity. The suggestion of ambiguity as being a viable effect sits easily with previous experimental research, which has highlighted that cognitive confidence increases as a function of the perceived distance between stimuli—so-called, subjective distance theory (Björkman, Juslin, & Winman, 1993). Alternatively, the results are just as easily explained by the “hard-easy” effect (see, Ferrell, 1995). Taken as a whole, these observations suggest that statistically-naïve participants, when presented with novel reasoning data, generally adopt, except when

[82] Relativity refers to the notion that when engaging in decision making, choices are generally decided upon by comparing them against alternative options and, thus, a mental index of *relative* worth is formed. Therefore, greater focus is placed on things that are easily comparable and less comparable items are avoided. This line of reasoning fits in well with the BT (GE) data.

the presented data is easily comprehendible, an underconfident approach[83]. Furthermore, the two processes (novelty and reasoning) tend to parallel one another (Zuk & Carpendale, 2007). To muddy matters further, there is now evidence suggesting that reasoning biases can manifest outside of conscious awareness (Freeman et al., 2006; Medalia, Thysen, & Freilich, 2008).

Following Moutoussis et al. (2011), in order to increase task engagement the experimental protocols of Dudley et al. (1997b) plus Young and Bentall (1997) could be employed, i.e. the judgment of personality characteristics to either *self* (Dudley et al., 1997b) or *other* (Young & Bentall, 1997). Furthermore, employing a syllogistic reasoning task in conjunction with the BT would shed invaluable light on the differing modes of everyday reasoning (Chater & Oaksford, 1999). Additionally, reasoning biases that are applied during the act of reasoning (e.g., motivational factors such as *fear*) might better capture immediate biases rather than relying on measures based on recollections and self-insight (Irwin et al., 2012). One such measure is the *Iowa Gambling Task* (Bechara, Damasio, & Damasio, 2000), which is a performance-based measure of emotion-based reasoning, which might usefully be applied to study the associations between reasoning biases and, for example, paranormal beliefs (Irwin et al., 2012).

7.3.7.2 OR 'Conf$_{50:50}$'

Due to the novelty of the OR confidence data, plus the apparent lack of previous literature, there is no, as far as can be ascertained, previous research against which to compare/contrast the results. Notwithstanding, one limitation could be that the 11-point linear confidence rating scale utilised ran from 0–100% (multiples of ten), and as such was not forced-choice (see, Klayman, Soll, González-Vallejo, et al., 1999). As such, the incorporation of a confidence rating scale that begins at, for example 50%, may be of greater interpretational value—that is, if recognitions are made, they must, by default, possess a certain level of certainty[84]. Such response criteria could also be applied to the GE variants of the BT, especially considering that when reasoning with two jars, any response must by mathematical necessity possess a minimum of 50% confidence. Alternatively, a Likert scale asking participants to explain their recognitions (e.g., 1 = "Definitely uncertain"; 2 = "Possibly uncertain"; 3 = "Undecided"; 4 = "Possibly sure; and 5 = "Definitely sure") would add valuable data by constricting response parameters (see, e.g., Migueles & García-Bajos, 1999). To this end, it was noted that some participants (mainly from XPG3) forwarded confidence judgments of 0% when making object recognitions.

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[83] The GE 'Global' condition reached a significant level between XPGs (*P* = 0.039) and post-hoc analysis revealed that the significant mean differences manifested between XPG1 ($M_{64.30}$) and XPG3 ($M_{58.38}$) (*P* = 0.037), but not between XPG2 ($M_{62.71}$) with either XPG1 (*P* = 0.778) or XPG3 (*P* = 0.163).

[84] The minimum value of 50% remains valid as long as participants follow test instructions by not inserting recognitions when they are completely unsure as to what the items may be.

7.4 General study limitations and future research directions

The CCTB proved to be efficacious in elucidating significant mean differences between XPGs in the cognitive domains of GCA (proxy IQ), illusory memory (DRM), probability reasoning (BT), OR, and RM; notwithstanding, three areas of research protocol may require adjustment: 1) psychometric assessment; 2) cognitive test inclusion; and 3) statistical analysis.

7.4.1 Psychometric adjustment

When evaluating schizotypal phenomena in the general population, the main psychometric alteration would be to utilise the O-LIFE as opposed to the SPQ-B (see also Chapter 2, section 2.6.2). This would allow for a more comprehensive assessment of schizotypal dimensions and, as noted in various sections above, may help shed light on cognitive deficits (e.g., CPT) and biases (e.g., false memory) in putatively psychosis-prone normals. Moreover, due to the vast array of anomalous experiences reported in the literature (Davidsen, 2009), it would have been beneficial to include a short interview as part of Phase 1, e.g. the Examination of Anomalous Self Experiences (Parnas, Møller, Kircher, et al., 2005; see also, Vollmer-Larsen, Handest, & Parnas, 2007) to further explore the range of ANCOG (see also, Kelleher, Harley, Murtagh, et al., 2011). To this end, utilising short scales specifically designed to assess the diversity of schizotypal phenomena (e.g., Wisconsin schizotypy scales) may, in conjunction with interview-based techniques, prove useful in the study of schizotypy in the general population (sc., Gross, Silvia, Barrantes-Vidal, et al., 2012).

Various additional SRMs could have been employed to complement the cognitive measures (see also, Section 4.8). Firstly, the Encoding Style Questionnaire (Lewicki, 2005) would aid in assessing stimuli encoding biases, especially with respect to the DRM, OR, and RM paradigms. Secondly, considering the significant differences revealed for '$\text{Conf}_{50:50}$' (OR test) and the GE 'hard 55:45' variant of the BT, utilising the Metacognitions Questionnaire (Cartwright-Hatton & Wells, 1997) may aid in teasing apart the exact nature of the (cognitive) under-confidence of XPG3. To this end, the Metacognitions Questionnaire assesses five empirically distinct domains of metacognition: 1) positive beliefs about worry; 2) negative beliefs about the controllability of thoughts and corresponding danger; 3) cognitive confidence; 4) punishment and responsibility; and 5) self-consciousness, the tendency to be aware of and monitor thinking. The cognitive confidence subscale can easily be related to the GE 'hard 55:45' and OR '$\text{Conf}_{50:50}$' data, whereas the self-consciousness subscale has immediate appeal regarding the SM task. Although not specific to cognitive performance, recent research has linked the Metacognitions Questionnaire to the expression of schizotypal personality traits (STA and LSHS-R), suggesting that the same patterns of distress and metacognition are evinced by high scoring schizotypals and individuals presenting an at-risk mental state (Barkus et al., 2010; see also, Stirling, Barkus, & Lewis, 2007), validating its use with normal samples. Other research, however, does not fully complement the work of Barkus et al., by indicating that anomaly-related distress as indexed by the Metacognitions Questionnaire is apparent in individuals with psychosis and in those presenting an at-risk mental state but not in individuals reporting subclinical PLEs or healthy controls (Brett, Johns, Peters, et al., 2009). Thirdly, considering the importance of the BIMP as a covariance measure and as a predictor of variations in CCTB measures, more indepth assessment of comorbid psychopathology (cf., Suhr & Spitznagel, 2004), including affective (mood-related) variables (e.g., Chepenik, Cornew, & Farah, 2007), would prove invaluable, e.g. the Beck Depression Inventory (BDI-II; Beck, et al., 1996) and/or the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). A fourth SRM that also should prove valuable in elucidating relationships between reasoning style and, specifically, delusion-like beliefs is the *Cardiff Beliefs Scale* (CBS; Pechey & Halligan, 2011). The CBS contains three separate scales: 1) subclinical delusional ideation in the general population (e.g., "People say or do certain things that contain special messages for you")—but that nonetheless possess the cognitive essence of delusional ideation as specified by the DSM-IV-TR (APA, 2000); 2) paranormal and religious beliefs (items drawn from the RPBS (Tobacyk, 2004); and 3) a set of items regarding contemporary scientific and socio-political beliefs, of which some are contentious (e.g. global warming, euthanasia). Utilisation of the CBS would have cast a far broader net with regard to the content of delusion-like behaviour placing a certain amount of influence within the sociocultural arena, a sphere within which all unusual and bizarre ideation, and any associated cognitive processes, thereof, must be contextualised (Bhavsar & Bhugra, 2008; Gearing, Alonzo, Smolak, et al., 2011).

7.4.2 Cognitive tests/CCTB adjustments

Additional cognitive tests that warrant inclusion are: 1) face recognition (Conklin, Calkins, Anderson III, et al., 2002; Poreh et al., 1994), including self-face recognition (Larøi et al., 2007), and facial affect recognition (e.g., Abbott & Green, 2013; Addington, Penn, Woods, et al., 2008b; Germine & Hooker, 2011; Shean, Bell, & Cameron, 2007; Williams, Henry, & Green, 2007)[85], which would complement the OR test by allowing for the dual analysis of cognitive and emotional processing (see, Luh & Gooding, 1999); 2) although utilising an alternative test of reasoning (decision making) to the BT may prove

[85] Facial affect recognition forms part of a set of nonverbal sociocognitive skills, which have been found to be negatively biased in high scoring schizotypals (see, Miller & Lenzenweger, 2012).

ecologically superior (Ziegler, Rief, Werner, et al., 2008), it is suggested that combining BT data with data gleaned from, for example, conditional inference tasks, may provide a bridge between semantic memory and reasoning biases (Sellen, Oaksford, & Gray, 2005), which immediately provides an exploratory link with DRM and RM performance (cf., Roediger, Watson, McDermott, et al., 2001); 3) considering the hypothesised relationship between certain aspects of ANCOG (e.g., RTS, DES) and subconscious modes of information processing, a test of subliminal (subthreshold) visual capture would be informative, possibly helping to explain any mean differences in overt (suprathreshold) visual awareness, e.g. the backward masking (Zener cards) paradigm adopted by Crawley et al. (2002), which found significant mean differences between participants scoring low and high on the Transliminality Scale-Form B (Thalbourne, 1998). In a more recent example, experimental evidence revealed a significant influence on affective and cognitive processes by retroactive anomalous phenomena[86], and this effect was significant in eight of the nine experiments (Bem, 2011). Both of the aforementioned paradigms should help place any supposed psi-related (anomalous) phenomena beyond the remit of paranormality and into the realm of cognitive dysfunction (deficits and biases); 4) theory of mind deficits could have been assessed to further explore the social cognition of high-scoring, especially high-scoring positive, schizotypals (see, e.g., Pflum, Gooding, & White, 2013); and 5) it is acknowledged that a large amount of research has been invested into investigating the relationship between latent inhibition (p. 90; see also footnote 22, p. 88) and schizotypy (e.g., Evans, Gray, & Snowden, 2007b; Schmidt-Hansen, Killcross, & Honey, 2009; Wuthrich & Bates, 2001) and as such incorporating a test of latent inhibition may aid in explaining any relationships between overt cognitive performance and learning biases.

The main alteration to the CCTB protocol would be to counterbalance presentations, and to intersperse BT variants throughout the CCTB (for example, temporally; see, Woodward et al., 2009). Such procedures would hopefully allow for increased involvement (see section *7.3.7.1*) via the varied presentation of tests in differing cognitive domains (e.g., intelligence, perception, source monitoring, reasoning/decision making, and variations, thereof). Alternatively, the CDA results suggest that the CCTB need only be made up of the DRM and OR paradigms, plus SRM assessments of comorbid psychopathology and visual imagery—the other experimental domains, perhaps, being better investigated in isolation.

On a more global note, the presentation of the CCTB was purely within the visual domain. The cognitive evaluation of additional sensory realms will no doubt prove beneficial in determining any biases and/or deficits in information processing. For example, individuals with schizophrenia show deficits in sensory judgment tasks such as pitch discrimination (Strous, Cowan, Ritter, et al., 1995) supporting what Javitt has termed as a *panmodal sensory imprecision* (Javitt, Liederman, Cienfuegos, et al., 1999). To this

[86] Retroactive refers to the influence of some future event on current psychological functioning.

end, using the SPQ as a measure of general schizotypy, Bates (2005) found that the precision of primary sensory representations are reduced during an auditory inspection task. Bates suggested that deficits in the fine structure of auditory representations may represent a vulnerability marker for the development of schizophrenia. In line with the theorising of Javitt and colleagues, and following Doniger et al. (2002, 2001), the analyses of auditory biases/deficits (see, e.g., Barkus et al., 2007) will no doubt complement the OR (sc., NCRs) results found in this research (see Chapter 6, section 6.6.1.1), highlighting multiple domains of sensory impairment (bias) in schizotypal individuals.

7.4.3 Statistical analyses adjustments

Despite the statistical analyses of CCTB variables being reasonably comprehensive, additional areas of cognitive functioning (performance/bias) could have been analysed, including: 1) with regard to IQ, raw scores, as opposed to T-scores (sc., MR), could have been utilised, which may have more accurately accounted for any age-related differences with regard to XPGs, i.e. the conversion criteria of the WASI (Wechsler, 1999) converts raw data preferentially as age increases; 2) with regard to sustained visual attention, response bias (In*ß*; see Appendix IX) could have been calculated in order to more accurately decipher the nature of performance deficits; 3) with regard to the OR test, numerous supplementary analyses could have been performed (see, e.g., footnotes 74 and 76) but the point at which participants make a correct recognition and are willing to attribute 100% confidence to that recognition is a pertinent one as it may explain the comparable OR result, placing any overt performance biases into the metacognitive, as opposed to perceptual, domain; 4) for the DRM paradigm, responses could have been computed within a Bayesian framework, which may help explain the nonsignificance of any list-length effect by demonstrating contextual reinstatement confounds (Dennis, Lee, & Kinnell, 2008); 5) for the RM paradigm, one immediate statistical omission is the lack of any word × picture effect analysis, which would potentially provide supplementary data regarding the differential effect of stimuli type on encoding and subsequent recognition mechanisms (Johnson, Kounios, & Reeder, 1994; Stenberg, Radeborg, & Hedman, 1995)[87], which may help explain any spontaneous imagery creation[88], an imaginal activation

[87] No significant word × picture effect (memory [recollection] or mode) was found by Ruiz-Vargas et al. (1999); the authors interpreted these findings as indicating that hypothetically hallucination-prone (LSHS) subjects "do not show any problems in the encoding of verbal and pictorial material, at least with simple stimuli (e.g., words and pictures)" (p. 158). It is, however, cautioned that using pictures at study can prove problematic when the aim of the experiment is to investigate any potential mean differences in the magnitude of any directed forgetting effect (Quinlan, Taylor, & Fawcett, 2010) possibly due to the picture superiority effect (e.g., Stenberg et al., 1995) differentially affecting recognition and monitoring processes (Johnson et al., 1994).

effect (Slamecka & Graf, 1978), that could also be applied to a pictorial version of the DRM paradigm (see, e.g., Foley & Foy, 2008); 6) with regard to the SM test, responses could have been coded in terms of SDT allowing for discrimination accuracy (d') to be calculated and subsequently compared to PEC performance (bias); and 8) with regard to reasoning and decision making, numerous additional statistics could have been calculated, however, for brevity two shall be proposed: i) with regard to the BT, and following (Freeman et al., 2008), analysis of disconfirmatory, as opposed to confirmatory, evidence could have been incorporated to highlight the direction of biases in reasoning (Buchy, Woodward, & Liotti, 2007; Woodward, Buchy, Moritz; et al., 2007; see also Figure 19); and ii) with regard to OR '$\text{Conf}_{50:50}$', data could have been analysed with regard to perceptual ability providing an index of recognition × confidence in light of increasing familiarity.

Regarding the CCTB as a whole, PCA has been recently utilised to extract realms of cognitive functioning in a sample of the general Chinese population (Chan, Wang, Yan, et al., 2011), which utilised the SPQ as an index of schizotypal traits. Of the 17 measures analysed, Chan et al's results revealed six factors (components) that accounted for a combined total of 75.42% of variance in the data set. Of note, significant partial correlations controlling for age, IQ, and gender were revealed between the positive (CP) and disorganised (DT) schizotypal trait dimensions and the factors of: 1) *allocation* (here defined as a response strategy)—'odd beliefs and magical thinking' [CP], $r = -0.19$, $P = 0.023$/'odd speech' [DT], $r = -0.24$, $P = 0.009$; 2) *semantic inhibition*—'suspiciousness' [CP], $r = 0.20$, $P = 0.034$; *visual memory and attention*—'unusual perceptual experiences' [CP], $r = 0.20$, $P = 0.033$/'odd or eccentric behaviour' [CP], $r = 0.23$, $P = 0.015$/'odd speech' [DT], $r = 0.18$, $P = 0.049$; *WM*—'suspiciousness' [CP], $r = -0.24$, $P = 0.012$; and *verbal memory*—'odd or eccentric behaviour' [CP], $r = -0.19$, $P = 0.045$/'odd speech' [DT], $r = -0.26$, $P = 0.006$/'suspiciousness' [CP], $r = -0.30$, $P = 0.001$. None of the three schizotypal dimensions (CP, ID, or DT) correlated with the factor of *executive functioning*, which contained independent factor loadings from the Wisconsin Card Sorting Test (WCST; Nelson, 1976) and the Sustained Attention Response to Task test (SART; Robertson, Manly, Andrade, et al., 1997). The authors interpreted these findings as providing further evidence highlighting a pattern of cognitive dysfunction in schizotypal individuals specifically manifesting as allocation and verbal- and working-memory dysfunction (Chan et al., 2011; see also, Nuechterlein, Barch, Gold, et al., 2004). The above findings tie in with the research reported here as the employment (comprehension and subsequent allocation) of cognitive resources, and WM (both verbal and visual) may have differentially disrupted performance on the false memory (DRM) and RM (cf., Roediger et al., 2001), and SM paradigms. Furthermore, Chan et

[88] See Chapter 3 (section *3.1.3.1*) regarding the unbidden intrusion of imagery into conscious awareness in relation to psychosis and schizotypy.

al's results also evince the manifestation of cognitive dysfunction beyond the negative schizotypal domain providing contributory evidence for this thesis's creation.

It is suggested that utilising CFA is a valid technique for unearthing relationships between variables, highlighting common domains of cognitive and psychopathological functioning. Despite CFA not being a data classification technique, it does possess certain statistical attributes that would be of interest to future research in this area (i.e., the cognitive antecedents of subclinical PLEs), including: 1) CFA includes an explicit model of the relation between test scores and latent variables (e.g., test anxiety) (Bollen, 1989); 2) CFA allows for statistical tests of alternative models, incorporating differing theoretical and practical applications, which can be readily compared and specified (Reeve & Bonaccio, 2008; Wicherts, Dolan, & Hessen, 2005); 3) any model containing linear relations (e.g., the Phase 2 data) can be expressed in terms of CFA (Bollen, 1989): and 4) CFA models can be extended to include nonlinear effects that may be relevant to issues such as test familiarity (Wicherts & Scholten, 2010). Alternatively, logistic regression could have been utilised. Such a procedure would have allowed for the inclusion of non-continuous—qualitative—variables (e.g., Gender), and test variables with unequal XPG membership (Walker & Duncan, 1967). The issue of non-normality is relevant to this thesis because of the two SRMs (PDI and DES; Phase 1), the two "transformed" experimental variable from Phase 2 (DRM 'Lures' and DTC 'Global'), and the one experimental variable that possessed insufficient variability and as such violated HOV (SM 'PEC'); however, logistic regression facilitates (and accounts for) non-normality (Press & Wilson, 1978).

Regarding participant inclusion, it may have been beneficial to have restricted XPG inclusion to those participants scoring ± 2.0 SD (sc., Yon, Loas, Monestes, et al., 2011). However, after extensive reading of the literature relating to cognition in psychometric schizotypy, XPG inclusion criteria seem to be arbitrary (e.g., median split, quartiles, ≤ 10^{th} percentile ≥ 90^{th} percentile). As such, this thesis's global inclusion approach, although, essentially over-inclusive, does not discount ostensibly psychologically healthy individuals on the basis of extreme psychometric deviance (see Figure 1). Furthermore, by focusing on the positive (anomalous) and disorganised aspects of schizotypal personality traits, the interpersonal dysfunction (negative) aspects of such a personality type have been necessarily neglected. It is, however, acknowledged that negative symptomatology (e.g., social anhedonia) has been extensively employed in psychometric studies of putatively high-risk schizotypes (Blanchard, Collins, Aghevli, et al., 2011; Daly, Afroz, & Walden, 2012; see, Cohen, Callaway, Najolia, et al., 2012, for a specific example).

7.5 Discussion of canonical discriminant results

In line with recent research (e.g., Fletcher & Frith, 2009; Keefe & Kraus, 2009; Kraus, Keefe, & Krishnan, 2009), which posits PE (see Chapter 3, section 3.1.7)[89] as being central to a bi-directional model of cortical dysfunction, memory functioning—a key domain of cognitive dysfunction in schizophrenia (Heinrichs, 2005; review: Heinrichs & Zakzanis, 1998)—the first CDA (Chapter 6, section 6.9.2) highlighted that mean differences in the number of Critical lures recognised from the DRM procedure (+) plus the NCRs (–) and $\text{Conf}_{50:50}$ (–) from the OR procedure were the best predictors of XPG membership. Taken as a whole the results of the first CDA indicate that the increased recognition of critical lures from the DRM test, a low NCRs on the OR test, and decreased confidence when uncertain on the OR test ($\text{Conf}_{50:50}$) are the best predictors of XPG membership, especially for XPG3.

The second CDA replicated the first by highlighting that (in the cognitive domain) XPGs could be best discriminated by DRM 'Lures' (+), OR 'NCRs' (–) and OR '$\text{Conf}_{50:50}$' (–); furthermore, two of the accompanying SRMs (BIMP+ and VVIQ+) completed this succinct five-variable model. Taken as a whole the results of the second CDA indicate that an elevated recognition of critical lures on the DRM test, a low NCRs and decreased confidence when uncertain ($\text{Conf}_{50:50}$) on the OR test, coupled with higher scores on the BIMP and VVIQ are the best predictors of XPG membership.

Aspects of the OR test may act in a similar fashion as critical lures (DRM); that is, both tests are concerned with the veridical representation of material from memory. In fact, both the OR and false (illusory) memory paradigms are, on one level, similar in nature, as biases in recognition memory (episodic [OR] or semantic [DRM]) may involve a misattribution of source (cf., RM paradigm) (see, Aldebot Sacks et al., 2012; Schacter & Dodson, 2001; Schacter, Israel, & Racine, 1999). The BIMP, which assesses comorbid psychopathology possesses a strong positive relationship with ANCOG (r_{78} = 0.61, $P \leq 0.0005$), which is unsurprising as comorbid subclinical psychopathology (e.g., depressive, anxiety-related, obsessive-compulsive) is known to correlate with the expression of schizotypal personality traits (Rössler, Angst, Gamma, et al., 2011); for example, one positive symptom (paranoid ideation) might be understood in the same way as anxiety-related symptomatology as both modes of cognitions might be conceptualised as deriving from the unreasonable cognitive appraisal of emotionally-laden 'threat beliefs' (Freeman, Garety, Bebbington, et al., 2006; Freeman, Garety, Kuipers, et al., 2002). The VVIQ, which assesses the vividness of visual imagery possesses a moderate positive relationship with ANCOG (r_{78} = 0.44, $P \leq 0.0005$), which is again unsurprising as the vividness of visual imagery has been suggested to be a vulnerability marker for a psychotic disorder. Overall, the second CDA

[89] Memory PEs are conceptualised as ensuing via dysfunction of the columnar circuitry subserving the cortex, which "may serve to continuously predict bottom-up activation based on invariant memories" (Keefe & Kraus, 2009, p. 414).

successfully predicted XPG membership for 80.8% (N = 21) of XPG1, 88.5% of XPG2 (N = 23) of XPG2, and 100% (N = 26) of XPG3. These results suggest that, in addition to memory and perceptual biases, comorbid psychopathology (e.g., Lewandowski et al., 2006; see also, Varghese et al., 2011) and imagery vividness (e.g., van de Ven & Merckelbach, 2003) play distinct roles with regard to cognitive functioning in individuals reporting elevated rates of ANCOG, including positive and disorganised schizotypal phenomena.

The above results are in accordance with previous research investigating the cognitive architecture of (self-reported) anomalous experiences. That is, the measures of primary import (memory and perceptual [sc., recognition] biases) are frequently reported as being integral to the mediation of anomalous experiences (Irwin & Watt, 2007; Landgraf, Amado, Berthoz, et al., 2012; Maher, 1999). Indeed, it has been recently suggested that one type of ANCOG (near-death experiences) can be wholly explained by aberrations in normal brain functioning—the authors concluded that "[T]aken together, the scientific evidence suggests that all aspects of near-death experiences have a neurophysiological or psychological basis" (Mobbs & Watt, 2011, p. 449). However, this study has been challenged for selectively using the data; that is, by using those data that excluded paranormality and ignoring that which did (Greyson, Holden, & van Lommel, 2012).

The CDA results confirm the utilisation of appropriate cognitive measures with healthy individuals from the general population when investigating subclinical PLEs. Such measures can further our understanding of how psychological biases (e.g., delusional ideation) might become pathologised in clinical and nonclinical groups. For example, the DRM paradigm places overt cognitive performance firmly on a continuum of psychosis as enunciated by Claridge (e.g., 1997) ranging from healthy participants reporting delusional ideation (Laws & Bhatt, 2005) through to individuals with a clinical diagnosis of schizophrenia (Bhatt, Laws, & McKenna, 2010). Although the DRM protocol is widely used in psychopathological research, the OR test presents an exciting experimental opportunity. That is, OR deficits have been found in individuals with schizophrenia (e.g., Doniger et al., 2002, 2001), however, this research has demonstrated that OR disturbances (biases) span the psychosis continuum and as such may potentially represent a vulnerability marker (e.g., Oertel et al., 2009; Sack et al., 2005; cf., Bell & Halligan, 2010).

7.6 Relating the results to the theoretical models of psychosis

Having distilled the statistical findings from Chapter 6 (ANOVA/LTA, covariance, linear regression, through correlational analysis), which culminated in two CDAs, the second of which, considering the combination of cognitive and SRM measures, meant that the statistically-significant predictor variables (rs ≥ 0.32; DRM ‘Lures’, OR ‘NCRs’, OR ‘$Conf_{50:50}$’, the BIMP, and the VVIQ) could be directly linked back to previous theoretical standpoints. Furthermore, despite certain variables (e.g., GE ‘hard 55:45’, OR ‘Initial recognition’) not being statistically predictive of XPG membership, the analysis of mean differences (ANOVA/LTA) suggested that they are important cognitive variables in the reporting of ostensibly ANCOG. Therefore, the following section will relate the major findings of this research back to the theoretical models of the positive symptoms of psychosis reviewed in Chapter 3.

The cognitive (neuropsychological) model as advocated by Frith (1992) attempts to explain the positive symptoms of schizophrenia as occurring via a disruption of the metarepresentational aspects of SM. As such, symptoms such as delusions and hallucinations occur via the misrepresentation of the source (agency) of such phenomena—a disruption in the SOA (see Figure 8 for a hypothetical illustration of how such a misrepresentation may occur). Due to the SM data possessing insufficient HOV for parametric analysis, it is difficult to reconcile how such SM biases (disruptions in the SOA) may manifest in ostensibly healthy individuals. One possible reason may relate to the scoring criteria employed, which produced a ceiling effect. Notwithstanding, the SM data point toward XPG3 as being less well equipped, for whatever reason (e.g., WM or action-monitoring failures) to monitor and subsequently correct errors when under instructions to do so (Wolpert et al., 1995; see Figure 28). As all participants reported correcting errors when they had noticed them suggests that there was no dysfunction in SM; rather some other aspect of cognition (e.g., the discrimination between alphanumeric figures) was producing a greater influence. That is, the test’s first instruction—left-click for letters and right-click for numbers—may have superseded any error-checking procedure. Notwithstanding, the SM results (section 6.8.1) indicate that some form of SM bias is in operation, especially with regard to XPG3.

In the first instance, the cognitive (biopsychosocial) model as advocated by Garety et al. (2007, 2001) agrees with the model of Frith (1992) by advocating that one possible route for the psychogenesis of the positive symptoms of psychosis may arise from difficulties with the SM of thoughts and actions. Secondly, the model adds confirmatory weight to the CDA finding. That is, comorbid psychopathology (psychological distress) may serve to propagate the weakening of previously encoded (shared) memories resulting in ambiguous, even fragmented, sensory input. Such a situation may also incur the intrusion of spurious (especially traumatic) memories into conscious awareness necessarily involving a reorganisation of the veridical aspects of current perceptual material (Hemsley, 1993; Morrison, 2001). An erroneous situation that may be further exacerbated by the ineffectual integration of contextual information (e.g., time, place, protagonists) during a trauma episode (e.g., Hemsley, 2005; Steel et al., 2002). Such reasoning suggests that the appraisal of ANCOG involves not only the associated psychological distress (sc., BIMP) but also the maladaptive contextual integration of previously encoded mental experiences (VVIQ?).

The metacognitive model as advocated by O'Connor (2009) proposes that the weight of conviction placed on a delusion (or hallucination), a process that involves, amongst other things, an individual's coping style, threat appraisal, level of emotional distress, and sociocultural beliefs, is intrinsic in deciphering whether that individually-oriented perceptual style is pathological or not. Those individuals who can adaptively (healthily) integrate their ANCOG into pre-existing schemata may be less prone to the potentially distressing outcomes such beliefs and ideation might incur (see, Coelho et al., 2008; Neppe, 1993).

Harking back to the models of Frith (1992) and Garety et al.. (2007, 2001), the mismatch between *intended* and *actual* (veridical) representations of events directly relates to the recent Bayesian approach as advocated by Fletcher and Frith (2009). That is, the misrepresentation of the source (agency) of a mental event (delusion or hallucination) is proposed to be subserved by *prediction error* (PE) in which the deluge of data to which we are bombarded is predicted by prior experiences, beliefs, expectations, etc. Such reasoning, in the form of Bayesian probability estimates, is clearly biased in XPG3 (in the 'hard 55:45' condition; see Figure 19), which may lead such individuals to make erroneous assumptions (sensory discrepancies) regarding the origins of experience as the ambiguity of the presented data increases (e.g., making misrecognitions from memory or assuming [nonexistent] causal relationships).

In sum, the cognitive (neuropsychological) models reviewed in Chapter 3 provide plentiful theoretical support for the study's main finding (second CDA): that biases in memory functioning (both semantic [DRM 'Lures'] and episodic (object) recognition [OR 'NCRs']), reasoning and decision making (OR 'Conf 50:50'), comorbid psychopathology (BIMP), and the vividness of visual imagery (VVIQ) form a robust and theoretically-relevant set of predictor variables with regard to XPG membership. Furthermore, the Bayesian reasoning data as assessed with the GE 'hard 55:45' procedure infer that, similar to the psychogenesis of the positive symptoms of psychosis (Fletcher & Frith, 2009) such reasoning strategies as evinced in XPG3 (i.e, underconfidence), might represent a fundamental cognitive mechanism. In further confirmation of this viewpoint, the OR 'Initial recognition' data (see section *6.6.1.2*) suggest that individuals from the general population differentially evaluate data given limited amounts of perceptual information, dependent on the criterion groups.

7.7 Conclusion

This thesis has established, in line with previous research, that PLEs are widespread in the general population (Phase 1) (review: van Os et al., 2009) and that such cognitions, as identified by CDA, are subserved by—amongst other things—biases in memory functioning and object recognition, self-reported visual imagery, and the presence of comorbid psychopathology, e.g. depressive and anxiety-related symptoms (Phase 2). Indeed, depressive states in general have been associated with diminished attentional resources during cognitive tasks (Ellis & Ashbrook, 1988); in addition, depressed individuals lack initiative when performing cognitive tasks (Hertel & Hardin, 1990) and display difficulties in inhibiting irrelevant material when undertaking cognitive tasks (Zacks & Hasher, 1994). The CDA findings corroborate the comments made regarding the power analyses (Chapter 6, section 6.8.2) by highlighting the prominence of the DRM and OR tasks, providing justification for the thesis's title.

Phase 2 also highlighted that participants from XPG3 exhibited decreased confidence when completing cognitive tests in the perceptual (OR) and reasoning (BT) domains. Such a cognitive profile (i.e., under-confidence) may well be an enduring personality disposition of individuals reporting high levels of ANCOG, possibly related to comorbid psychological distress (e.g., Krabbendam et al., 2004; see also, Bell, Halligan, Pugh, et al., 2011; Polito et al., 2010), and negative emotional processes, such as anxiety (Bell et al., 2011; cf., Brett, Peters, Johns, et al., 2007), decreased self-esteem (Garety et al., 2007, 2001; Peters, Lataster, Greenwood, et al., 2012) and the fear of rejection/criticism (sociotropy) (Kwapil, Brown, Silvia, et al., 2012; Morrison, Bentall, French, et al., 2002). However, as a point of interest, and referring back to Chapter 1 (section 1.9), the results of Völter, Strobach, Aichert, et al. (2012) who utilised the SPQ and a German version of the NEO-FFI (Borkenau & Ostendorf, 1993) in their study of the behavioural adjustment following cognitive conflict (N = 106), suggested that "Previous findings of deficits in cognitive control in schizophrenia patients were extended to the subclinical personality expression of the schizophrenia phenotype and found to be specific to schizotypal traits over and above the effects of negative emotionality" (p. 1). Additionally, and in accordance with Lenzenweger's (2010) alterations to Meehl's schizotaxia-schizotypy model (see Figure 1), epigenetic factors have recently been implicated in the social underpinnings of emotion regulation, especially in the context of social cognition (e.g., Zachar, 2012)[90]. This additional confound may further muddy the waters when attempting to tease apart the relative contributions of personality facets (sc., schizotypy) toward emotional (affective) and/or

[90] One example of an epigenetic factor is the regulatory variation of the serotonin responder, which has been related to anxiety- and depression-related symptomatology (Munatò, Clark & Flint, 2005). Moreover, such regulatory variations are thought to display a distinct role in social cognition (Canli & Lesch, 2007).

psychopathological factors in schizophrenia vulnerability (Gee, Karlsgodt, van Erp, et al., 2012; Livingstone, Harper, & Gillanders, 2009; Modinos, Ormel, & Aleman, 2010).

In sum, the findings of this research suggest that cognitive biases, particularly in perceptual and memory-based functioning (see, Krishnan et al., 2011; Landgraf et al., 2012), in association with comorbid psychopathology and visual mental imagery are psychological domains requiring further exploration with regard to the psychogenesis of PLEs (see, e.g., Broughton, 2006; Freeman, Gittins, Pugh, et al., 2008; Soriano, Jiménez, Román, et al., 2009). Indeed, such endophenotypic measures (including, cognitive and SRM; see also Chapter 1, Figure 1) may provide a valuable link cutting across the conventional diagnostic boundaries possibly revealing patterns of associations between schizophrenic symptoms and behaviours with (schizotypal) personality traits (Jablensky, 2006; Lenzenweger, 2010)[91]. On a cognitive level such biases (distortions) may help in unravelling the pattern of social perception disruptions, including theory-of-mind and agency, evinced in autism-spectrum, psychopathic, and schizotypic individuals (Gray, Jenkins, Heberlein, et al., 2011).

Beyond these necessarily expansive findings, the research project has further fuelled a personal search into the essence of reality and the pervasiveness of illusory experience. Can the two be clearly separated? Research into the borderlands spanning normality and abnormality suggests not. Such differentiation may become all the more nebulous as technology progressively takes us away from the personal (face-to-face) to the impersonal (avatar-to-avatar) realms of cyberspace (Suler, 2004). Indeed, a recent study found that participants scoring high on the G-PTS reported significantly more paranoid ideation than low-scoring participants when undertaking a virtual reality paradigm containing emotionally-neutral characters (Freeman, Pugh, Vorontsova, et al., 2010). Imagine the impact of personally-relevant stimuli on vulnerable individuals!

“Why it’s simply impassible”

Alice: “Why, don’t you mean impossible?”

Door: “No, I do mean impassible. (*chuckles*) Nothing’s impossible!”

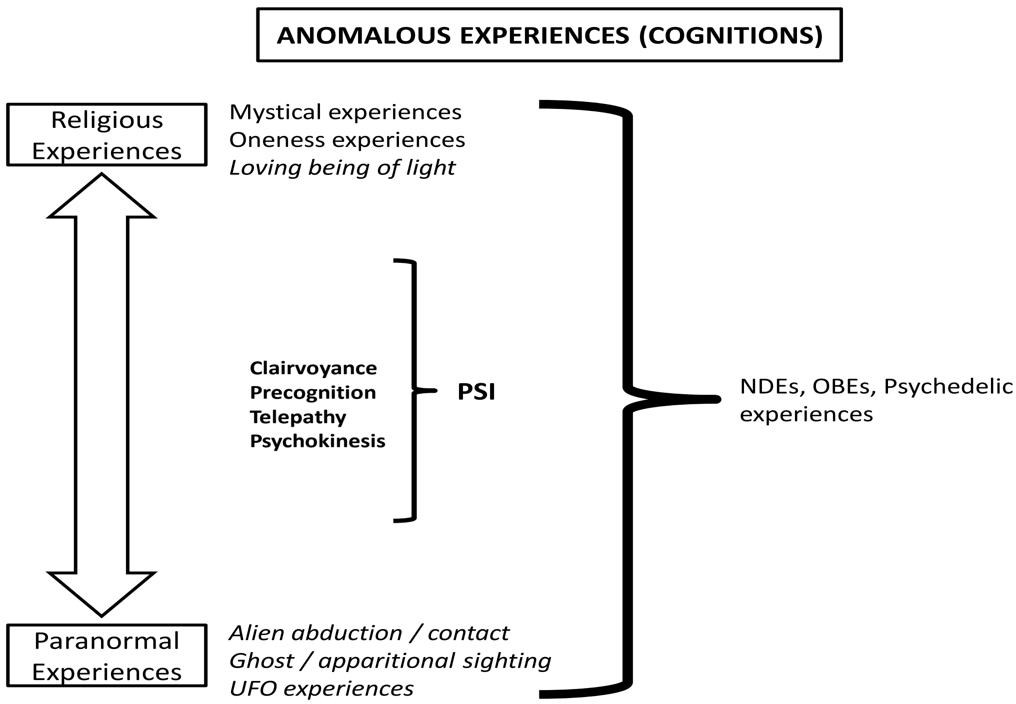
(*Through The Looking Glass*; Carroll, 1871)

[91] Although it would be nice to come to a firm conclusion with regard to the influence of schizotypal personality traits on cognitive functioning, it must be borne in mind that subclinical PLEs (ANCOG) are transitory in nature (Davies, 2007; Wiles, Zammit, Bebbington, et al., 2006). Therefore, any conclusions reached from this thesis can only be viewed in such transitory terms. Longitudinal studies will help to shed light on this temporal matter (cf., Wiles et al., 2006).

Appendices

Appendix I (Figure 32; para-religious spectra—Phase 1)

Hypothetical paranormal/religio-spiritual experiences spectra illustrating the interplay between the two modes of experiential interpretation[92].



[92] Considering the potential overlap of anomalous and religio-spiritual experiences (cognitions), it has been suggested that there is a "need for a multiaxial classification system that can unify anomalistic experiences of a variety of kinds relating to subjective paranormal experiences, psychopathological hallucinations, delusional phenomena, illusions, near-death experiences, and temporal lobe symptomatology" (Neppe,1989b, p. 244). For example, Neppe's Multiaxial Schema for Anomalous Events (Neppe, 1985, 1989a), which provides a 16-axis experiential hierarchy for assessing the locus of anomalous experiences ranging from the subliminal to the end phase of symptom diagnosis.

Appendix II (front sheet of the Phase 1 questionnaire battery)

Participant Identity
Number (PIN):

Demographic Information

The information held on this page is for administrative purposes only. No details pertaining directly to you will be utilized within the study. You will be allocated a **PIN** only (see above). To further ensure anonymity, an independent observer will code (compute) all responses. It must be stressed that as a participant you are under **NO** obligation to answer any items within any of the eleven questionnaires (including this one) with which you feel uncomfortable. Thank you.

Name: ____

Gender:
1. Male ______
2. Female ______

Age: _______

Parental Status:
1. Parent ______
2. Non-Parent ______

Ethnicity (Race):
1. White-Caucasian ______
2. Black-African/-Caribbean ______
3. Asian/Middle Eastern ______
4. Asian-Pacific (Oriental) ______
5. Other ______

Socioeconomic Status:
1. Student ______ (please enter parental/partners' occupation from options below)
2. Retired ______ (please enter previous occupation from options below)
3. Unskilled Manual (e.g., general labourer) ______
4. Administrative (e.g., clerical)/Sales ______
5. Technical (e.g., engineer) ______
6. Self-employed ______
7. Skilled manual (e.g., plumber, armed forces) ______
8. Professional (e.g., lawyer, doctor)/Managerial (e.g., director) ______
9. Other ______

Would you consider yourself to be a religious person?
1. Religious ______ 2. Non-religious ______

Contact Information:
Email: ____
Telephone (landline and/or mobile): ______________________________

Appendix III (screening questionnaire, Phase 2)

Psychological Screening Questionnaire

1. Do you have or have you ever been diagnosed with a psychological, psychiatric or neurological disorder (e.g., depression, epilepsy)?

YES	**NO**
Name:	

2. If so, were you prescribed, or are you currently being prescribed, medication or other treatments to help treat the condition?

YES	**NO**
Treatment/s:	

3. Does anyone in your family have a history of neurological, psychological or psychiatric illness?

YES	**NO**

4. Have you ever participated in recreational drug use (e.g., cannabis)? If so, how often? Please place your answer on the scale below by circling the appropriate number. Thankyou.

Never	Only once or twice ever	Less than once a year	A few times each year	About once a month	A few times each month	About once a week	Few times each week	Daily
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

5. In times of distress (e.g., emotional) would you say that in general you have a good support network (e.g., close friends)? Please rate your response by circling the appropriate number (1–5) on the table below:

Very Poor	Poor	Adequate	Good	Very Good
1	**2**	**3**	**4**	**5**

Appendix IV (Figure 33; Bayesian probability tables—Phase 2)

Bayes' probability reasoning tables (GE). Probability values for beads 1–20 for three variants ('easy 85:15', 'medium 70:30', and 'hard55:45').

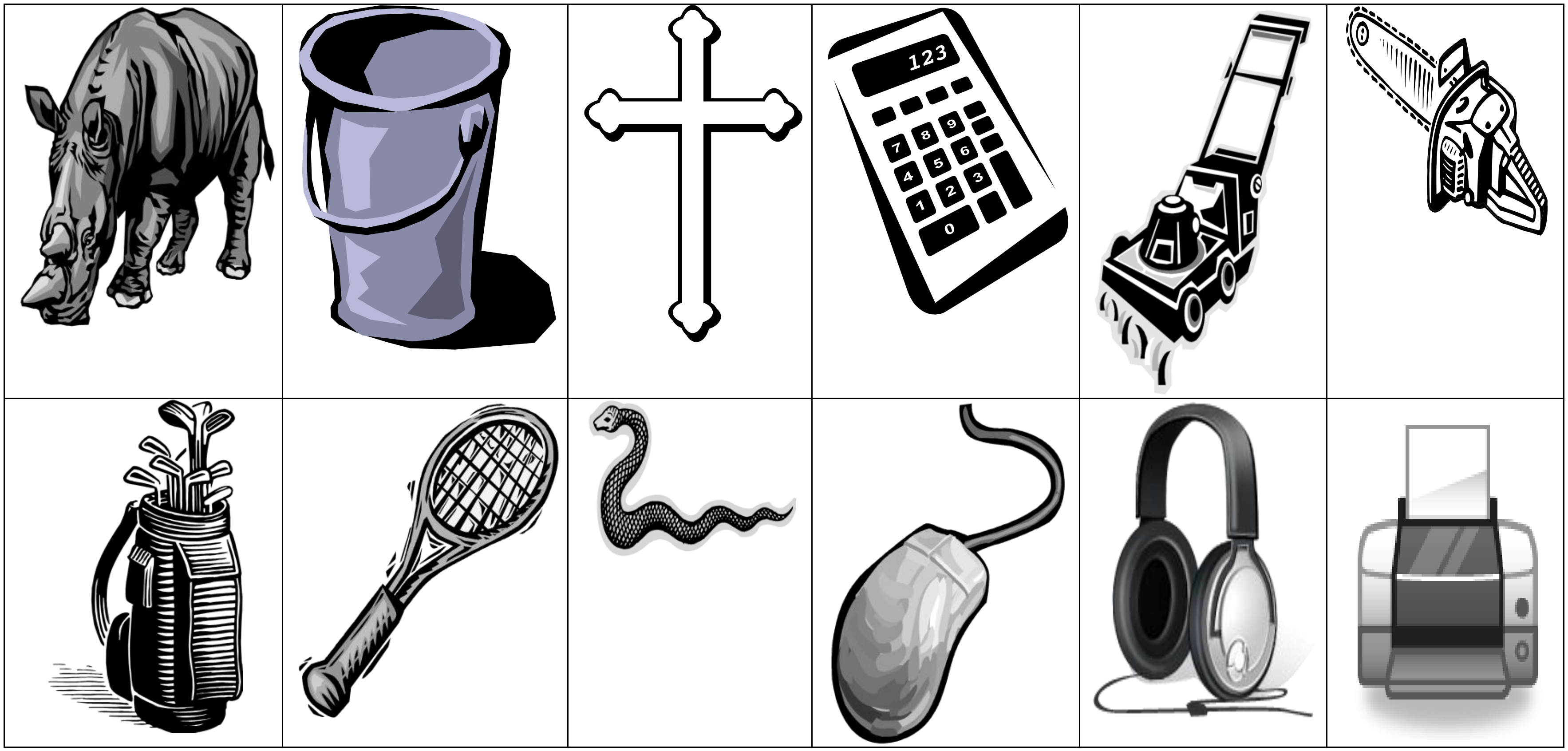
		No of Red drawn																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
no of Green drawn	0		0.85	0.97	0.99	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0.15	0.50	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	2	0.03	0.15	0.50	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.01	0.03	0.15	0.50	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	4	0.00	0.01	0.03	0.15	0.50	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	5	0.00	0.00	0.01	0.03	0.15	0.50	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

		No of Red drawn																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
no of Green drawn	0		0.70	0.84	0.93	0.97	0.99	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0.30	0.50	0.70	0.84	0.93	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	2	0.16	0.30	0.50	0.70	0.84	0.93	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.07	0.16	0.30	0.50	0.70	0.84	0.93	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	4	0.03	0.07	0.16	0.30	0.50	0.70	0.84	0.93	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	5	0.01	0.03	0.07	0.16	0.30	0.50	0.70	0.84	0.93	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

		No of Red drawn																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
no of Green drawn	0		0.55	0.60	0.65	0.69	0.73	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0.45	0.50	0.55	0.60	0.65	0.69	0.73	0.77	0.80	0.83	0.86	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98
	2	0.40	0.45	0.50	0.55	0.60	0.65	0.69	0.73	0.77	0.80	0.83	0.86	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97
	3	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.69	0.73	0.77	0.80	0.83	0.86	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97
	4	0.31	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.69	0.73	0.77	0.80	0.83	0.86	0.88	0.90	0.92	0.93	0.94	0.95	0.96
	5	0.27	0.31	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.69	0.73	0.77	0.80	0.83	0.86	0.88	0.90	0.92	0.93	0.94	0.95

Appendix V (Figure 34; Pictorial Distractor Task—Phase 2)

Twelve images comprising the Pictorial Distractor Task



Appendix VI (Participant Information Form; Phase 2)

The information contained within this form provides you with a brief overview of the computerised cognitive test battery (CCTB) requirements, your rights and obligations as a participant, and a breakdown of the small monetary incentives. Please read carefully and indicate, prior to testing, any part of the procedures with which you feel uncomfortable. Either immediately before or after testing you will also be asked to complete a further short battery of questionnaire measures.

<u>Test requirements:</u>

All of the eight tests contained within the CCTB will be undertaken in the following (fixed) order:

1) A test of fluid (visuoconstructive) IQ.
2) A test of sustained visual attention.
3) A test of memory functioning.
4) A test of probability reasoning.
5) A test of object recognition.
6) A test of verbal (premorbid) IQ.
7) A test of self-monitoring.
8) A of reality monitoring.

Please strike a line through any test you do not feel comfortable with.

<u>Rights and obligations:</u>

1) You have the right, at any stage, to refuse to complete any of the tests with which you feel uncomfortable.
2) You have the right to see an individual copy of yours but nobody else's results.
3) You have the right to a full debriefing. That is, pre- and post-CCTB explanations of test meanings and objectives.
4) You are obliged **not** to confer with any of the other participants regarding CCTB contents and objectives.

Monetary incentives:

Small monetary incentives are to be rewarded as follows:-

The participant attaining the greatest individual score on any of the eight CCTB measures will receive £5 (cash or gift voucher), and the participant attaining the greatest overall score (combined CCTB) will receive £10. This provides you with the scope to win a total of £50.

Appendix VII (standard operating procedures, Phase 2)

On the cognitive antecedents of psychosis-like (anomalous) experiences: Variance within a stratified quote sample of the general population

Standard Operating Procedures (SOPs) for the Computerised Cognitive Test Battery (CCTB):

David A. Bradbury

Test SOPs:

- Wechsler abbreviated scale of intelligence (WASI): 'Matrix reasoning' (MR) subtest – proxy spatial and logic-based (visuoconstructive) IQ – control measure.
- National adult reading test (NART) – proxy premorbid verbal IQ – control measure.
- Continuous performance test (CPT) – experimental measure.
- Illusory memory (DRM paradigm) – experimental measure.
- Beads test (BT): Graded estimates (GE) and Draws to Conclusion (DTC) variants – experimental measures.
- Object recognition (OR) – experimental measure.
- Reality monitoring (RM) – experimental measure.
- Letters & Numbers Game: Self-monitoring test – experimental measure.

SOP: **Wechsler abbreviated scale of intelligence (WASI; Wechsler, 1999)**

The WASI is a brief measure of intelligence that was developed from the Wechsler adult intelligence scales (WAIS; Wechsler, 1997). For the purposes of this study the MR subtest of the WASI will be used. The SOPs are as follows:

Description

This subtest is composed of four types of nonverbal reasoning tasks: 1) pattern completion; 2) classification; 3) analogy; and 4) serial reasoning. The examinee looks at a matrix from which a section is missing and completes the matrix by clicking in the appropriate check-box from one of five response options.

General Directions

- The MR subtest of the WASI consists of a series of 37 incomplete gridded patterns for each of which participants have to decide (by clicking in the appropriate checkbox) which one of five possible options completes the sequence. Scores for the first five gridded patterns are discounted unless participants fail any after two trials. In order to avoid guessing, once an answer is inserted (mouse click) the test automatically moves onto the next item.
- There are no rigid time limits for the MR subtest. Most examinees will finish an item within 30 seconds. If after 30-seconds, the examinee has not provided a response, say: “Let’s try the next one”.

Discontinue

Discontinue after four consecutive scores of 0 or ***four scores of 0 on five*** consecutive items.

Stop

If the discontinue criterion has not been met, stop ***after*** the item specified for the examinee’s age group:

• Ages 12—44: No stop point
• Ages 45—79: After Item 32
• Ages 80—89: After Item 28

SOP: **National adult reading test (NART; Nelson, 1982)**

This test is purported to measure premorbid verbal intelligence. The SOPs are as follows:

Description

The NART consists of 50 words decreasing in familiarity as the test progresses.

General Directions

Participants are instructed to provide the correct pronunciation for each of the 50 words. Participants had as long as deemed necessary to compose themselves before forwarding an answer; to navigate to the next item (word) participants are required to press the SPACE BAR.

SOP: **Continuous performance test (CPT)**

The CPT is a test of sustained visual attention. The SOPs are as follows:

Description

This version of the CPT requires participants to press the SPACE BAR every time the letter "f" is presented on screen and to ignore this rule if the letter "d" immediately precedes the letter "f". The full complement of letters presented includes "f" "d" "b" and "t". All four letters are presented in a fixed order, with equal opportunities for 'hits' 'misses' and 'false alarms'. Interstimulus durations are set to a constant of 200-milliseconds. After a 30-seconds practice period, when composed and confirming that they fully understand test requirements, participants engage in the five-minute test period.

General Directions

Say to the participant:-

"You will be shown a random selection of letters on the screen, one after the other. Your task is to press the SPACE BAR every time you see the letter 'f' **unless** the letter that comes before 'f' is the letter 'd'. Do you understand what you have to do?"

Repeat the instruction as necessary.

"You will now have a short practice session to make sure you understand the task. If you have any questions, please ask the researcher".

The programme will record the number of hits, misses, false positives, and false negatives for each participant.

SOP: **Beads test (BT)**

The BT aims to assess probability judgments under differing conditions of uncertainty. This version of the BT consists of two variants: firstly, an assessment of participants' confidence judgments when probability reasoning (GE). The second variant, DTC, assesses participants' propensity to JTC. That is, to base their decisions on scant evidence. SOPs are as follows:

Graded estimates (GE)

Description

This variant involves three conditions within which participants are presented with two jars (on opposite sides of the screen) each containing 100 coloured beads in opposite ratios (BLUE-RED 85:15/RED-BLUE 15:85 – easy condition; GREEN-RED 70:30/RED-GREEN 30:70 – medium condition; and GREEN-YELLOW 55:45/YELLOW-GREEN 44:55 – hard condition).

General Directions

Participants are presented with a series of, as far as they are concerned, "randomly computer-drawn" (although in truth pre-ordered) series of coloured beads.

Say to the participant:

"For each bead that is presented please click on the jar you think the bead was most likely (in your opinion) to have been drawn from, and then subsequently rate your confidence in that estimation as a percentage on the attached scale."

This procedure is completed twenty times for all three conditions. The optimum mean confidence for each of the three conditions is as follows: easy (85%), medium (70%), and hard (55%).

Draws to Conclusion (DTC)

<u>Description</u>

The task involves presenting participants with the same ratios of beads as the GE condition but in differing colour combinations (BLUE-YELLOW 85:15/YELLOW-BLUE 15:85 – easy condition; 70:30 BLUE-YELLOW/30:70 YELLOW-BLUE – medium condition; and 55:45 RED-BLUE/45:55 BLUE-RED – hard condition).

<u>General Directions</u>

Say to the participant:

"This time, you can confirm a jar at any point once you are fully confident that the bead or string of beads is being drawn from your choice of jar. That is, rather than selecting a jar and then placing a confidence rating for each sequential bead, you will be initially presented with one solitary bead upon which to make a decision; however, if you require further evidence (another bead or string of beads) before confirming a jar (i.e., being 100% sure that the bead came from the chosen jar) then you can request it with a simple left-click of the mouse (anywhere in the grey background)."

This procedure was completed for all three conditions.

SOP: **Deese-Roediger-McDermott (DRM) illusory memory paradigm (Deese, 1959; Roediger & McDermott, 1995)**

This test is designed to assess participants' susceptibility to remember words not presented in lists. The test is split into two phases; *encoding* and *recognition*. SOPs are as follows:

Encoding phase

<u>Description</u>

This phase involves presenting participants with eight lists each containing fifteen words, making a total of 120 words.

General Directions

Say to the participant:

"You will be presented with eight lists each containing fifteen words and your task is to simply name each word aloud."

After completing the encoding phase participants complete approximately 15-minutes of distractor tasks (i.e., CCTB tests). No clue is given at any point as to a later recognition phase.

Recognition phase

Description

During the recognition phase participants are presented with 24 words (eight critical lures; eight previously presented words; and eight new words), and asked to discriminate which they may have encountered in the previous encoding phase.

Say to participants:

"By clicking in the appropriate check-box, your task is to provide one of four possible responses for each of the following 24 words as to whether the word has been previously encountered: 1. 'Old' – definitely seen before; 2. 'Probably old' – could have been seen before; 3. 'New' – definitely not seen before; and 4. 'Probably new' – may have not been seen before."

SOP: **Object Recognition (OR) Test**

This test is designed to assess participants' ability to perform image closure. That is, to recognise a series of eight familiar line-drawn objects presented in decreasing degrees (six levels) of degradation. SOPs are as follows:

Description

This test involves participants being presented with fragmented line drawings of familiar objects.

General Directions

Say to the participant:

"You will be presented with eight line-drawn images of "familiar" objects in six levels of decreasing fragmentation. That is, each set of images will become progressively clearer with each subsequent level.

Your task is for each of the eight images, at each of the six levels (which makes 48 images in total), to forward a written response (by typing in an adjoining box) coupled with a confidence judgment (by clicking in the appropriate check-box of an 11-point percentage scale; 0-100, multiples of ten). If you are completely unsure as to what any particular image may be they please leave the response box blank and insert no confidence rating."

Once participants have inserted the correct written response coupled with 100% confidence, the image will disappear. Additionally, if participants name (identify) an object correctly but spell it wrong they are to be advised as to the correct spelling.

SOP: **Reality Monitoring (RM) Test**

This test aims to measure participants' ability to discriminate between internally- and externally-generated imagery. The test is split into two phases; *encoding* and *recognition*. SOPs are as follows:-

Encoding phase

Description

This phase requires participants to speak aloud 24 'words' and name 24 'pictures' (objects), which are presented in a counter-balanced order one item every 2.5-seconds.

Say to the participant:

"You will now be presented with a series of 24 words and 24 pictures at a rate of one item every two and a half seconds. Your task is simply to say aloud (identify) each of the 48 items. For the words please read them and for the pictures please name them."

Recognition phase

Description

The recognition phase – akin to the DRM procedure, is completed after approximately 15-minutes of distractor tasks (i.e., CCTB tests). It requires participants to identify (recognise) the previously encoded 48 items plus 24 additional distractor items (12 words and 12 pictures).

Say to the participant:

"You will now be presented with another series of words and pictures. For each item, I would like you to choose whether: 1) the item has been previously viewed as a 'word'; 2) whether the item has been previously viewed as a 'picture'; or 3) whether in fact the item has been 'Not previously viewed'. You can make your choice by clicking in the appropriate check-box."

SOP: **Letters & Numbers Game: Self-Monitoring (SM) test**

The test is designed to measure the extent to which participants monitor their actions. SOPs are as follows:

Description

This novel test involves participants utilising the mouse to differentiate between visually-presented 'letters' (left click) and 'numbers' (right click).; and also to monitor their performance by correcting, if noticed, their mistakes.

General Directions

Say to the participant:

"Every few seconds, a small square will appear at any point on the screen and either a letter or a number will appear within it. Your task is to provide a 'left' mouse-click when a 'letter' appears and to provide a 'right' mouse-click when a 'number' appears. I do not want you to try and work out the order of the letters and numbers but just to react to them when they appear.

As this a performance measure[93] – maximum score equalling 100% – what I am going to say next regards the most important aspect of the task: When playing the game, if at any time you think you have made a mistake then you **must** correct that mistake at once. A mistake will result in a ten-percent penalty; however, correcting a mistake will redeem 5-percent. For example, if a letter appears but you perform a right mouse-click, then you must press the letter "c" on the keyboard to correct your mistake.

If you have any questions about the task then please ask the researcher. We will now have a 30-seconds practice session to acquaint you with the task. Click on the START button when you are ready to begin the task".

Ask the participant if they understand the instructions. Repeat the instruction on correcting mistakes to ensure that the participant fully understands:-

"Do you understand what you should do if you make a mistake?" Repeat correction instructions anyway. "If at any time you think you have made a mistake then you must correct that mistake at once. For example if a letter appears but you perform a right mouse-click, then you must press the letter 'c' on the keyboard to correct your mistake".

The settings for the Practice Trial are:

(Length of test in seconds = 30, Length of stimulus in seconds = 2.5, ratio of interruptions to pattern = 3)

After the trial test:

The settings for Test Phase are:-

(Length of test in seconds = 300, Length of stimulus in seconds = 2.5, Ratio of interruptions to pattern = 4).

Concluding remarks

At the end of the test thank participants for their involvement, debrief CCTB aims, and advise that a full copy of individual results, once analysed, will be available upon request.   End.

[93] "Performance measure" in this context refers to the advice presented to participants at the outset of the CCTB pertaining to the cash incentives.

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