Swansea University
Prifysgol Abertawe

Cronfa
Setting Research Free

Swansea University E-Theses

The influence of the unusual experiences dimension of schizotypy on timing within a reinforcement schedules and explicit timing judgements context.

Randell, Jordan

How to cite:

Randell, Jordan (2011) *The influence of the unusual experiences dimension of schizotypy on timing within a reinforcement schedules and explicit timing judgements context..* thesis, Swansea University.
http://cronfa.swan.ac.uk/Record/cronfa42836

Use policy:

This item is brought to you by Swansea University. Any person downloading material is agreeing to abide by the terms of the repository licence: copies of full text items may be used or reproduced in any format or medium, without prior permission for personal research or study, educational or non-commercial purposes only. The copyright for any work remains with the original author unless otherwise specified. The full-text must not be sold in any format or medium without the formal permission of the copyright holder. Permission for multiple reproductions should be obtained from the original author.

Authors are personally responsible for adhering to copyright and publisher restrictions when uploading content to the repository.

Please link to the metadata record in the Swansea University repository, Cronfa (link given in the citation reference above.)

http://www.swansea.ac.uk/library/researchsupport/ris-support/

Swansea University
Prifysgol Abertawe

The Influence of the Unusual Experiences Dimension of Schizotypy on Timing within a Reinforcement Schedules and Explicit Timing Judgements Context

Jordan Randell

Submitted to the University of Wales in fulfilment of the requirements for the Degree of Doctor of Philosophy

2011

UNIVERSITY OF WALES SWANSEA LIBRARY

ProQuest Number: 10821226

All rights reserved

INFORMATION TO ALL USERS
The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript
and there are missing pages, these will be noted. Also, if material had to be removed,
a note will indicate the deletion.

ProQuest 10821226

Published by ProQuest LLC (2018). Copyright of the Dissertation is held by the Author.

All rights reserved.
This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

Summary

Schizotypy as a research framework for schizophrenia emphasizes a link between the symptoms of the disorder and schizotypal traits in the non-clinical population, and argues for a symptom orientated approach to the field. One such symptom area concerns that of unusual experiences, such as hallucinations and delusions that occur in both schizophrenia and in the normal population, but differ in intensity and frequency. Hallucinations and delusions are affected by the environment in which they occur, such as a perceptually ambiguous environment. However, given that both hallucinations and delusions are misinterpretations of the current environment, the content of both could also be influenced by previous experiences, where properties of previous experiences interact with the current environment to produce such experiences. One factor that could influence hallucinations and delusions in this way is time. That is, it could be that those individuals more prone to hallucinations and delusions have stronger temporal links with the properties of previous experiences that facilitate hallucinatory and delusional experiences.

The current thesis explores the relationship between the influence of environmental properties on hallucinatory reports and the possibility of differences in timing between individuals scoring high or low in schizotypy through tasks that incorporate temporal elements for optimum performance, such as time based schedules of reinforcement, or measure timing more directly, such as temporal bisection tasks. Findings from the thesis show that high schizotypy scorers make more hallucinatory-like reports than low scorers and that those reports are linked to properties of the environment in which they occur. In addition, there is some evidence that high scorers differ in timing across both schedule and temporal bisection tasks, but only under very specific circumstances.

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .... (candidate)

Date ....1/8/2011...

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed .... (candidate)

Date ....1/8/2011...

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations

Signed .... (candidate)

Date ....1/8/2011.......................................

NB: *Candidates on whose behalf a bar on access has been approved by the University (see Note 9), should use the following version of Statement 2:*

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loans **after expiry of a bar on access approved by the University of Wales Swansea.**

Signed .... (candidate)

Date ....

Contents Page

Acknowledgements

A portion of this thesis has already been accepted for publication in the Journal of Behaviour Therapy and Experimental Psychiatry and Personality and Individual Differences.

I would like to thank my supervisor Prof. Phil Reed, a great teacher, for his guidance and wisdom throughout the completion of this thesis, for steering me into the field of research in the first place and for providing help and support above and beyond that required along the way.

I would also like to thank my parents, Julie and Steve Randell, for providing love and support (especially financially!), it would not have happened without you. I would also like to thank Claire Tarling for her patience, understanding and encouragement at the most stressful of times, and for helping me keep going.

I would also like to thank Leigh Edwards and Isaac Jones for their invaluable assistance in programming the experiments in Chapter 2, and to David Mann for kick starting me on using Visual Basic for programming the rest of the experiments.

I would also like to thank all the participants that took part in the experiments and all the members of the Psychology department, whether it be for any direct help to my thesis, broadening my mind more generally, or simply joining me in some good times!

Publications

Randell, J, Ranjith-Kumar, A.C., Gupta, P., & Reed. P., (2009). Effect of schizotypy on responding maintained by free-operant schedules of reinforcement. *Personality and Individual Differences*, 47, 783 – 788.

Randell, J., Goyal, M., Saunders, J. & Reed, P. (2010). Effect of a context of concrete and abstract words on hallucinatory content in individuals scoring high in schizotypy, *Journal of Behaviour Therapy and Experimental Psychiatry*, 42 (2), 149-153.

Randell, J., May, C., Jones, C., & Reed, P. (2011). High schizotypal individuals manifest differential performance on time-based schedules of reinforcement, *Personality and Individual Differences*, 50 (5), 735-741.

Conference Presentations

Randell, J. & Reed, P. (2006). *The Study of Hallucinatory Content: Reprising the Verbal Summator*. Annual Conference of the European Association for Behaviour Analysis. Milan, Italy. July, 2006.

Randell, J. & Reed, P. (2007). *The Study of Hallucinatory Content: Reprising the Verbal Summator*. 36th Annual Student Conference of the British Psychology Society: Welsh Branch. Swansea, UK. March, 2007.

Randell, J. & Reed, P. (2008). *The Effects of Schizotypy on Responding Maintained by Free-Operant Schedules of Reinforcement*. Annual Conference of the European Association for Behaviour Analysis. Madrid, Spain. Sept, 2008.

Chapter 1: Introduction.

The present thesis concerns the topic of hallucinations and their underlying causes within the framework of schizotypy. The underlying causes are discussed in terms of the currently present environment, as well as previous experiences, in a manner similar to that suggested by several theories of hallucinations and delusions (e.g. Frith, 1979; 1987; Grossberg, 2000; Garety & Freeman, 1999; Tonneau, 2004). Although these topics are explored in terms of schizotypy, there is also a focus on the relevance for hallucinations and delusions as they occur in individuals diagnosed with schizophrenia. An approach focusing on increasing the understanding of the underlying processes involved with cognitive functioning similar to those involved in hallucinatory experiences within schizotypy may increase understanding for similar experiences in a clinical population, where such experiences are more serious. This approach may shed light on differences between high and low schizotypy scorers in these processes that further extend to more severe schizophrenia. Alternatively, it could be that different processes are involved in hallucinatory-like experiences in the non-clinical population than those involved in schizophrenic patients. Either way however, increasing the understanding of the underlying mechanisms of hallucinatory-like processes in the non-clinical population will in turn reveal relevant information that contributes to the understanding of hallucinations.

1. Schizophrenia

1.1 Symptoms, diagnosis, and prevalence

The modern day view of schizophrenia argues that the disorder is a dimensional one consisting of a group of brain disorders known as schizophrenia spectrum disorders (APA, 1994; Kety, Rosenthal, Wender, Schulsinger, & Jacobsen, 1975; Bentall, 2003e; Jablensky, 2002). For the majority of this section, a broad view of schizophrenia will be the focus of discussion encompassing the spectrum as a whole or relating to schizophrenia as outlined in the DSM-IV (APA, 1994), with the related and subtype categories included where applicable.

Schizophrenia consists of a combination of symptoms from a set of five symptom categories including hallucinations, delusions, disorganized behaviour and speech, and negative symptoms such as affective flattening (American Psychiatric Association; APA, 1994). Diagnosis requires three diagnostic criteria to be met; firstly, the presence of two or more symptoms from the above symptom categories for at least one month, secondly, social or occupational dysfunction, and finally, the persistence of the above two criteria for a period of six months or more (APA, 1994). In addition, the diagnosis for schizophrenia included exclusion criteria that cover the DSM-IV highlights several related and similar disorders such as schizoid and schizotypal personality disorders, schizophreniform disorder, and schizoaffective disorder (APA, 1994), some of which are identified as exclusion criteria for schizophrenia and each of which include their own criteria for diagnosis as separate disorders (APA, 1994). Prevalence rates for schizophrenia range from approximately four to seven per 1,000 people depending on the type of prevalence estimate used (see Saha, Chant, Welham & McGrath, 2005 for a review of prevalence studies). Prevalence studies for related disorders remain largely unexplored, or are incorporated within reviews of schizophrenia spectrum disorders (e.g. Jablensky, 2002). The traditional view of schizophrenia is that of diathesis –stress, whereby an underlying biological predisposition interacts with stressful life events allowing for the emergence of the disorder (Zubin & Spring, 1977). For example, one theory argues that schizophrenia is a result of an over-activity of the neurotransmitter dopamine in the mesolimbic (positive symptoms) and mesocortical (negative symptoms) pathways of the brain that result in the emergence of the disorder, (Buchanan, Freedman, Javitt, Abi-Dargham & Lieberman, 2007; Crow, 1981; Davis, Kahn, Ko & Davidson, 1991; Meltzer & Stahl, 1976; Walter, Kammerer, Frasch, Spitzer & Abler, 2009). This theory stems from the general findings that drugs that either increase or inhibit dopamine reuptake exacerbate or suppress the symptoms of schizophrenia accordingly (Abi-Dargham & Moore, 2003; Carlsson & Lindqvist, 1963; Carlsson, Waters, Waters & Carlsson, 2000; Walter et al 2009).

Despite the popular view that schizophrenia is a "brain disease" (see Read, 2004a), there is much evidence to suggest that such a perception of the schizophrenia spectrum disorders as physical illnesses, is both theoretically, and, in particular, methodologically flawed (see Bentall, 2003a; Read 2004a, 2004b, 2004c; Read, Mosher & Bentall, 2004). Stemming from research covering broad conceptual areas, such as: the history of 'madness' in society (e.g., Foucault, 1965), genetics (see Read & Mason, 2004 for an overview), medication (see Bentall & Morrison, 2002), adverse life events (e.g., Warner, 1985), and the methodological flaws underlying the demonstrations of the validity and reliability of schizophrenia (see Read, 2004c, for an overview), as well as its classification (see Bentall, 2003b), there appears to be enough evidence to suggest that the view of schizophrenia as a biological disorder is, at the least, questionable.

One of these problematic areas concerns the manner in which diagnoses are made, which, according to the DSM-IV diagnostic criteria for schizophrenia, requires the presence of two, or more, symptoms, taken from a set of five symptom categories, and which have to be present over a 6-month period (APA, 1994). The symptom categories required for diagnosis of schizophrenia are: hallucinations, delusions, disorganized speech, disorganized behaviour, and negative symptoms (such as affective flattening). The total range of symptoms that fall into these categories include delusions, hallucinations, disorganised speech, and grossly disorganised or catatonic behaviour; whilst the negative symptoms include: lack of emotion and/or interest in life, low energy and/or motivation, affective flattening, alogia, avolition, a lack of interest in socializing, inappropriate social skills, inability to care about having, making or keeping friends and social isolation (APA, 1994). Given that any two of five symptom categories are required, it is worth noting that this gives ten distinct ways in which an individual can be diagnosed with schizophrenia, and this is without considering further symptom specifics (e.g. paranoid delusions or delusions of grandeur). However, diagnosis procedures do attempt to account for such differences in symptom structures between patients by identifying related disorders such as schizoaffective disorder, schizophreniform psychoses, process-non process, catatonic, disorganized, residual and paranoid schizophrenia (APA, 1994), but these in turn also present the possibility of different symptom combinations (APA, 1994; see Bentall, 2003e for a discussion). Adding to the confusion also is the classification of disorders that, although not falling under a subtype of schizophrenia, fall along the same spectrum, such as schizotypal personality disorder, where the symptoms presented are similar to schizophrenia but are focused on the negative symptom type (APA, 1994). Despite some efforts then to account for within-patient symptom differences by classifying subtypes of schizophrenia and related disorders along the same spectrum, there remains some degree of confusion and within-patient differences in symptoms also for specific forms of the disorder.

A further issue that questions the traditional view of schizophrenia concerns prevalence rates, chiefly due to inconsistencies, and misinterpretations, presented in cross-cultural studies (see Bentall, 2003c). For example, Torrey (1987) reported a "ten-fold range of schizophrenia", despite finding a fifty-five fold difference in prevalence between the highest and lowest prevalence rates across two different countries. Moreover, there is also evidence that the incidence of schizophrenia varies depending on rural or urban environments within countries. For example, Mortensen et al (1999) found that a greater risk for the development of schizophrenia in urban areas of Denmark than in rural ones, whilst similar trends have been reported in the Netherlands (Marcelis, Navarro-Mateu, Murray, Selten & van Os, 1998), England and Wales (Takei et al, 1995), and Sweden (Lewis, David, Andreasson & Allebeck, 1992), although the overall effect on the type of environment have not shown significant results in more detailed analysis of prevalence (Saha et al, 2005).

The findings of varied incidence and prevalence rates, dependent on rural or urban environments, highlights the importance of an environmental contribution toward the formation and maintenance of schizophrenia perhaps beyond that offered by the 'traditional' biological approach. Indeed, historically, the term 'madness' has been argued to have been interchangeable with 'treatment of the mad'; meaning that the symptoms of mental illness exhibited by "the mad" were in fact a response to the kind of environment or treatment methods these individuals were exposed to that were thought to alleviate such symptoms (see Foucault, 1965; Tuke, 1813; Pinel, 1801). For example, the inoculation of abscesses and scabies and the force-feeding of chimney soot, woodlice and soap, were taken as effective for the treatment of madness in some institutions, despite the obvious distress that could be caused by such grim methods (Foucault, 1965; Read, 2004d). In light of this, it would not be surprising if those patients exposed to such distressing treatment methods responded in a way akin to that taken to be evidence of madness. Moreover, modern research into schizophrenia has found that the occurrence, and content, of symptoms are associated with, for example, levels of stress, and the contents of the current environment (Skirrow, Jones, Griffiths & Kaney, 2002; Spivak, Trottern, Mark, Bleich, & Weizman, 1992). Some of these issues however will be discussed in the following sections within the framework of schizotypy (Meehl, 1962, 1989).

1.2 **The history of schizophrenia**

Emil Kraepelin (1913) began the attempt to categorise all types of mental illness with the belief that correct categorisation would precede discovery of an underlying physiological cause for "madness"; a view, in part, supported by the discovery of syphilis, and its underlying physiological causes (Bayle, 1822, cited in Read, 2004d). Taking groupings of symptoms defined at the time as *catatonia* (abnormal body postures), *hebephrenia* (deterioration of mental functioning onset in adolescence) and *dementia paranoides* (characterized by unusual fears or persecution), Kraepelin (1913) grouped them further to classify the illness *dementia praecox,* or a severe mental deterioration onset in adolescence (see Bentall, 2003b, 2003d).

The term 'schizophrenia' was later coined by Eugen Blueler (1911, cited in Bentall 2003d) in a continued attempt to categorise several 'abnormal' behaviours under one banner, albeit with some re-defining, resulting from inconsistencies of the severity of the mental deterioration between patients, and age of onset, as implied by dementia praecox (Bentall, 2003d). In an attempt to clarify the term 'schizophrenia', or, more specifically, aid psychiatrists in making a correct diagnosis of the disorder, Schneider (1959) identified what he believed to be the "first-rank symptoms" of schizophrenia, which included "audible thoughts, voices heard arguing, voices commenting on ones actions, experiences of influences on the body, thought withdrawal, thoughts as ascribed to other people who intrude their thoughts upon the patient, thought diffusion, delusional perception, feelings, impulses (drives) and volitional acts that are experienced by the patient as the work of influence of others" (Schenider, 1959, cited in Bentall, 2003d, p. 32-33). These first-rank symptoms are still relied upon heavily within the diagnostic criteria for schizophrenia (APA, 1994; see section 1.1 above). It is also worth noting, here, that they relate largely to the hallucination and delusion symptom areas, which will become a focus of the current thesis.

Moving away from a categorical approach to schizophrenia, the 1960's and 70's saw a move toward a more dimensional approach to the disorder (Meehl, 1962; ; Kety et al, 1975). Stemming from Meehl's (1962) argument for "schizotaxia" - that individuals hold a predisposition to develop schizophrenia, and exhibit personality traits associated with schizophrenia symptomology – the consideration of schizophrenia began to move toward a more dimensional entity, largely due to the work of Kety et al (1975). Following research into the genetic underpinnings of the disorder amongst family members of diagnosed patients, Kety et al (1975) reported that, although finding very little evidence of suffering from psychotic illness in the relatives of patients with schizophrenia, the study suggested that these relatives showed many unusual and eccentric personality characteristics such as supernatural beliefs. As a result, "schizophrenia spectrum disorder" was proposed as a new approach to the diagnosis of schizophrenia, whereby such related characteristics could be accounted for in related but different disorders as well as in terms of latent schizophrenia or a predisposition toward it (Kety et al, 1975; Bentall, 2003e; Jablensky, 2002). As a result of this research, schizophrenia spectrum disorders along a multi-axial system (psychiatric diagnosis along axis I and personality disorders along axis II) were subsequently included in the following revisions of the DSM, where they remain (APA, 1994; DSM-IV-TR; APA, 2000). However, the use of axis II as a diagnostic criteria for disorders such as schizotypal personality disorder remains somewhat problematic, with the reliability for the categories included within axis II proving to be low (Bentall 2003e; Mellsop, Varghese, Joshua & Hicks, 1982). This means that, although a dimensional approach to schizophrenia spectrum disorders accounts for some of the shortfalls in variability between patients, symptoms and biology, pinning down these disorders to distinct disorders with a definitive set of symptoms, aetiology and outcomes remain unclear (McDonald & Schulz, 2008; Tsuang, Stone, & Faraone, 2000).

1.3 **Problems with the classification**

The classifications made by the pioneers of schizophrenia (e.g., Bleuler, 1911, cited in Bentall 2003d; Kraepelin, 1913) have continued to be further redefined (see Bentall, 2003b; Read, 2004b). However, these redefinitions, themselves, have suffered from an inability to successfully incorporate a consistent set of symptoms, outcomes, an observable cause, or time of onset, and have, as a result, seen redefinitions include groupings of behaviours seemingly 'made-to-fit' the disorder or spawning related disorders with varied symptoms (Read, 2004b). For example, a recent review highlights the differences in the diagnostic criteria for schizophrenia included across versions of the DSM, and in a paper entitled "*Toward Reformulating the Diagnosis of Schizophrenia*", the conclusion is made that success in treating and/or preventing the disorder: "*will depend to an important extent on an accurate understanding of its causes*" (Tsuang, Stone, & Faraone, 2000, p. 1041), arguing that research is needed to establish the possibility of "*schizotaxia with psychosis (schizophrenia) and schizotaxia alone as distinct diagnostic conditions*" (Tsuang, Stone, & Faraone, 2000, p. 1041).

Thus, without covering all of the research area, it is clear that there is still much debate surrounding schizophrenia spectrum disorders, as is evident in the variability of the possible diagnostic criteria for the schizophrenia alone; just considering the five symptom categories without the individual symptoms, however, gives fifteen possible ways that two people meeting these criteria could be diagnosed as schizophrenic, yet without having any symptoms in common (Read, 2004c). Such variations of symptoms in the definitions of schizophrenia raise questions of reliability and validity from a scientific standpoint (Bannister, 1968; Bentall, 2003a, 2003b; Bentall et al., 1988; Boyle, 1990; Ross & Pam, 1995).

In terms of the reliability of the construct of schizophrenia, no significant relationship between clinical and research diagnoses have been demonstrated (Whaley, 2001). Moreover, a study that specifically examined the reliability of the schizophrenia construct, by examining the use of sixteen different classification systems for schizophrenia, has shown a dramatic variation, of between 1/248, and 203/248, patients being diagnosed with the disorder (Herron, Schultz, & Welt, 1992).

In turn, the concept of 'schizophrenia' has been argued to show low levels of validity due to a large degree of symptom co-morbidity with other disorders (Craig & Hwang, 2000; Crow, 1990; Ellason & Ross, 1995; Torgalsboen, 1999a), and a lack of common prognosis; with psycho-social factors contributing to, and, in some cases, being argued to be the best predictors of outcomes as opposed to the diagnosis of schizophrenia (Doering et al., 1998; Harrison et al., 2001; Malmberg, Lewis, David & Alleback, 1998; McGlashan, 1988; Mueser et al., 1990; Torgalsboen, 1999b). Furthermore, as Read (2004a) points out, the three arguments that are used to justify the view that schizophrenia has a biological basis; uniform frequency throughout the world, abnormal brain features and a genetic predisposition, are all flawed to some extent. This is due, firstly, to evidence to the contrary, or, at least, to the evidence being misinterpreted, or questionable, especially that which shows great variation in prevalence across cultures (Torrey, 1987; but see also Read, 2004a).

In addition, a biological basis for schizophrenia has been identified in terms of biochemical and anatomical theories, to name but two (see Read, 2004a). One such theory is the 'dopamine hypothesis', which argues that schizophrenia is caused by over-activity of the neurotransmitter dopamine in the brains of schizophrenic patients (Buchanan et al, 2007; Crow, 1981; Davis et al, 1991; Meltzer & Stahl, 1976; Walter, et al 2009). However, evidence for this theory has been argued to be inconclusive and over-simplistic as a result of more recent research implicating other neurological mechanisms, such as the influence of serotonin and the neurotransmitter glutamate, removing the focus away from the influence of dopamine alone, and toward more complex interactions (Coyle, Tsai & Goff, 2003; Kapur & Remington, 1996; Laruelle, Kegeles & Abi-Dargham, 2003). The existing evidence pertaining to alterations in dopamine levels could also be a *result* of schizophrenia, as opposed to a *cause* (Snyder, 1974). Similarly, although research into the genetic underpinnings of schizophrenia, through adoption studies, have provided support for the genetic argument (Kety et al, 1975; Tienari et al, 1987; Tienari, 2000; Wender et al, 1974), a number of critical reviews of these studies have highlighted some major methodological issues in the criteria used, such as broadening the criteria to include non-psychotic schizophrenia disorders, inadequate definitions of schizophrenia and failure to strictly control or account for degrees of relatedness between relatives (Bentall, 2003a, 2003b, 2003c; Read, 2004a).

2. Schizotypy

2.1 Development of the concept and its implications

The word "schizotypy" was first used by Rado (1953) as an abbreviation for the term "schizophrenic phenotype", and to refer to a sub-clinical predisposition to schizophrenia. This notion was later elaborated by Meehl (1962), who argued that, due the inconsistent evidence accrued from genetic research into schizophrenia, the disorder itself could not be assumed to be inherited. Rather, the term 'schizotypy' could be used to conceptualise a predisposition toward the development of schizophrenia, which may have some genetic component triggered by exposure to particular environmental conditions. Thus, the development of the concept of schizotypy can be viewed, in part, as a reaction to inadequacies in the construct validity of schizophrenia as an "illness".

As a result of these problems, a dimensional approach using schizophrenia spectrum disorders (Kety et al, 1975) has become the dominant approach to diagnosis. In line with this, a growing body of researchers have argued for a more symptom-orientated approach to examining schizophrenic symptoms using sub-clinical populations, which may be more beneficial in understanding and helping those who exhibit bizarre behaviours and suffer from abnormal experiences (Bentall, 2003e). This approach argues for a continuum of psychosis-like behaviour, on which every individual, clinical or non-clinical, falls (Chapman & Chapman, 1980; Chapman, Chapman, Kwapil, Eckblad, & Zinser, 1994; Claridge, 1990). This in turn compliments the notion of a spectrum of schizophrenia disorders that vary in symptom type, intensity and clustering, such as schizoaffective disorder, which emphasizes the influence of affective states (depression and anxiety) alongside the classic symptom groups of schizophrenia, into which those patients who do not meet the classical schizophrenia criteria may be included (Blacker & Tsuang, 1992). A dimensional approach argues that every individual differs in the degree to which they have experiences associated with schizophrenic symptoms, but lacking in the clinical severity to warrant clinical treatment (McCreery & Claridge, 1996a, 1996b; Verdoux, van-Os, Maurice-Tison, Gay, Salamon, & Bourgeois, 1998).

The clinical implications of schizotypy and a dimensional approach to schizophrenia centre largely on the identification of "at-risk" individuals and the potential for developing interventions and treatment therapies for those most prone to the development of schizophrenia spectrum disorders (Faraone, Green, Seidman & Tsuang, 2001). In line with this, a large number of longitudinal studies have identified task types where poor performance predicts development of schizophrenia or related disorders on follow-up, such as motor functioning (Fish, Marcus, Hans, Auerbach, & Perdue,1992; Olin & Mednick, 1996; Erlenmeyer-Kimling, Adamo, Rock, Roberts, Bassett, Squires-Wheeler, et al, 1997; Walker & Lewine, 1990) and poor psychosocial skills (Olin & Mednick, 1996; Erlenmeyer-Kimling et al, 1997; Walker & Lewine, 1990; Hans, Marker, Henson, Auerbach & Mirsky, 1992). However, more work needs to be done in establishing the predictive validity of these tasks for the onset of schizophrenia spectrum disorders along with the course of these disorders before reliable and valid interventions can be developed (Faraone et al, 2001). In addition, although the development of interventions for those deemed most "at-risk" would be beneficial, it is also important, from a clinical perspective, to consider how intervention types may interact with the disorder. For example, family-focused interventions may be affected by relatives responses to the individuals symptoms and affect their relationship accordingly (Faraone et al, 2001). Indeed, in the study of expressed emotion, the relationship between a patient experiencing psychosis and family members has been shown to increase the likelihood of relapse (Butzlaff & Hooley, 1998; Pilling, Bebbington, Kuipers, Garety, Geddes, Orbach & Morgan, 2002). Moreover, considering the heterogeneity of schizophrenia spectrum disorders, the relatives of patients with schizophrenia may not be the best proponents of a familial intervention, given that they may exhibit some bizarre behaviour and experiences associated with schizophrenia themselves (Faraone et al, 2001). In terms of the clinical implications of schizotypy then, the potential for the identification of "at-risk" individuals and the development of intervention approaches in these individuals accordingly is highly desirable, but more research is currently required into the predictive validity of the behavioural deficits already thought to be associated with the schizophrenia spectrum, the course of these disorders and the potential interaction of these behavioural deficits with the mechanics of intervention approaches.

2.2 **Predictive validity of schizotypy.**

Another feature of a dimensional approach to schizophrenia and the concept of schizotypy concerns the possibility of identifying individuals "at-risk" to develop the disorder (Meehl, 1962). With this in mind, a number of studies have sought to examine the predictive validity of schizotypy and its methods of measurement in the development of more severe psychosis over time (Cannon, Cadenhead, Cornblatt, Woods, Adlington, Walker, Seidman, Perkins, Tsuang, McGlashan & Heinssen, 2008; Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994; Gooding, Tallent & Matts, 2005; Horan, Reise, Subotnik, Ventura & Nuechterlein, 2008; Erlenmeyer-Kimmling, Cornblatt, Rock, Roberts, Bell & West, 1993; Kwapil, 1998; Miller, Lawrie, Byrne, Cosway & Johnstone, 2002; Miller, Byrne, Hodges, Lawrie, Owens & Johnstone, 2002). The majority of research into predictive validity focuses on specific methods of assessment (e.g. Miller, Byrne et al, 2002) or questionnaire measurement (e.g. Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994) but taken together these studies illustrate the value of schizotypy as a predictive tool for identifying individuals at-risk to develop schizophrenia spectrum disorders (Cannon et al, 2008; Gooding et al, 2005; Kwapil, 1998; Miller, Byrne et al, 2002) or at least show evidence for an increased level of psychotic-like experiences over time (Chapman et al, 1994; Erlenmeyer-Kimmling et al, 1993; Gooding et al, 2005). Indeed, the use of schizotypy as a tool that can identify those most "at-risk" of developing schizophrenia is, in part, a driving force behind the development of the concept (Meehl, 1962; Bentall, 2003e). However, it is important to note here that, in terms of the kinds of longitudinal research required for accurate studies into predictive validity, and this, accompanied by the large volume and focus on specific measurements of the concept (see section 2.2), means that, in a broad sense, research into the predictive validity of schizotypy for schizophrenia is still relatively young and therefore requires more research to obtain a more complete picture of the longitudinal relationship between the two. Moreover, studies of predictive validity as outlined above tend to show some inconsistencies of the extent of intensity of symptoms at follow-up, with findings falling somewhere between a schizophrenia diagnosis and simply more intense psychotic-like experiences (e.g. Chapman et al, 1994; Gooding et al, 2005), a more refined and standardised approach then be a might shed more light on the predictive validity of schizotypy.

2.3 **Measurement of schizotypy**

Schizotypy is measured through self-report questionnaires; of which there are a variety and each with their own particular view on the construct (Bentall, Claridge & Slade, 1989; Chapman, Chapman, & Raulin, 1976; Chapman, Chapman, & Raulin, 1978; Claridge & Broks, 1984; Eckblad, Chapman, Chapman & Mishlove, 1982; Mason, Claridge & Jackson, 1995; Neilson & Peterson, 1976; Raine, 1991; Venables, Wilkins, Mitchell, Raine & Bailes, 1990; Williams, 1993). For example, the full and brief versions of the Schizotypal Personality Questionnaire (SPQ; Raine, 1991; SPQ-B; Raine & Benishay, 1995) relates directly to schizotypal personality disorder, which is distinct from but related to schizophrenia, and measures those schizotypal traits that relate directly to that particular disorder. The Kings Schizotypy Questionnaire (Williams, 1993) measures schizotypy with a focus on "familial liability to schizophrenia". Other questionnaires measure schizotypy in terms of positive or negative trait clusters; such as the Body Image Aberration Scale (Chapman, Chapman, & Raulin, 1978) and the Physical and Social Anhedonia Scale (Chapman, Chapman, & Raulin, 1976), are designed to tap into specific symptom types; such as the Magical Ideation Scale (Eckblad & Chapman, 1983), and the Launay-Slade Hallucination Scale (LSHS; Launay & Slade, 1981). Alternatively, they can cover a broad range of symptoms related to schizotypy, such as; the Combined Schizotypy Personality Questionnaire and Schizophrenism scale (Bentall, Claridge & Slade, 1989). Still other questionnaires related to the topic include the Schizophrenism Scale (Neilson & Peterson, 1976), the Schizoidia Scale (Golden & Meehl, 1979), the Impulsive Nonconformity Scale (Chapman, Chapman, Numbers, Edell, Carpenter & Beckfield, 1984), the Schizotypal Questionnaire (Claridge & Broks, 1984), the Schizotypy Scale (Venables et al., 1990), the Wisconsin Schizotypy Scales (Eckblad et al, 1982), and those scales measuring Intense Ambivalence (Raulin, 1984), Social Fear (Raulin & Wee, 1984), Cognitive Slippage (Miers & Raulin, 1985), Delusion Proneness (Peters, Joseph, Day & Garety, 2004), and elements of the Minnesota Multiple Personality Questionnaire that may be related to schizotypy (see Golden & Meehl, 1979).

One of the most popular psychometric questionnaires used for measuring schizotypy is the Oxford-Liverpool Inventory of Feelings and Experiences (OLIFE; Mason, Claridge & Jackson, 1995), which was developed to measure psychosis proneness in normal individuals, and has since been reduced to a brief version of the scale (OLIFE-B; Mason, Linney & Claridge, 2005). Both the OLIFE, and OLIFE-B, can be broken down into four subscales that are designed to measure four trait clusters of schizotypy; three of which are related to the previously identified symptom clusters of schizophrenia, and a fourth is related cluster identified through development of the OLIFE and OLIFE-B (Mason et al, 1995, 2005; see also Mason & Claridge, 2006). Each question of both scales takes the form of a YES/NO question, and relates directly to experiences of the individual; for example, "Have you ever thought that you had special, almost magical powers?" The answer to each question then carries a mark of "1" or "0" (for either "yes" or "no" answers depending on the direction for each question), and accumulate to give a score for each subscale on: Unusual Experiences (UE), relating to instances of bizarre thinking and perceptual experiences (hallucinations and delusions); Cognitive Disorganisation (CD), measuring issues of concentration, attention or decision-making; Introvertive Anhedonia (IA), measuring degrees of social enjoyment; and Impulsive nonconformity (IN), measuring reckless, antisocial and self-abusive behaviours (Mason et al, 1995). Each score therefore contributes to the severity of experiences based on these four subscales with higher scores taken to mean a higher degree of psychosis-proneness (Mason et al, 2005). Advantages of using the OLIFE-B to measure hallucination-like experiences within a schizotypy framework centre on the resemblance of the cognitive experiences measured by the scales items to the symptoms of schizophrenia. This similarity falls in line with the notion of a schizotypal continuum, where "normal" cognitive experiences are deemed to relate to schizophrenic symptoms but at a lesser intensity (Mason et al, 2005). This scale holds an advantage over similar scales as it provides an overview measurement of schizotypy as a whole, as opposed to those scales more directly related to specific schizophrenia-associated disorders (e.g. SPQ; Raine, 1991) or those focused on one set of symptoms (e.g. LSHS; Launay & Slade, 1981). With this in mind, examination of the UE subscale of the OLIFE-B in particular would be useful in exploring the relationship between schizotypy and the cognitive processes most associated with these symptoms. The OLIFE-B is particularly useful in the current context as it was specifically designed to measure the psychotic characteristics of healthy individuals (Mason et al, 1995, 2005; Mason & Claridge, 2006). In addition, the full version of the OLIFE is based on the largest factor-analytic study to date on schizotypal traits, taken from fifteen measures of psychosis-proneness (Claridge et al, 1996), whilst the reduced number of items in the brief version is more convenient whilst maintaining reliability, for use in a research environment (Mason et al, 2005). Moreover, the OLIFE-B breaks down and categorizes those psychotic characteristics in healthy individuals directly associated with psychosis, namely hallucinations and delusions, in the form of the unusual experiences (UE) subscale (Mason et al, 2005). This allows for the detailed examination of specific effects of UE levels on task performance.

Despite the wide degree of usage, the self-report approach to schizotypy is not without its limitations. In terms of clinical diagnosis, self-report measures have been reported as less likely to identify familial vulnerability and even futile if participants have little insight into the behaviours they are, or are not, reporting (Kendler, Thacker & Walsh, 1996), and even when they are reported, self-report symptoms may not be clinically relevant (Verdoux & Van Os, 2002).

As well as the clinical limitations however, self-report measures also face more general limitations. In general terms, social desirability could play a role in the self-reporting of feelings and experiences in that each individual responds according to perceived cultural norms (Crowne & Marlowe, 1960). As a result, it could be that some bizarre experiences and abnormal thoughts and feelings are subsequently under-reported by individuals when completing psychometric questionnaires.

More specifically, it could be that the types of characteristics of symptom clusters measured by schizoptypal questionnaires in turn affect participants responses across items not directly related to those particular clusters; for example, the IN subscale of the OLIFE-B measures the tendency of participants to rebel against social norms or act impulsively, characteristics that may result in participants giving the opposite responses to their true feelings and experiences across all of the OLIFE-B subscales. In addition, participants responses could be affected by characteristics associated with schizotypy but not directly measured by the psychometric questionnaires employed, such as where a reduced outward expression of emotion may mean that participants are unable to accurately report their thoughts, feelings and experiences (Kring, Kerr, Smith & Neale, 1993). Similarly, self-report questionnaires are unable to measure automatic motor and behavioural characteristics associated with schizophrenia such as aloofness, poor eye contact and restricted affect and could therefore blur the similarities between schizophrenia and schizotypy (Battaglia, Cavallini, Macciardi, & Bellodi, 1997; Kendler, Thacker & Walsh, 1996; Vollema & Hoijtink, 2000). Moreover, the self-report nature of psychometric measures reflect subjective experiences of these behaviours and experiences and as a result may not be an accurately objective reflection of schizotypy, or the specific characteristic/symptom cluster as an objective entity. In addition, if the same mechanisms involving self-awareness and insight into their experiences are present as they are in schizophrenia, where schizophrenia sufferers are unable to screen out irrelevant stimuli during task performance (Light & Braff, 2000), unusual experiences may be over reported. Furthermore, Light & Braff, (2000) also argued that self reports may not accurately reflect the "automatic" behaviours that accompany schizotypy, thus masking schizotypal individuals, but not to a degree that these subjects are capable of self-reporting so. Finally, and with reference to the OLIFE-B directly, although the items are worded so as to include a general sense of frequency, the nature of the measure does not account for marked differences in the frequency of which a respondent performs a behaviour or has the experiences they report due to the simple "yes" versus "no" responses for each item, thus, an individual that answers "yes" to having experienced an item such as "When in the dark do you often see shapes and forms even though there is nothing there?" scores the same point for having this experience a handful of times as someone who has had the same experience every day for considerable period of time.

2.4 **Schizotypy and schizophrenia**

Factor analytic studies have shown that schizotypal traits are linked to schizophrenic symptoms (Bentall, Claridge, & Slade, 1989; Claridge & Beech, 1995; Claridge, McCreery, Mason, Bentall, Boyle, Slade, & Popplewell, 1996); in that both schizotypal traits and schizophrenic symptoms fall into the same three categories; positive, negative, and cognitive disorganisation (see Bentall, 2004).

This approach has led to a variety of findings with regard to these symptom clusters, with high scorers on measures associated with these clusters showing heightened performance on measures such as creativity and responsivity to threatening stimuli (Fisher, Mohanty, & Herrington, 2004), as well as an increase or decrease depending on the symptom cluster in performance on tasks such as verbal perceptual tasks (Tsakanikos & Claridge, 2005) and latent inhibition (Shrira & Tsakanikos, 2009). Such findings have been shown to hold across a diverse range of topics, including, but certainly not limited to, areas pertaining to neuropsychology

(Fisher et al, 2004; Folley & Park, 2005), verbal and visual perception abilities (van Strien & van Kampen, 2008; Tsakanikos & Claridge, 2005), creativity (Green & Williams, 1999; Nettle, 2006), lifestyle correlates (Wan, Friedman, Boutros, & Crawford, 2008), experimental and cognitive task deficits (Applegate, El-Deredy & Bentall, 2009; Shirra & Tsakanikos, 2009), and other psychometric measures (Lewandoski, Barrantes-Vidal, Nelson-Gray, Clancy, Kepley, & Kwapil, 2006; Rossi & Daneluzzo, 2002).

Moreover, research into a number of topic areas have shown both schizophrenic patients and high schizotypy scorers to show the same performance effects on the same tasks depending on the type of task and dominant trait or symptom cluster (i.e. positive, negative or cognitive disorganization; Shrira & Tsakanikos, 2009; Lubow, 2005). These topic areas include latent inhibition (Shrira & Tsakanikos, 2009; Lubow, 2005), false memory (Dagnall & Parker 2008; Moritz & Woodward, 2006), and attention (Bergida & Lenzenweger, 2006), as well as in areas such as, dissociation and sleep-related disturbances (see Koffel & Watson, 2009 for a review), unorganized speech (Kiang, 2009), and creativity (Claridge & Blakey, 2009; Keefe & Magaro, 1980). However, of most interest to the current thesis is the positive cluster of symptoms associated with hallucinations and delusions.

2.5 **Schizotypy as a research tool**

Given the above findings, there is certainly a case to be made that schizotypy, at the very least, can be used as a model to understand schizophrenia. Additionally, comparing the psychotic symptoms of patients to similar experiences in typical subjects may give a better understanding of the nature of these differences between the normal processes at work in normal experiences and the associated deficits in similar processes in psychotic patients. For example, understanding normal performance on tasks in non-clinical individuals may shed light on the symptom clusters that effect task performance in patients with schizophrenia. Indeed, research examining latent inhibition within a schizotypy framework has shown the differing influence of both positive and negative trait clusters in high scorers on these clusters, a finding which may extend to, and have implications for, schizophrenic patients with dominant positive or negative symptoms (Shrira & Tsakanikos, 2009). Moreover, the use of schizotypy as a framework for schizophrenia may also be useful in identifying the needs of patients, and enhancing their future outcomes through the development of early interventions that prevent full-blown psychosis in those most at risk (Johns & van Os, 2001; McGrath & McGlashsan, 1999; van Os & Verdoux, 2003).

Moreover, the use of schizotypy as a model for research into schizophrenia allows for the avoidance of potential confounds associated with research into a clinical population, such as the effects of medication, symptom severity and patient distress (Dagnall & Parker 2009; Mitropoulou, Harvey, Zegarelli, New, Silverman & Siever, 2005; Raine & Lencz, 1995; Tsakanikos & Reed 2005a), which may mask or lead to false results, such as in instances where motor responding in tasks may be effected by the side-effects of medication, such as tardive dyskinesia (Kane, 2006) or where the symptoms presented are so severe that the patient may not respond to task requirements or become distressed. Examples of the disruption to research caused by these types of events include involuntary movement by participants in tasks that require motor-responding or periods of no movement (such as experimental computer tasks or those involving neurological techniques) or in an experimental situation in general, where paranoid symptoms may be exacerbated by the fact that the participants is being experimented on.

3. **Hallucinations and Delusions**

One trait cluster that has attracted much attention in the research literature is that associated with positive schizophrenic and schizotypal traits; hallucinations and delusions (e.g. Bentall, 1990; Garety & Freeman, 1999). Hallucinations and delusions were heavily implicated amongst Schneider's (1959) "first-rank symptoms" of schizophrenia and are highly influential in the diagnostic process of the disorder, where the presence of hallucinations or delusions alone is enough to reach a diagnosis of schizophrenia, provided that delusions are bizarre, or that hallucinations are made up of a voice keeping a running commentary on the individuals actions of thoughts, or if two or more voices are heard in conversation with one another (APA, 1994; see section 1.2 above).

The DSM-IV definition of a hallucination is: "*A sensory perception that has the compelling sense of reality of a true perception but that occurs without external stimulation of the relevant sensory organ*" which can occur across all five-sense modalities (APA, 1994, as cited by Bentall, 2003f). However, this definition does not accommodate all types of hallucination, especially those perceived as coming from outside the body, or those attributed internally (see Bentall, 2003). Slade and Bentall (1988: 23) attempted to give a more precise definition of a hallucination in terms of: "*any percept-like experiences which (a) occurs in the absence of an appropriate stimulus (b) has the full force or impact of the corresponding actual (real) perception, and (c) is not amenable to the direct control or voluntary control of the experience.*" This definition holds an advantage over the DSM-IV criteria, as it draws attention to the use of an appropriate stimulus - allowing for hallucinations to occur alongside certain environmental stimulation (e.g., auditory input; Margo, Hemsley, & Slade, 1981), lack of control of the individual, and the apparent reality of the experience (Bentall, 1990; Bentall, 2003f); although, it should be noted that this definition, too, is limited to some extent (see Bentall, 2003f).

Similarly, the DSM-IV definition of a delusion may be regarded as problematic: "*A false personal belief based on incorrect inference about external reality and firmly sustained in spite of what almost everyone else believes and in spite of what usually constitutes incontrovertible and obvious proof of evidence to the contrary*" (APA, 1994). Bentall (2003g) notes that it is unclear exactly what "incorrect inference", "external reality", and "incontrovertible and obvious proof", actually means. In an attempt to define delusions outside of the diagnostic criteria of the DSM-IV, researchers have, in practice, identified delusions as being held with high conviction, resistant to evidence and reason, and to fit one or more of the content criteria presented in diagnostic manuals (Garety & Freeman, 1999), but, again, this definition could be regarded as vague, with problems such as determining when a delusion is false, bizarre, incorrigible, or sub-culturally deviant, or distinguishing delusions from obsessions (see Garety & Hemsley, 1994) . Fortunately, this lack of specific criteria in defining delusions has not held back a recent rise in research into delusions but, as is also the case with hallucinations, a resultant variation in approaches to delusion research has emerged, which is not restricted to research as a topic aligned to psychopathology (Garety & Freeman, 1999; Garety & Hemsley, 1994).

3.1 **Bizarre experiences in schizophrenia and schizotypy**

Despite being considered a key component toward the diagnosis of schizophrenia, the prevalence rate of hallucinatory experiences in 'normal' individuals, at approximately 13%, is approximately ten times greater than the population that will be diagnosed with schizophrenia across most countries (see Bentall, 2003c, 2003e). Research into the prevalence rates of hallucinations have found reports of hallucinatory experiences to have been experienced by otherwise healthy, non-clinical individuals in studies of undergraduate students (Barrett & Etheridge, 1992; Bentall & Slade, 1985; Posey & Losch, 1983), and in more extensive samples of the general populations of different countries (van Os, Hanssen, Bijl & Ravelli, 2000; Poulton, Caspi, Moffitt, Cannon, Murray, & Harrington, 2000).

Although prevalence rates of delusions have been less thoroughly studied, both Poulton et al. (2000), and van Os et al. (2000), reported up to one fifth of the population had experienced delusions, whilst Verdoux et al. (1998) reported that between 23.4% and 69.3%, of the 750 (approx) participants studied with no history of psychiatric disorder, reported having delusional beliefs, relating to beliefs about others and events, persecution, magical powers, or supernatural forces.

Moreover, research into hallucinatory occurrences have shown that both schizophrenic patients (Gallagher, Dinin & Baker, 1994; Margo, Hemsley & Slade, 1981; Mintz & Alpert, 1972; Young, Bentall, Slade & Dewey, 1987), and high schizotypy scorers (Cella, Taylor & Reed, 2007; Tsakanikos & Reed, 2005a, 2005b; Tsakanikos, 2006), report a greater degree of hallucinatory-like experiences on experimental tasks than non-clinical controls and low schizotypy scorers. For example, Mintz and Alpert (1972) used the "White Christmas" task to examine the vividness and accuracy of understanding of their false auditory perceptions by asking participants to close their eyes and imagine hearing the song "White Christmas" and then measuring the degree to which participants believed that they had actually heard the song. Hallucinating schizophrenic patients reported more intense mental imagery of hearing the song as well as less ability in accurately describing the nature of their experiences (i.e. imagined the song being played versus actually hearing it) than both non-hallucinating schizophrenic patients and a non-psychotic control group (Mintz & Alpert, 1972). Similarly, Cella et al (2007) employed a visual word-detection task that required participants to report actual words presented amongst non-words on a computer-screen, and examined the occurrence of falsely reported words between high and low schizotypy scorers. Cella et al (2007) found that high schizotypy scorers made more false-word reports than low schizotypy scorers, and also that the number of false reports made was somewhat dependent on the violation of the expected stimuli to be presented, particularly in high schizotypy scorers.

3.2 **Hallucination and delusions in other disorders**

Experiences of hallucinations and delusions are not limited to schizophrenia spectrum disorders and schizotypy, but are also related to other environmental, neurological, and emotional factors also, as well as other psychiatric disorders (see Bentall, 2003e, 2003f). For example, hallucinations have been the topic of interest in Parkinson's Disease, and Charles Bonnet syndrome patients (Barnes & David, 2001; Gold & Rabins, 1989), and have been studied within neurological, (Weiss & Heckers, 1999), and treatment research contexts (Shergill, Murray & McGuire, 1998). Research into delusions span topic areas such as Alzheimer's disease (Rao & Lyketsos, 1998), specific types of delusion, such as paranoia (Bentall, Corcoran, Howard, Blackwood & Kinderman, 2001), and parasitosis (Wykoff, 1987), and both hallucinations and delusions have been considered together alongside topics such as cognitive-behavioural treatment approaches to both symptoms (Haddock, Tarrier, Spaulding, Yusupoff, Kinney, & McCarthy, 1998), and in line with heightened levels of emotional stress, anxiety and trauma (Freeman & Garety, 2003; Honig, Romme, Ensink et al., 1998; Morrison, Frame, & Larkin, 2003; Read & Argyle, 1999) in hallucination sufferers. Prevalence rates for hallucinations range from 8 to 40 % in Parkinson's disease patients (Barnes & David, 2000), from 11 to 15% in Charles Bonnet syndrome patients (Menon, Rahman, Menon & Dutton, 2003), from 25 to 94% in schizophrenic patients (Shergill et al, 1998) and from 10 to 39% in the general population (Bentall & Slade, 1985; Posey & Losch, 1983; Slade & Bentall, 1988; Tien, 1991), whilst prevalence rates for delusions range from 16 to 22% in Alzheimer's patients (Bassiony, Steinberg, Warren, Rosenblatt, Baker & Lyketsos, 2000; Burns, Jacoby & Levy, 1990), and between 20 and 69.3% in individuals with no history of a psychiatric disorder (Poulton et al, 2000; van Os, 2000; Verdoux et al, 1998). These prevalence rates highlight the degree to which hallucinations and delusions can occur beyond the domain of schizophrenia and with reference to other disorders and cognitive problems that may help to shed light on these types of experiences in general. In addition, the specific relationships between hallucinations and delusions and the populations mentioned above have also been shown, such as the prominence of visual hallucinations in Parkinson's disease and Charles Bonnet syndrome patients (Barnes & David, 2000; Menon et al, 2003), persecutory delusions in Alzheimer's patients (Burns et al, 1990), or the relationship between anxiety and the content of both hallucinations and delusions (Freeman & Garety, 2003). Such a variety in the way in which hallucinations and delusions occur and the differing prevalence and type of presentation alongside other disorders then has led to a number of causal theories as to how these experiences arise.

3.3 **Theories of bizarre experiences**

There are a number of theories as to why hallucinations and delusions occur therefore, with different underlying mechanisms and processes argued to be involved. However, although the existing theories are outlined below, the current thesis is not concerned with which of the existing theories is correct, but instead wishes to point out a number of factors important in the generation of bizarre experiences that may be relevant here, such as sub-vocalization as implicated in theories of hallucinations (Gould, 1948, 1949, 1950; Green & Preston, 1981; McGuigan, 1966) or a "jumping to conclusion bias" as a theory of delusions (Fear & Healey, 1997; Peters, Day & Garety, 1997; Huq, Garety & Hemsley, 1988; Garety, Hemsley & Wesseley, 1991; Garety & Hemsley, 1994).

3.3.1 ***Theories of hallucinations***

In a review of the hallucination literature, Bentall (1990) described several hallucination theories, grouping them into four types of theory, which are mentioned briefly in the following section. Firstly, 'simple conditioning theories' give evidence that false-perceptions can be trained through classical conditioning (Davies, 1974a, 1974b, 1976; Davies, Davies, & Bennett, 1982), but are let down by an inability to explain why hallucinations vary depending on stress or environmental stimulation (Bentall, 1990), a symptom regarded as a significant contributor to psychotic disorders (APA, 1994). Secondly, 'seepage theories' postulate that hallucinations occur due to a breakdown in the filtering process, and the subsequent interference of preconscious material with the contents of consciousness. Such views rely on environmental stimulation as a facilitator for hallucinations (Frith, 1979; West, 1962, 1975). Unfortunately, the predominant existing theories contradict one another in terms of whether, or not, more or less environmental stimulation should lead to increased hallucinatory occurrence and, in both cases, the relationship between environmental stimulation and hallucinatory experiences seems to be too complex for either theory to handle (see Bentall, 1990).

Thirdly, theories derived from 'imagery' studies, which postulate that hallucinations occur as a result of the misinterpretation of unusually intense normal mental imagery, have tended to produce conflicting results (Heilbrun, Blum, & Haas, 1983; Slade, 1976), or have produced findings that could arguably be attributed to others factors (Bentall, 1990). Finally, 'subvocalisation theories', attempt to link the processes of inner speech with hallucinatory experiences, and have provided some evidence linking the processes involved in these two areas together (Gould, 1948, 1949, 1950; Green & Preston, 1981; McGuigan, 1966), and further to neurological deficits in the brain (Green, Hallett & Hunter, 1983; Jaynes, 1979), but account only for one modality, namely auditory, as a forum for hallucination occurrence.

A more recent theory is that of Grossberg (2000), which argues that normal learning and memory contributes to a system that learns to match incoming perceptual (bottom-up) information of the immediate environment with self-generated (top-down) sensory mental representations, to achieve the accurate interpretation of that environment. However, a breakdown, through "hyperactivity" of the system, in the modulation in perception of top-down or bottom-up information, is thought to lead to hallucinatory experiences. That is, hallucinations occur as a result of the diminished ability to distinguish self-generated information from that incoming from the environment; with a bottom-up interpretation wrongly attributed to a top-down processing of events (Grossberg, 2000). In addition, this model accounts for individual differences in hallucinatory content, arguing that varying vigilance across trials where these matching processes are learned, leads to differing degrees of generalization of stored exemplars, and hallucinatory content can then differ accordingly (Grossberg, 2000). For example, if vigilance is low, then the stored exemplar will be more general, such as of a type of person (male or female), however, if vigilance is high during learning, then this exemplar will be more specific, such as being a specific person (e.g., the individual's brother). Hallucinatory content is, then, thought to be linked to these generalizations, being more specific, or general, accordingly, such as hearing a relative, or a random voice (Grossberg, 2000).

An alternative approach to understanding hallucinations, delusions, and the processes that produce them comes from the neo-realism theory of consciousness (Tonneau, 2004). Tonneau (2004) argues that bizarre experiences occur as a product of past experiences where previously experienced objects or events are recombined with the current environment. This recombining occurs as a result of similar properties of previous experiences, where those properties can relate to those physical in nature such as colour and shape, or more abstract properties such as when the experience occurred and the co-occurrence of other events, having strong temporal links to those present in the current environment, which then leads to a mismatched interpretation of current experiences (Tonneau, 2004). Although not as widely researched as the above views (see section 3.3.1), there does seem to be some evidence to support the neo-realist account.

3.3.2 ***Theories of delusions.***

Theories of delusions fall into three main categories (Garety & Freeman, 1999), theories of: probabilistic bias (Garety & Hemsley, 1994); attributional style (Bentall, Kaney, & Dewey, 1991; Bentall, Kinderman, & Kaney, 1994; Kinderman & Bentall, 1996); and theory of mind (Frith, 1992). Older theories incorporate memories, affective moods, wishes of the individual (Freeman, 1981, 1990; Nelki, 1988), and abnormal explanations of experiences (Maher, 1974; Matussek, 1952; see also, Freeman, Garety, Kuipers, Fowler & Bebbington, 2002).

The theory of a probabilistic reasoning bias was developed by Garety and colleagues (Garety, 1991; Garety & Hemsley, 1994), and argued while all delusions were unlikely to share a common cause; probabilistic reasoning was likely to contribute to their formation and maintenance. This approach incorporated past experience, affect, self-esteem, motivation, perception, judgement, selective attention and confirmation bias, arguing these factors, and interactions between them, as influential in delusion formation and maintenance, although the influence of these factors may differ in degree, depending on the type of delusions (see Garety & Freeman, 1999).

In exploring the theory, probabilistic reasoning tasks were implemented, following a Bayesian framework - incorporating elements of prior beliefs and information on the current environment, and participants were measured on the degree to which they "jumped to conclusions" within these tasks (Fear & Healey, 1997; Peters, Day & Garety, 1997; Huq, Garety & Hemsley, 1988; Garety, Hemsley & Wesseley, 1991; Garety & Hemsley, 1994). In general, deluded participants tended to make earlier judgements, with more confidence, than controls (Fear &

Healey, 1997; Peters, Day & Garety, 1997; Huq, Garety & Hemsley, 1988; Garety, Hemsley & Wesseley, 1991; Garety & Hemsley, 1994).

While similar tasks have supported the probabilistic theory (John & Dodgson, 1994; Kemp, Chua, McKenna, & David, 1997; Young & Bentall, 1995), studies that have provided more information to participants have shown that, when information is available to participants, they are equally as able to use it as controls (Bentall & Young, 1996; Dudley, John, Young & Bentall, 1997). Overall, it appears that deluded subjects seem to acquire less information in decision-making when left to their own devices in data gathering, but, when more information is available, the tendency to jump to conclusions disappears.

Another attempt at explaining delusion formation and maintenance came from Bentall and colleagues, extending an earlier notion that delusions are a form of defence mechanism (Neale, 1988), and employing an attributional bias as a function of a self serving bias specifically orientated toward protecting the individual's self-esteem (see Bentall, Kaney, & Dewey, 1991; Bentall, Kinderman, & Kaney, 1994; Kinderman & Bentall, 1996). According to this theory, delusions are formed to maintain the self-esteem of the individual in order to avoid discrepancies between how they perceive themselves and how others perceive them (Bentall, Kaney, & Dewey, 1991; Bentall, Kinderman, & Kaney, 1994; Kinderman & Bentall, 1996). The result is the exaggeration of the self-serving bias (Bentall, Kinderman, & Kaney, 1994); attributing negative events to external sources and positive events to the self (internal; Miller & Ross, 1975).

Experimental findings regarding this approach view have been mixed. Some results have shown that deluded subjects are more likely to attribute negative events externally, especially toward other people. However, they are not more likely to attribute positive events internally; suggesting the presence of an attributional bias, but not necessarily as a defence mechanism, and possibly more likely to serve the shaping of delusional content, as opposed to being a cause (see Garety & Freeman, 1999).

A third theory attempts to explain delusions as a deficit in theory of mind (Frith, 1992), focusing specifically on delusions of reference and persecution as an inability to correctly infer the beliefs, thoughts, or intentions of others (Garety & Freeman, 1999). This theory stems from earlier work that argues that delusions arise from the processing of information within the current environment that normally would not be attended to (Frith, 1979; 1987). Normal thought processes then seek to explain these perceptions. Although there is some evidence to support the theory, such as poorer performance on theory of mind tasks in schizophrenic patients over controls (Corcoran, Cahill, & Frith, 1997; Corcoran, Mercer, & Frith, 1995; Doody, Gotz, Johnstone, Frith, & Cunningham-Owens, 1998; Frith & Corcoran, 1996; Langdon, Michie, Ward, McConaghy, Catts, & Coltheart, 1997; Mithchley, Barber, Gray, Brooks, & Livingstone, 1998; Sarfati, Hardy-Bayle, Besche, & Widlocher, 1997), this theory is largely un-investigated, and requires further research (Freeman & Garety, 1999).

3.4. **Similarities between hallucinations and delusions**

Given the difficulty in producing a specific definition of hallucinations and delusions, it is perhaps better to explain each symptom in terms of the research methods used in each field, and the theories that guide them. The difference between hallucinations and delusions lies in the interpretation of abnormal perceptual experiences, with some instances giving rise to reports of bizarre perceptual reports, whilst others see bizarre explanations given for events. This approach argues that hallucinations and delusions are the product of the same underlying mechanism, and postulates that hallucinatory experiences help to facilitate delusions. Such a notion has some empirical support (e.g., Ellis & Young, 1990; Ellis et al., 2000; Escher et al., 2002; Slade, 1972; 1973; Tarrier, 1987). In addition, clinical hallucinations are often reported as having the same underlying themes for each experience (Bentall, 1990), suggesting that the interpretation of hallucinatory experiences contributes to the maintenance of a particular underlying belief.

In addition to an apparent contribution to the formation and maintenance of delusions by hallucinations, there is also evidence to suggest that the relationship operates in the opposite direction; with delusional beliefs facilitating the occurrence of hallucinations (Haddock, Slade & Bentall, 1995; Krabbendam, Arts, van Os and Aleman, 2004). Several studies regarding auditory hallucinations have highlighted a link between suggestibility and hallucinatory occurrence (Barber & Calverly, 1964; Haddock, Slade & Bentall, 1995; Jakes & Hemsley, 1986; Mintz & Alpert, 1972; Young, Bentall, Slade & Dewey, 1987). For example, Mintz and Alpert (1972; see also Young et al., 1987) used the 'White Christmas' task, where participants were told to listen to a recording of the song, which was not in actually played. Subjects who reported previous experiences of hallucinations were found to respond to the suggestion that the song was played, by reporting that they actually heard it. The fact that participants hallucinated in accordance with their beliefs implies that hallucinatory experiences can be influenced by expectancies about the environment, and, given that delusions reflect the understanding of the environment (Garety & Hemsley, 1994), it is perhaps not surprising that delusional beliefs can facilitate hallucinatory experiences.

4 Similarities between theories of bizarre experiences

Although there are a number of different theories of how hallucinations and delusions occur (see sections 3.3.1 and 3.3.2) there are also a number of similarities between these theories that contribute to bizarre experiences. For example, Tonneau's (2004) theory of consciousness argues that properties of previous experiences can interact with similar properties of the current environment to allow for hallucinatory occurrences. Similarly, Grossberg (2000) argues that hallucinations occur through a breakdown in the ability to accurately match incoming perceptual information of the current environment with self-generated sensory mental representations, and therefore resulting in a diminished ability to distinguish between self-generated information and that incoming from the current environment. In addition, seepage theories argue for the breakdown in the filtering process that leads to preconscious material interfering with the contents of consciousness (Bentall, 1990; Frith, 1979; West, 1962, 1975), imagery theories argue for the contribution of unusually intense mental imagery (Bentall, 1990; Heilbrun, Blum, & Haas, 1983; Slade, 1976) and subvocalisation theories that argue for the influence of the interpretation and interference of inner speech on hallucination occurrence (Bentall, 1990; Gould, 1948, 1949, 1950; Green & Preston, 1981; McGuigan, 1966), all of which seem to give some acknowledgment to the role of the interaction between internal processes and the current environment, albeit in varied specific forms.

Theories of delusions also argue for the interaction between the current environment and mental representations, including elements of previous experiences included in the theory of probabilistic reasoning (Garety, 1991; Garety & Hemsley, 1994), the perception of the self associated with the self-serving bias theory of delusions (Bentall, Kaney, & Dewey, 1991; Bentall, Kinderman, & Kaney, 1994;

Kinderman & Bentall, 1996; Miller & Ross, 1975), and the incongruence between the understanding and ability to infer the beliefs, thoughts or intentions of others as argued by the theory of mind approach to delusion occurrence (Frith, 1979, 1987, 1992; Garety & Freeman, 1999).

Although there are some variety in the specifics of each of the theories attempting to account for hallucinations and delusions, there does seem to be some similarities regarding factors such as the influence of previous experiences, the current environment and the interaction between the two.

4.1 **Previous experience**

Firstly, in terms of occurrence, poor social adjustment and social anxiety have been found to be precursors for schizophrenia (Jones, Rodgers, Murray & Marmot, 1994; Kugelmass et al, 1995; Malmberg, Lewis, David & Allebeck, 1998), whilst psychosis has been linked to previous periods of depression, anxiety and irritability (Birchwood, Macmillan & Smith, 1992; Docherty, Van Kammen, Siris & Marder, 1978; Yung & McGorry, 1996a, 1996b; Freeman & Garety, 2003). This suggests that some elements of an individual's previous experiences predict later hallucinatory occurrences.

Secondly, in terms of content, episodes of hallucinations in the clinical population are reported as following consistent themes (Bentall, 1990; Romme & Escher, 1993), argued to reflect previous experiences (Chadwick & Birchwood, 1994, 1995), be the product of disruption in the integration of memories and events in the current environment (Hemsley, 1993), or, specifically regarding auditory hallucinations, the interference of stored linguistic information on current language production (Hoffman, 1986; Hoffman & Rapaport, 1994).

Freeman and Garety (2003) argue that the most common types of delusion are linked to emotional themes, and suggest that delusions are formed through the combination of an underlying bias associated with delusion formation and the emotional state of an individual. This latter point is also applied to hallucination formation, although to a lesser extent than delusions (Freeman & Garety, 2003). Although the majority of research into previous histories and the content of hallucinations and delusions, has focused on the relationship between content and underlying emotions, or content and trauma, Morrison et al. (2003) suggest that, although there appears to be a causal link between trauma and psychosis, this link may not be directly related to trauma per se, but to an individual's personal developmental experiences in general. This would seem to suggest that previous experiences could indeed influence current hallucinatory experiences regardless of the specific topic.

In more detailed approaches regarding specific underlying themes of bizarre experiences, the relationship between content and underlying emotional factors, such as neuroticism, and previous traumatic experiences, have been highlighted (Freeman & Garety, 2003; Honig et al., 1998; Morrison et al, 2003; Read & Argyle, 1999). Some studies suggest the occurrence of hallucinations and delusions result from either a traumatic experience (Read & Argyle, 2003), or their memory (Honig et al, 1998; Morrison et al, 2003), particularly events such as sexual abuse and childhood physical abuse (Read et al., 2002; Heins, Gray & Tennant, 1990; Sansonnet-Hayden, Haley, Marriage & Fine, 1987). In addition, both somatic delusions, such as parasitosis, and sex delusions, have been linked to previous experiences of sexual abuse and childhood incest (Beck & van der Kolk, 1987; Oruc & Bell, 1995), although these themes are less direct in terms of specific content.

4.2. **Bizarre experiences and memory**

An obvious research perspective to include when considering the content of hallucinations and delusions as being a product of past events would be memory research. While, high and low schizotypy scorers have not differed in performance on working memory and verbal recall tasks (Lenzenweger & Gold, 2000), some tasks have highlighted deficits in performance in high schizotypy scorers. Heilbrun (1980) found that individuals, prone to hallucinations, were less able to recognise their own statements taken in a previous interview than controls. Similarly, Morrison and Haddock (1997) showed that 'hallucinators' gave lower confidence ratings to words as being their own, especially when the words were emotionally salient. In addition, individuals prone to hallucinations have also been shown to mistake items (word-pairs) presented during a test phase, as being present during the presentation phase of a word-pair recall tasks (Bentall, Baker & Havers, 1991; Brebion, Amador, David, Malaspina, Sharif & Gorman, 2000a; Brebion, Smith, Amador, Malaspina, & Gorman, 1998; Brebion, Smith, Gorman, Malaspina, Sharif, & Amador, 2000b; Rankin & O'Carroll, 1995), and have reported the distorted playback of their own statements as being that of others (Allen, Freeman, Johns & McGuire, 2006; Johns & McGuire, 1999).

Perhaps of most interest when considering a neorealist approach to hallucinations, however, comes from research into prospective memory (PM), such as that reported by Wang et al. (2008). PM concerns remembering to perform an action in the future when a specific event occurs in the environment (event based

PM), at a particular time (time based PM), or following the completion of another task (activity based PM). This is important in everyday situations, such as managing appointments, moving on to the next task following completion of another in work, and remembering to take medication at the correct time (Wang et al., 2008). Wang et al. (2008) found that high schizotypy scorers suffered from impaired performance across all three types of PM task. Although the majority of research into hallucinations and delusions consider the interpretation of events at the time of the experiences, the fact that high schizotypals show a deficit for remembering to perform intended actions under certain later circumstances, suggests that memory for past events may influence current behaviours or environmental interpretations. For example, forgetting to perform an action based on some previous experiences outright has obvious implications for important events, such as remembering to take medication. Moreover, if, in line with the neorealist account for consciousness, there is a deficit regarding the basic mechanisms in memory for previously experienced properties (of whatever nature) and their relationship to the current environment, then these deficits could lead to the misinterpretation of the current environment, in terms of sensory experiences, such as hallucinations, or more complicated experiences, such as delusions. Indeed, as discussed above, subjects prone to hallucinations have shown difficulty in remembering where items were presented in experimental tasks as well as recognising their own responses (Bentall, Baker & Havers, 1991; Brebion et al, 1998; Brebion, et al, 2000a; Brebion, et al, 2000b; Rankin & O'Carroll, 1995). It could be argued that in the instances described above, there is deficit in memory for hallucinating subjects for some properties of the task (the parts of the tasks where the stimuli were presented), whilst other properties of the tasks remained, such as remembering that the stimuli *were* present.

4.3 **Current environment**

Support for the influence of the current environment on hallucinatory content comes from studies of the relationship between content and the dominant news stories in the media at the time (Skirrow et al, 2002), and in cross-cultural differences in the reports of hallucinatory content (Kent & Wahass, 1996). In addition, Garety and Hemsley (1994) argue that delusion sufferers relate objects in "some significant way", and that these "feelings of relatedness, based on temporal or spatial contiguity between experiences, may proceed to an assumption of a causal relationship between them". Furthermore, studies showing hallucinatory reports to be influenced by suggestion, propose that beliefs about current environments influence both hallucination occurrence and content (Mintz & Alpert, 1972; Young et al, 1987; Haddock et al., 1995).

Experimental tasks examining hallucinations in the non-clinical population have shown hallucinatory experiences to be related to expectancies of the current environment (Reed, Wakefiled, Harris, Parry, Cella, & Tsakanikos, 2008), environmental stimulation (Cella, Taylor & Reed, 2006; Skirrow et al, 2002), and prior suggestibility (van de Ven & Merckelbach, 2003; Young et al, 1987).

In addition, delusional experiences have been argued to be the result of a breakdown in the perceptual processing of experiences, which are then explained through normal thought processes (cf. Chapman & Chapman, 1988; Freeman, 1981; 1990; Frith, 1979, 1987, 1992; Hemsley, 1987; Maher, 1974; Matussek, 1952; Nelki, 1988; Salzinger, 1984). In this context, delusion formation is suggested to result from either, a breakdown of the perceptual context of experiences (Mattusek, 1952; Salzinger, 1984), explaining unusually intense sensory input (Chapman & Chapman, 1988; Maher, 1974), or attending to stimuli that would not normally be attended to (Frith, 1979; 1987; 1992).

4.4 Combination of past and present

Although several current theories of hallucinations and delusions agree that previous experiences interact with the current environment to contribute to formation of bizarre experiences, reasons why specific past events and properties of the current environment give rise to hallucinations and delusions are less agreeable. However, one approach to hallucinations, through the neo-realist account for consciousness (Tonneau, 2004), suggests that temporal links between the past and present environment may play a role, with these temporal links between past experiences and the current environment, in individuals who suffer from hallucinations, being stronger than in individuals who do not experiences hallucinations.

Taken together then, this implies that properties of previous experiences and the current environment somehow compete, and in the case of properties of previous experiences emerging dominant, misinterpretations in the form of hallucinations subsequently occur. This raises the issue concerning how and why particular properties are favoured. Moreover, if the strength of the temporal link to properties of previous experiences contributes to hallucination formation, as well as the properties of the previous experiences themselves, then this might suggests that some previous experiences should have stronger temporal links to the present, allowing for the competition between properties of previous experiences and the current environment to take place. Taking the latter point from the neorealist account for consciousness, that hallucinations are influenced by stronger temporal links between properties of the current environment and previous experiences, it would be expected that individuals more prone to hallucinatory experiences, such as high schizotypals, would show differences in timing compared to those less prone to such experiences. This is because, if the occurrence of hallucinatory experiences according to the neorealist account depends on the strength of the temporal link between properties of previous experiences and properties of the current environment, then these strong temporal links should be evident in individuals prone to hallucinations and could manifest in one of two ways. Firstly, it could be that the strength of the temporal link may be a result of a shorter subjective time having passed between the properties of previous experiences and those of the current environment. Secondly, it could be that properties of previous experiences are simply judged to have occurred later on the temporal path, and thus misjudged to have occurred closer to events in the current environment, in individuals prone to hallucinations. This would have implications for the neorealist account for hallucinations by highlighting the nature of the temporal links between properties of previous experiences and the current environment as manifesting as either a result of a physical timing mechanism difference between individuals or as an issue of memory or decision-making. Either way, the outcome would be that individuals prone to hallucinations subjectively experience the properties of previous experiences as closer to the events occurring within the current environment.

5. Timing

The implications for hallucinations described by the neorealist approach to consciousness therefore suggest a role for previous experiences along the "temporal path" on current environmental interpretations (Tonneau, 2004). That is, properties of an individual's previous experiences somehow interact with those of the current environment to produce misinterpretations of that environment. This approach implies that mechanisms of timing contribute toward the occurrence and content of hallucinations, through some form of interaction between common properties of previous experiences and the current environment, and the strength of the temporal link between the current environment and previous experiences. Given this possibility it would be useful then to examine timing within the context of schizotypy, as this may illuminate differences in timing processes between high and low schizotypy scorers, and allow for further investigation of hallucinations within this context. In addition, although timing has been examined in schizophrenia sufferers (e.g. Densen, 1977; Freedman, 1974; Tysk, 1983; Wahl & Sieg, 1980; Carroll, Boggs, O'Donnell, Shekhar & Hetrick, 2008; Elevag, McCormack, Gilbert, Brown, Weinberger & Goldberg, 2003; Waters & Jablensky, 2009), and in non-clinical individuals (Lee, Dixon, Spence & Woodruff, 2006; Penney, Meck, Roberts, Gibbon, Erlenmeyer-Kimling, 2005), it remains a relatively untouched field of research. Moreover, exploration of a timing influence on hallucinatory and delusional content may also help to shed light on how and why content arises along recurring themes (Bentall, 1990), in line with underlying beliefs, or in understanding of the current environment (Garety & Freeman, 1999; Garety & Hemsley, 1994). For example, strong temporal links between the occurrence of hallucinations and delusions may facilitate the reoccurrence of particular content or reflect underlying beliefs or environmental understanding.

5.1 **Hallucinations, past experience and timing**

Hallucinatory and delusional experiences vary in content between individuals (Bentall, 1990; Garety & Hemsley, 1994; Romme, 1993; Skirrow et al, 2002), and, in the case of hallucinations, even occur across different sensory modalities (APA, 1994). This seems to suggest that the individual, which for the case of the neo-realist account for consciousness, would suggest that the properties of previous experiences that are prevalent during current misperceived events differ between individuals, defines hallucinatory content. The temporal element of hallucinations, however, could also contribute to the understanding of the reasons why hallucinatory and delusional experiences occur, with a stronger link between previous experiences and current events inducing, and interacting, with the relevant properties, to facilitate hallucinatory and/or delusional experiences.

One way in which the strength of the temporal link between previous experiences and current events could be affected is through a slower timing mechanism. In these terms, a slower timing mechanism would mean a shorter subjective temporal link between an individuals previous experiences and the current environment. Alternatively, it could be that properties of previous experiences are simply judged, perhaps due to the memory or decision-making processes associated with timing (Gibbon, 1977; Wearden, 1991a, 1991b), to have occurred later on the temporal path and thus closer to events in the current environment without a direct involvement of a timing mechanism. If this is the case then the strength of the temporal link between previous experiences and the current environment would take the form of issues involving memory and decision-making processes. Either way however, properties of previous experiences would have stronger temporal links with the properties of the current environment, which would, in turn, lead to an increased likelihood of integration between these past and present properties. Hallucinations and delusions would then occur in the form of misinterpretations of the current environment, resultant of an integration of the properties of previous experiences with those of the current environment.

5.2 Timing and schedules

Many theories of timing stem from the work of B.F. Skinner (see Ferster & Skinner, 1957; Skinner, 1938), and subsequent followers of the behavioural approach, through the development of operant conditioning and, more specifically, schedules of reinforcement that incorporate a temporal element (see Lejeune, Richelle, & Wearden, 2006). Schedules of reinforcement produce reliable and distinctive patterns of responding (see Ferster & Skinner, 1957), and deviations from these distinctive patterns can offer insight into processes, and deficits, that determine behaviour. Fixed-interval (FI) schedules of reinforcement, as a function of equal temporal spacing of reinforcement availability, typically produce, after training, response patterns characteristic of little or no responding earlier in the period leading to reinforcement with an increase in responding leading to the time that reinforcement is made available (Ferster & Skinner, 1957). Important to note, here, is that non-reinforced responses made during the period leading to reinforcement have no bearing on the availability of reinforcement. In contrast, a differential-reinforcement of low rate responding (DRL) schedule allows for potentially equal spacing of reinforcement availability, but only when there is no responding during a pre-set temporal period on the schedule (Ferster & Skinner, 1957). For example, a DRL-10s schedule would require a period of no responding for ten seconds before the next response would be reinforced, whilst an FI-10s schedule would reinforce the first response made after ten seconds regardless of prior responding. Examples of research using these schedules has covered detailed manipulations of the schedules such as how reinforcement signalling (Reed, 1989; Reed, 2003; Reed, Strachtman & Hall, 1988), and reinforcement magnitude shapes responding (Reed & Wright, 1988), and how response sequencing can be shaped by schedule parameters (Schwartz, 1982).

However, experiments examining human performance on schedules of reinforcement often produce varied and different patterns of behaviour to those exhibited by nonhumans; with verbal rule formation, and a variety of learning histories outside the laboratory, thought to contribute to these differences (see Raia, Shillingford, Miller, & Baier, 2000). For example, Lippman & Meyer (1967) illustrated how instructions administered to participants prior to exposure to a FI reinforcement schedule subsequently produced both high and low rate of response, with a response pattern of a high constant rate without post-reinforcement pause exhibited when subjects were told that reinforcement (in the form of points) was dependent on a certain number of responses, whilst a pattern of low rate responses with a post reinforcement pause was exhibited when participants were told that reinforcement would be received after a certain amount of time had passed since the previous reinforcement (see also, Weiner, 1969). Moreover, Lippman & Meyer (1967) also showed that when participants were not given prior instructions, those that produced high response rate patterns with no post-reinforcement pause verbally stated that they believed a certain number of responses were required to obtain reinforcement whilst those that produced low response rate patterns with a post-reinforcement pause (correctly) stated that a certain amount of time was required to pass before they would receive reinforcement. As well as the influence of verbal rule formation and instructions, reinforcement histories are also thought to contribute to between species differences in reinforcement schedule response patterns. This line of thinking extends to the numerous potential exposures to reinforcement schedules throughout everyday human experience, but has also been shown directly in experiments where prior exposure to different reinforcement schedules act as controlling variables for later responding on a FI schedule of reinforcement (see Weiner, 1969). As well as reinforcement histories and verbal rule formation, other factors have also been argued to potentially contribute to reasons why human performance on reinforcement schedules differ from that of nonhumans, such as age, gender, socio-economic status, educational background and personality (Baron, Perone & Galizio, 1991), all of which have led some researchers to question the usefulness of human subjects in the study of the principles of behaviour analysis (e.g. Davey, 1988; Lowe, 1979; Wearden, 1988).

One potentially important, and little investigated, factor that might contribute to the apparent variety of human schedule performance are individual differences in specific personality characteristics (Baron et al, 1991); in this case, with regard to schizotypy (see Chapter 1 and 2). Schizotypal characteristics could affect basic schedule behaviour in a number of ways, for example, high scores in introvertive anhedonia, or impulsive non-conformity, could produce lower rates of responding as these subscales are associated with a lack of motivation, and a tendency to rebel against the norm respectively (Mason et al, 1995). In addition, identifying differences in schedule performance between high and low schizotypy scorers could aid the understanding of the basic mechanisms underlying schizotypal characteristics.

The pattern of behaviour produced by FI schedule performance is temporally differentiable, that is, the pattern is dependent on the temporal element of the schedule, as evident in the response patterns produced by the FI schedule, with less responding toward the start of each trial which subsequently increases toward the end of the period before reinforcement (Ferster & Skinner, 1957; Schwartz, 1982). As Lejeune et al. (2006) point out; this suggests that there is some sort of discrimination occurring between the earlier and later at each point on the schedule. It seems, then, that the temporal element plays a role in producing response rates on schedules of reinforcement, but the exact nature of how time is regarded has been the source of much debate, especially in terms of what the timing mechanism actually is (Dragoi, Staddon, Palmer & Buhusi, 2003; Gibbon, 1977; Killeen & Feterman, 1988; Lejeune et al 2006; Machado, 1997; Staddon & Higa, 1999; Staddon, Chelaru , & Higa, 2002).

To give an example, in discussing the development of the FI schedule, Skinner (1938) suggests that periods of no responding may be reinforced, a notion which subsequently led to the development of differential-rate-of-other-behaviour and fixed-time schedules of reinforcement, among others, which vary in the degree that responding is connected to reinforcement and, in fact, require periods of diminished, or no, responding in order for reinforcement to be made available (see Lejeune et al., 2006). This idea has led further to the study of periods of other indirect behaviours, or periods of no responding, and their relationship with timing; following the notion that responding and periods of no-responding or other behaviours are grouped in such a way that provides for temporal discrimination (e.g. Dragoi et al., 2003).

However, although the origins of the existing literature on timing can be attributed to the development of temporally controlled schedules, it is also worth noting that some previous researchers have argued that timing should be examined beyond the context of schedules of reinforcements (Platt, 1979; Stubbs, 1979). In addition, although the radical behavioural approaches to timing mentioned above provide a compelling argument for a theory of timing, theories arguing from an internal process standpoint are equally compelling and make use of experimental tasks beyond the schedule context. Indeed, the dominant theory within the timing literature is that of scalar expectance theory (SET), which argues for the presence of an internal clock, in the form of a pacemaker-accumulator mechanism, alongside a role for memory and decision making processes (Gibbon, 1977). Given this fundamental debate between the incorporation of an internal mechanism, it would be useful here to outline the existing theories of timing.

5.2.1 ***Behavioural timing theories***

Killeen and Feterman's (1988) Behavioural Timing Theory (BeT) argues that adjunctive behaviours (behaviours judged to be a result of the schedule, but not directly related to the delivery of reinforcement), controlled by a pacemaker, act as cues for responding on a schedule of reinforcement, with the reinforcement rate defining the pacemaker speed (Killeen & Feterman, 1988). However, the theory also highlights the possibility of other factors influencing the behavioural state transitions, other than the pacemaker speed, which could then result in revisited states, or even states that are not activated long enough for the associated behaviour to be emitted (Killeen & Feterman, 1993; Lejeune et al., 2006).

Machado (1997) constructed the learning to time (LeT) model, in an attempt to move away from the influence of an internal pacemaker. Instead, the LeT model argues that following reinforcement, a "time-marker", such as the prediction of a significant biological event (or the event itself), cues the activation of a series of consecutive behavioural states that each entail their own level of activation and association to the operant response (Machado, 1997; Machado & Keen, 1999). Responding then occurs when the level of activation of the current behavioural state and the associative link between that state and the operant response is sufficiently strong (Machado, 1997; Machado & Keen, 1999).

The adaptive timer model (ATM; Dragoi et al, 2003) argues that interval timing emerges as a product of non-temporal learning processes, through the competition between reinforced and other behaviour. As a result of this competition, sequences of reinforced, or other, behaviours occur, depending on the strength of the previous reinforcement history for each, and upon a decay parameter that controls the alternation between both behaviours, the strength of which is affected by the rate of reinforcement (Dragoi et al., 2003).

Finally, a theory of timing that moves away for the notion of an internal clock, but instead argues for the influence of another internal process, namely memory, is Staddon and Higa's (1999), Multiple Time Scale model (MTS), and it's derivative, the Tuned-Trace model (TTM; Staddon et al, 2002). Taken together, the MTS argues that, through incorporating habituation and short-term memory, interval timing is a product of the memory for reinforced and non-reinforced responses, whilst the TTM adds a decay element of the memory trace in applying the model to a series of schedule tasks (Staddon et al, 2002).

In summary then, one of the existing theories of timing, the LeT model (Machado, 1997), argues that temporal functioning from a purely behavioural viewpoint, stating that timing is a product of transitions between behavioural states and associated links with the required responses. The remaining theories however, although similar, argue the case for some form of internal timing mechanism but disagree on the details of this process, with some form of memory or pacemaker process the common point of debate.

5.2.2 ***Scalar expectancy theory***

As noted above, the most dominant theory within the timing literature, however, is that of Scalar Expectancy Theory (SET; Gibbon, 1977, 1991). This theory argues for the presence of a mechanism, much like that of an internal clock; that is; a pacemaker mechanism that sends "pulses" to an accumulator, and also incorporates a memory and decision-making components that compares the value in the accumulator to previously stored representations of time (Gibbon, 1977). This theory also emphasizes a scalar property defined as a form of Weber's Law; where the standard deviation of time increases as a function of the mean, although considerations of this are also included within other theories (Dragoi et al, 2003; Gibbon, 1977; Killeen & Feterman's, 1988; Lejeune et al., 2006; Machado, 1997; Staddon & Higa, 1999; Staddon et al, 2002).

Advantages for the SET model over other theories comes from the ability of SET to provide more detail in the nature of timing differences between populations and in research that illustrates and manipulates the speed of the internal clock (Droit-Volet & Wearden, 2002; Droit-Volet, Clement & Wearden, 2001; Meck, 1983; Penton-Voak, Edwards, Percival & Wearden, 1996; Treisman, Faulker, Naish & Brogan, 1990; Wearden, 1992; Wearden, Denovan, Fakhri, & Haworth, 1997; Wearden & Penton-Voak, 1995; Wearden, Wearden & Rabbitt, 1997; but see also Wearden, 2003). For example, Wearden (2003) illustrates how SET can be used to show not only that there are differences in performance on a temporal generalization task between age groups but also shows how these groups differ thus providing "theoretically meaningful comparisons of the behaviour of different groups, thus going much further than the usual final conclusion that different groups differ in performance" (Wearden, 2003: 4).

More specifically, SET also provides an explanation of the kinds of processes that are occurring when humans and non-humans are performing on timing tasks by using statistical modelling that mathematically reflects the components of the timing process (i.e. clock speed, memory and decision making; Gibbon, 1977; Meck, 1983; Wearden, 1991a, 1991b, 2003). Meck (1983) illustrated how pharmaceutical manipulations through several types of drug could illustrate the changes in the various components of SET to effect timing in rats, by employing a "state-change" paradigm that trained rats to discriminate between two signals presented for a "short" and "long" amount of time whilst either under the influence of a particular drug or having been administered a saline injection. Subjects were then tested either under the same conditions or with the drug or saline administration reversed for half the subjects (see Meck, 1983). Application of SET to the results allows for the discrimination between the underlying processes, namely internal clock speed or memory storage of times, as the relevant process of the results under each of the pharmaceutical conditions (Meck, 1983). This is because, where clock speed is the relevant process, when trained in a normal state (saline condition) the subjective time measured by the internal clock (t) directly reflects the objective time (T) and the reference memory for reinforced times (M) accurately stores t values for later use during the decision-making stage, whilst the clock constant (K) and memory constant (Y) are equal to 1 (Meck, 1983). Then, when later tested under a condition where clock speed has increased, the relationship between t and T alters so that $t > T$, but the previous trained relationship between M and T remains unaffected, as a result, when comparisons during testing are made between M and t, an overestimation of objective time occurs (Meck, 1983). Similarly, when clock speed is decreased during the testing phase, the relationship between t and T becomes $t < T$ and an underestimation of objective time then occurs (Meck, 1983). Alternatively, under conditions that alter the memory for timed periods, when an increase in the memory constant (Y) occurs the relationship between M and t will change so that $M < t$ and an underestimation of t therefore occurs, whilst a decrease in Y would lead to $M > t$ and an overestimation of t would occur (Meck, 1983). Statistical modelling of SET to the results across four experiments showed that methamphetamine and haloperidol can effect clock speed, increasing and decreasing clock speed respectively, whilst vasopressin, oxytocin and physostigmine can selectively decrease the remembered durations of reinforced times and that atropine can selectively increase those durations (Meck, 1983).

Research into temporal bisection and temporal generalisation tasks with human subjects have also explored the underlying processes of the comparisons between the standard and experimental phase stimuli presentation lengths (Wearden & Ferrara, 1995, 1996). These tasks involve typically, although not always (Wearden & Ferrara, 1995), a training phase, where a stimulus is presented for a length of time defined as a standard (typically the shortest and longest of a range in bisection experiments and the mid-point of a range in generalisation experiments) followed by an experimental phase where the rest of the range is presented (Allan & Gibbon, 1991; Wearden, 1991a, 1991b; Wearden & Ferrara, 1995). Participants are then required to choose between "short" or "long" options in relation to which standard they feel that the current presentations length is closer to in bisection experiments, or "same" or "different" options in relation to the standard for the current presentation length for generalisation experiments (Wearden, 1991a). Analysing the results of these experiments in accordance with SET have shown that, for example, participants may not be comparing the current presentation length with the shortest and longest standards on temporal bisection tasks, but some average of the two instead (Wearden, 1991b; Wearden & Ferrara, 1995). In addition, SET includes an assumption that the pacemaker component of the model generates pulses at random but that the rate at which this occurs is on average accurate (Gibbon, 1977; Wearden, Edwards, Fakrhi & Percival, 1998). As a result, slower pacemaker rates have been shown to produce more variable temporal estimates from trial to trial and can therefore be used as an index of pacemaker speed provided that this assumption is maintained (Gibbon, 1977; Wearden et al, 1998). This notion can be specifically applied to temporal bisection tasks as these tasks allow for the calculation of specific indices of timing behaviour, such as the Weber ratio which is an index of the variability of participants "short" or "long" responses and thus providing an indication of individual differences in clock speed (Ferrara, Lejeune & Wearden, 1997; Wearden, 2004; Wearden, Rogers & Thomas, 1997).

5.2.3 **Timing and schizophrenia**

Although the primary aim of the present thesis is to examine potential timing differences between those who score high on self-reports of hallucinatory and delusional experiences, it is worth considering the factors from the above theories that have already been shown to differ between schizophrenia sufferers and controls, and between individuals differing in levels of schizotypy.

In terms of the memory component included in the SET, MTS and TTM models, differences in memory performance have been found between individuals differing in proneness to hallucinations across a variety of memory tasks (Bentall, Baker, & Havers, 1991; Brebion et al, 1998; Brebion et al 2000a, 2000b; Rankin & O'Carroll, 1995; Wang et al., 2008). Similarly, hallucinations have recently been associated with deficits in directed forgetting tasks (see Soriano, Jiminez, Roman, & Bajo, 2009), which may have some scope for research in line with the decay elements of the ATM, MTS, and TTM timing models.

Research into habituation, over a variety of tasks, such as the acoustic startle response (Takahashi, Iwase, Ishii, Ohi, Fukumoto, Azechi et al., 2008), and pre-pulse inhibition (Moriwaki, Kishi, Takahashi, Hashimoto, Kawashima, Okochi et al., 2009), have shown that schizophrenia sufferers, and individuals with a higher degree of psychosis proneness, hold a deficit in habituation on these tasks (Allen, Freeman, & McGuire, 2006; Kunugi, Tanaka, Hori, Hashimoto, Saitoh & Hironaka, 2007; Moriwaki et al., 2009; Taiminen, Jääskeläinen, Ilonen, Meyer, Karlsson, Lauerma et al., 2000; Takahashi et al., 2008). If this effect of habituation extends to those processes associated with timing, as described by the MTS and TTM models, then high scorers on unusual experiences may hold a timing deficit accordingly.

Deficits in decision making and their contribution to delusions and hallucinations have already been discussed here (see section 3.3.2), but within the SET context, if deficits in decision-making do exist, then it could be that timing in high scorers in schizotypy is similarly difficult when making decisions between present and past interval comparisons.

In terms of behavioural states, the strength of the arousal component of the LeT model could extend to findings of increased arousal in those highly prone to hallucinations, in the same way that stressful life events, such as bereavement of a loved one, or involvement in military conflict, have brought on hallucinatory episodes in previously unaffected individuals (Belenky, 1979; Comer, Madow, & Dixon, 1967; Cooklin, Sturgeon, & Leff, 1983; Grimby, 1993, 1998; Reese, 1971; Siegel, 1984; Toone, Cooke, & Lader, 1981). Interestingly here, emotional arousal is also implicated in altered perceptions of time (see Droit-Volet & Meck, 2007; Wearden, 2001). Similarly, the associative links implicated between behavioural states and responding as part of the LeT model also draws parallels with research regarding hallucinations and delusions linking unusual experiences with existing underlying beliefs and emotional states (e.g. Freeman et al., 2002; Grimby, 1993, 1998; Heilbrun et al., 1986).

Although the above discussion points toward some similarities between some factors of the existing models of timing and findings from hallucinations, delusions, schizotypy, and schizophrenia, the links are still tenuous, and without further research into the similarities between these processes remain speculative. A starting point, however, given that the one thing that all of the above models have in common is an account for timing, would be to examine the potential differences in timing between high and low scorers in unusual experiences, across several tasks.

Clinical observations of schizophrenic patients have noted a tendency to report some degree of time distortion (Freedman, 1974; Tysk, 1983; Wahl & Sieg, 1980). Early research with schizophrenic patients reported differences in time estimation between schizophrenic patients and controls (Lhamon & Goldstone, 1956; Rabin, 1957; Weinstein, Goldstone & Boardman, 1958; Dilling & Rabin, 1967; Normington, 1967; Densen, 1977; Waters & Jablensky, 2009). However, such early experiments did not pay attention to consistent methodologies and terminologies, meaning that the generalizations of these findings are somewhat limited or are in need of stricter controls for further exploration.

Several studies that took these factors into account, have shown that schizophrenic patients, and those at risk of developing schizophrenia, hold a tendency toward overestimating the passage of time across different types of tasks (Tysk, 1983; Wahl and Sieg, 1980). Although it should be noted that these findings are dependent on the modality through which the experimental stimuli are presented; with those defined as high-risk to develop schizophrenia showing an increased tendency toward shorter time estimations for visual stimuli, when compared to auditory stimuli presented for the same duration (Penny et al, 2005).

6. **Aims of Current thesis**

Given these findings, it seems that there is some scope for further research into timing differences between high and low schizotypy scorers, particularly in line with hallucinations and delusions as measured by the UE subscale of the OLIFE-B, in order to better understand the influence of timing processes within a schizotypy framework. Moreover, developments in theories of timing, and the methodologies used to explore them, allow for more detailed analysis of these differences, and for more detailed exploration of the underlying processes that influence timing, and that may, subsequently, be found to differ between high and low schizotypy scorers. For example, the use of chronometric counting, which examines timing below the threshold of counting seconds (see Wearden, 1991a). The present thesis therefore sought to explore the potential for differences in timing between high and low scorers on a self-report measure of schizotypy, the OLIFE-B, with particular focus on the unusual experiences (UE) subscale, within the context that hallucinations and delusions may occur within a neo-realist like framework of consciousness, albeit at a foundation level.

Chapter 2 aimed to illustrate the usefulness of the OLIFE-B, within the current context, by examining differences between high and low scorers on the UE subscale, and the degree to which they made false reports when listening to a series of words played against a background of white noise. This chapter also incorporated a contextual element with regard to the words (abstract or concrete) to give an extra dimension, namely, whether or not false reports of words would relate to the underlying context of the words actually presented.

Chapter 3 examined differences in performance between high and low schizotypy scorers on a yoked RR-RI schedules of reinforcement, taking into account differences in response patterns that may be a product of a lack of temporal element within the RR schedule, as opposed to the RI schedule. This chapter also incorporated a measure of the degree to which participants were aware of the contingency on which they were performing, that is; the optimal strategy on which to gain reinforcement. Chapter 4 sought to expand on this analysis by exploring two schedules of reinforcement with a strong temporal element (FI and DRL), to further explore the influence of level of UE score on timing performance within the schedule context.

Chapter 5 then sought to explore the already established differences in timing performance based around the temporal element of schedules of reinforcement by removing the schedule context, and exploring differences within performance in a pure timing task, namely temporal bisection. Incorporation of this experiment was particularly useful as it allowed for more exploration as to the nature of the timing differences between high and low UE scorers, in terms of a slower or faster timing mechanism in high schizotypy scorers or a result of memory and/or decision-making processes.

The present thesis then aimed to show that high schizotypy scorers, more prone to reporting hallucinatory and delusional experiences, would show differences in timing compared to low scorers and that this difference would manifest either in the form of a slower timing mechanism or in line with memory and decision-making processes associated with timing, with a view to providing a foundation for future research into the potential influence of timing on hallucinations and delusions.

Chapter 2: <u>The Effect of Local Environmental Context in Individuals Scoring High in Schizotypy.</u>

2.1 Introduction

Given the correspondence between schizotypal traits and schizophrenic symptoms, as noted in Chapter 1, using schizotypy as a model for researching schizophrenia may be useful; particularly in avoiding the confounds encountered in schizophrenia sufferers (e.g., medication, etc.), and in allowing the examination of specific characteristics, or symptoms, on any number of behavioural or cognitive phenomena. One measure of schizotypy is the OLIFE which focuses on personality characteristics associated with the symptoms of schizophrenia in healthy individuals (see chapter 1, section 2.2; Mason et al, 1995) across four subscales relating to positive (UE), cognitive (CD), negative (IA) and impulsive non-conformist (IN) characteristics. Similarly, the OLIFE-B measures these characteristics in the normal population, but across a reduced number of items than the full OLIFE and, like the OLIFE, high scores on the OLIFE-B are taken as a higher degree of psychosis-proneness in individuals (Mason et al, 2005; Mason & Claridge, 2006).

A substantial number of non-clinical individuals report hallucinatory experiences (Posey & Losch, 1983). In particular, those non-clinical individuals scoring highly on the unusual experiences sub-scale of the OLIFE scale reported elevated numbers of such experiences (e.g., Cella, Taylor & Reed, 2007), which potentially allow for detailed experimental analysis regarding hallucinations, without interference from other confounding variables associated with schizophrenia.

In experimental investigations of auditory hallucinations, participants are exposed to auditory stimuli, and their reports of words, or sounds, which are not actually present are noted (Barber & Calverley, 1964; Bentall & Slade, 1985; Johns & McGuire, 1999). Although the factors linking the likelihood of hallucinatory experiences occurring have been examined (e.g., Reed, Wakefield, Harris, Parry, Cella & Tsakanikos, 2008), the underlying factors related to specific hallucinatory content are less well understood (Slade & Bentall, 1988). In part, the relative lack of experimental investigation may be attributed to the fact that hallucinatory experiences often differ between individuals (Hamilton, 1984), thus, providing content inconsistencies that make empirical research difficult.

Obviously, the mechanisms concerning hallucination manifestation involve an interaction between the individual and the environmental characteristics. Skirrow et al. (2002) found that hallucinatory content reported by patients in an intensive care unit were directly linked to the predominant media events at the time. However, the occurrence of such vivid, specific, and complex hallucinations in the laboratory, using a non-clinical population, is unlikely. Moreover, a procedure that could be used for the environmental control more specifically than through noting relationships to current media-reported events, would be desirable.

An additional issue regarding the interaction between the individual and environmental characteristics more specifically is that of imagery. Although some previous research, such as that by Skirrow et al (2002), suggest that the environment facilitates the occurrence of hallucinations through invoking intense mental imagery, the relationship between imagery and hallucinations across other modalities, such as in the auditory form, is less well understood. For example, words differ in the degree to which they are associated with mental imagery, the most obvious example being names of objects that therefore have additional visual representations. However, auditory hallucinations often occur in the form of meaningful sentences (Stephane, Thurras, Nasrallah, Georgopoulos, 2003) which require the use of a variety of word types, varying in the degree of association to additional visual representation, in order to make grammatical sense. More complex mechanisms may be at work when auditory hallucinations occur therefore, in terms of the relationship between word imagery and hallucinatory content. In addition, the level of imagery, such as names of objects that are strictly stimulus-bound (e.g. "chair"), or words that are not stimulus bound but nevertheless provoke high imagery (e.g. "love"; Paivio, Yuille & Madigan, 1968), may also affect hallucinatory content differently, although the influence of imagery on hallucinatory content has been called into question previously (Bentall & Slade, 1985; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972; Posey & Losch, 1983). Nonetheless, further exploration into the relationship between concreteness and imagery on hallucinatory content in line with the context in which these words are presented (concrete versus abstract, high versus low imagery) would benefit from further exploration.

Of the tasks that have been used to study hallucinations, one that offers good potential to study the content of hallucinations produced in different contexts, is an adaptation of the verbal summator. Skinner (1936) used the "verbal summator" to play vowel sounds, barely audible, or set against background noise, to psychiatric patients who then made meaningful responses, in the form of words or sentences, when hearing the stimuli. The summator paradigm holds an advantage over previous paradigms as it: avoids leading participants in terms of content, as in the "White Christmas" task (Barber & Calverely, 1964); focuses solely on hallucinatory content as opposed to source (Johns & McGuire, 1999); uses several items of stimuli as opposed to one (Bentall & Slade, 1985); and uses meaningful, as opposed to ambiguous, stimuli (Skinner, 1936).

The present study, therefore, hoped to accomplish two main objectives. Firstly, it is hoped to develop a technique for the examination of hallucinations in a non-clinical population, specifically to show that those with high schizotypal scores exhibit a greater proneness to hallucinations than those with low scores in schizotypy (thus, helping to validate the OLIFE-B as a measurement instrument). Secondly it is hoped to experimentally examine the relationship between environment and hallucinatory content; specifically to investigate if the predominate content of the environment has an impact on the types of hallucinations that are produced, regarding concreteness (Experiment 1), or visual-imagery (Experiment 2).

2.2 General Methodology

2.2.1 Measures

2.2.1.1 ***Schizotypy***. The 43-item version of the Oxford-Liverpool Inventory of Feelings and Experiences (OLIFE-B; Mason et al, 2005) assessed hallucination-proneness through the unusual experiences (UE) subscale. The OLIFE-B also measures cognitive disorganisation (CD), introvertive anhedonia (IA), and impulsive nonconformity (IN) and has an internal reliability (Cronbach α) of between 0.62 & 0.8, and a concurrent validity of between 0.9 and 0.94 (UE $\alpha = 0.8$, validity = 0.94; CD, $\alpha = 0.77$, validity = 0.93; IA, $\alpha = 0.62$, validity = 0.91; IN, $\alpha = 0.63$, validity = 0.9; Mason et al, 2005. For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the OLIFE-was comparable to the range outlined above $\alpha = 0.69$.

2.2.1.2 ***Depression***. The Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961) was administered. The BDI is a 21-item questionnaire with a four-point scoring scale (0–3) per question and a total range of 0–63. The internal reliability (Cronbach α) of the scale is between 0.73 & 0.92, and a concurrent validity of between 0.55 to 0.73 for non-psychiatric subjects (Beck, Steer, & Garbin, 1988). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the BDI was comparable to the range outlined above, $\alpha = 0.75$.

2.2.1.3 ***Anxiety***. The *Spielberger Trait Anxiety Inventory* (STAI-T; Spielberger, 1983) rates the affective, cognitive, and physiological manifestations of anxiety in terms of their long-standing patterns (i.e., trait anxiety). Each item is scored between 1 (not at all) and 4 (very much so) with regard to item intensity, and the total score can range from 20 to 80. The internal reliability (Cronbach α) of the scale is 0.93, and a concurrent validity = 0.52 to 0.8 (Spielberger, Gorsuch, & Lushene, 1970). Measures of depression and anxiety were included as a controlling measure for statistical analysis on hallucinatory reports and schizotypy scores, given that both are associated with hallucination formation (Freeman & Garety, 2003). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the STAI was comparable to that outlined above, $\alpha = 0.89$.

2.2.2 **Experimental Task**

The experimental task was programmed using Fruity Loops Studio-Express, which is a computer programme that enables the user to record, mix, and edit several sound recordings into one. Ten one-minute recordings of white noise were made for each experiment, two contained concrete words and two contained abstract words in

Experiment 1, whilst two contained high imagery words and two contained low imagery words in Experiment 2, embedded at an average of 9s intervals (ranging between 6 and 16 seconds). In both experiments, the recordings containing words were presented during trials 3, 4, 7, and 8, with the types of words (concrete/abstract, Experiment 1; low/high visual imagery, Experiment 2) counterbalanced across these trials (see Figure 2.1). The remaining 6 recordings were white noise only. The recordings were played through Windows Media Player, on a Hewlett Packard Pavilion MX70 computer (1.4GHz processing speed). Participants listened to the recordings at a moderate volume through J-Win earphones.

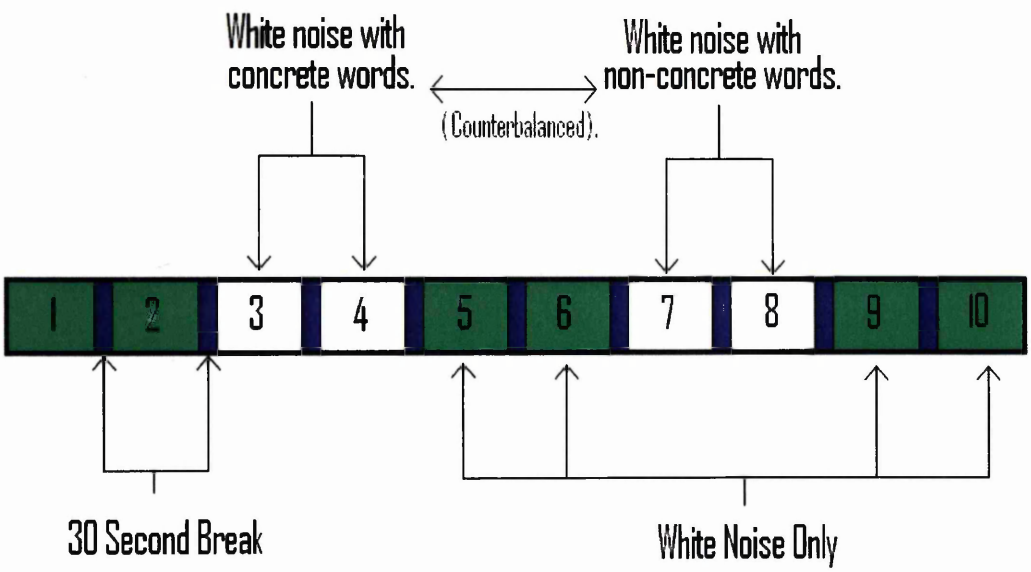

Figure 2.1: Schematic representation of the procedure, where presentations 3 & 4 and 7 & 8 represent the recordings in which concrete or abstract words were embedded in the white noise, whilst presentation 1 & 2, 5 & 6 and 9 & 10 were white noise only.

2.3 **Experiment 1**

In Experiment 1, participants were presented with concrete words (e.g., desk, arm, letter), and abstract words (e.g., myth, abyss, sorrow), which have been shown to be differentiable on various cognitive tasks (Paivio, 1971; 1978). Concrete and abstract words were chosen to allow for a basic, dichotomous, examination of whether the environmental content impacts on hallucination formation, and in order to examine any differences in hallucinations when the context was more (concrete), or less (abstract), stimulus-bound. It was predicted that: (1) more reports of abstract words not actually present would be made then concrete words overall (2) participants scoring highly in UE would report more words not actually present; and (3) that the type of word falsely reported would be related to the trial type (i.e., more false reports of concrete words in the concrete condition, etc.).

2.3.1 **Method**

2.3.1.1 ***Participants***

Forty-six undergraduate students from Swansea University (19 male, 27 female), with a mean age of 23.33 ($\pm$ 4.54) years (range 18 to 35), were employed, having responded to an advert posted through the university subject-pool system. The participants received course credit for their participation, and reported no previous history of psychosis or depression.

2.3.1.2 ***Procedure***

Following giving their informed consent, the participants were tested individually in a quiet, distraction-free room, and told that they would hear 10, one-minute recordings of white noise, which may contain words embedded within them. Participants were given response sheets for each recording, where they noted each time they heard a word, and wrote that word. Participants were asked not to guess what they believed a word to be if they were unsure, but simply just to tick that they had heard a word. This instruction was stressed as very important. As a result, a record could be kept of falsely reported words in two ways: firstly, participants' reports of the presence of words; and secondly, the specific words heard.

For each word reported, the concreteness or abstractness was judged based on whether or not the word was linked to a physical object (e.g., desk). For example, for the concrete recordings, names of objects were used, such as; field, table, coin, knife, arm, apple and chair, whilst for the abstract recordings the words chosen were not names of objects, such as; myth, detail, deep, age, effect, lose and recognise. For the purposes of this study it was the specific words, rather than the report of the presence of a word, that was of interest, in order to provide a specific focus on hallucinatory content, as opposed to occurrence.

Participants were then presented with the 10 recordings (trials) as outlined above (see Figure 2.1). The words were randomly formulated by the experimenter, with the only common features of each set being their concrete, or abstract, characteristics. The average frequency of use for concrete words was 91, whilst for the abstract words this was 151 (Hofland & Johansson, 1982). Finally, all participants completed the above measures before receiving a full debriefing.

2.3.2 **Results and Discussion**

Five participants were removed from the analysis for either having incomplete questionnaire scores (n = 3), or for falling as outliers within the dataset (n

= 2). The numbers of falsely reported words (either concrete or abstract) were calculated across all four experimental trials of the study in relation to whether not they were (concrete) or were not (abstract) stimulus-bound (i.e. names of objects).

Participants were then divided into high and low scorers for each of the scales, based on a median split of the scores For UE, 22 participants were grouped into the low UE group (mean = 0.86 $\pm$ 0.83), whilst the remaining 19 participants were placed in the high UE group (mean = 5.63 $\pm$ 2.17). For CD, 21 participants were grouped into the low CD group (mean = 1.78 $\pm$ 1.09), whilst the remaining 20 participants were placed in the high CD group (mean = 7.1 $\pm$ 2.37). For IA 20 participants were grouped into the low IA group (mean = 0.64 $\pm$ 0.49), whilst the remaining 21 were placed in the high IA group (mean = 3.72 $\pm$ 1.6). For IN, 23 participants were grouped into the low IN group (mean = 1.83 $\pm$ 1.11), whilst the remaining 18 were placed into the high IN group (mean = 5.61 $\pm$ 2). For BDI scores, 21 participants were placed into the low BDI group (mean = 2.44 $\pm$ 1.73) whilst the remaining 20 were placed in the high BDI group (mean = 13 $\pm$ 6.88), and for STAI-T, 20 participants were grouped into the low STAI-T group (mean = 32 $\pm$ 3.61) whilst the remaining 21 were placed into the high STAI-T group (mean = 47.21 $\pm$ 8.26).

This method was used in preference to a regression technique; firstly, due to the sample size, and secondly, because it was not known if the impact of the various traits on hallucination reports would have a linear- or step- function. In addition, a group design is neutral with regard to this issue, but a regression analysis assumes a linear relationship which is not certain to be obtained between psychometric functions and performance (see Osborne, McHugh, Saunders, & Reed, 2008). For example, rather than a relationship between traits and hallucinations where hallucinatory reports increase as a linear function of higher trait scores, it could be that hallucinatory reports increase as a step function whereby when a certain trait score is reached, hallucinatory reports increase sharply. One way around these issues could be to either perform a linear transformation of the data prior to linear regression analysis or to perform a nonlinear regression, but these approaches also have their limitations. For example, performing a linear transformation of the data distorts the experimental error and some transformations alter the relationship between X (the independent variable) and Y (the dependent variable), violating the assumption that all the uncertainty in the data lies with Y (see Motulsky & Ransnas, 1987 for a discussion). Although nonlinear regression is another alternative, the calculation involved requires the relationships between the predictor variables (psychometric scores in our case) to be identified, in terms of an equation, prior to calculation of the model, in order for the nonlinear regression calculation to be built upon (Motulsky & Ransnas, 1987). However, this would require a knowledge of how the OLIFE-B subscales interact with one another to affect false perceptions, beyond that of UE, a relationship which is currently unclear, and could result in the nonlinear regression calculation converging upon the wrong regression model, or not reaching convergence at all (Motulsky & Ransnas, 1987). Moreover, the later experiments in the current thesis present data from experimental tasks where the relationship between the OLIFE-B subscale scores and the data in those experiments are uncertain or unknown and as a result exacerbate the issues mentioned here; it would thus be more beneficial to the thesis as a whole avoid linear (with or without transformation) and nonlinear regression analysis then and to utilise the same approach to the data for each experiment. A median-split approach is adopted then to avoid confounds of assuming the linear or step relationship between the OLIFE-B subscales and the data throughout the thesis, thus providing a theoretically conservative approach. Moreover, a median-split approach is in-keeping with much of the literature on the interaction between levels of schizotypy and the experimental task that have adopted a categorical approach (e.g. Cella, Taylor & Reed, 2007; Reed et al, 2008; Tsakanikos, Sverdrup-Thygensen & Reed, 2003; Langdon & Coltheart, 2004).

There were no instances of participants reporting the presence of words in the non-experimental white noise trials.

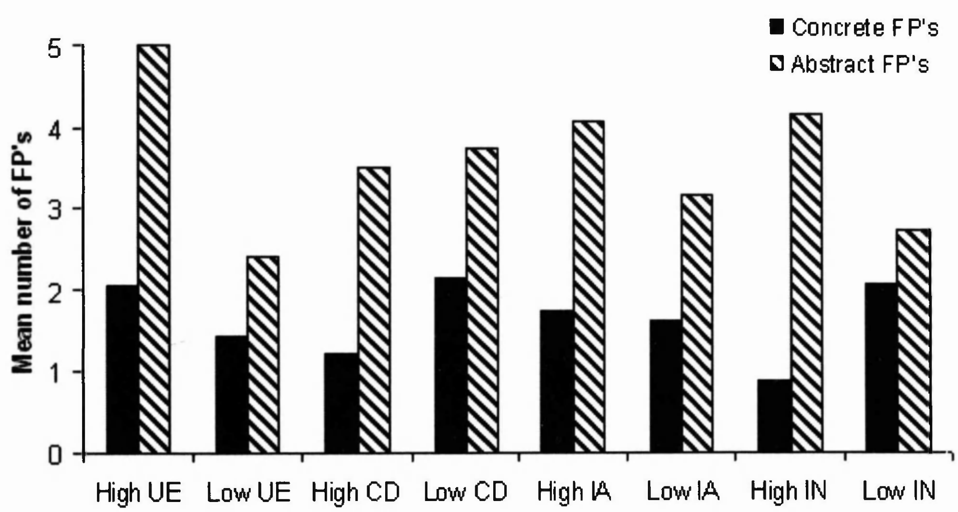

Figure 2.2: Mean number of concrete and abstract false perceptions (FP's) experienced by participants scoring high or low on each of the subscales of the OLIFE-B in Experiment 1.

Figure 2.2 shows the number of false reports of both types of words reported by low and high scorers in each of the sub-scales of the OLIFE-B, with more abstract FP's made for both high and low scorers across all four subscales, but with high UE and high IN scorers showing the largest differences. These data were analysed using a series of two-factor mixed-model analysis of covariance (ANCOVA) with word type (abstract versus concrete) as a within-subject variable, and subscale group (high versus low) as a between-subject variable (one analysis for each scale), and depression and anxiety as covariates. This analysis showed a statistically significant main effect for the UE scale, $F(1,25) = 17.15, p < 0.001$; and the IN scale, $F(1,25) = 4.81, p < 0.05$, but no significant main effects or interactions for the CD or IA subscales, $F < 1$.

Planned comparison analysis of these data showed statistically significantly more false reports overall in high UE scorers than low UE scorers ($n = 22$, mean = 0.86 ± 0.83), $F(1,50) = 27.47; p < 0.01$, significantly more abstract false reports in high UE scorers, ($n = 19$, mean = 5.63 ± 2.17) than in low UE scorers $F(1,50) = 13.44; p < 0.01$, and significantly more abstract reports than concrete ones in high scorers $F(1,50) = 11.37; p < 0.01$. In addition, there were significantly more abstract reports for high IN scorers ($n = 18$, mean = 5.61 ± 2) than concrete reports for low IN scorers($n = 23$, mean = 1.83 ± 1.11), $F(1,50) = 9.51; p < 0.01$, and significantly more abstract reports than concrete ones in both low, $F(1,50) = 5.34; p < 0.025$, and high, $F(1,50) = 4.64; p < 0.05$, IN scorers.

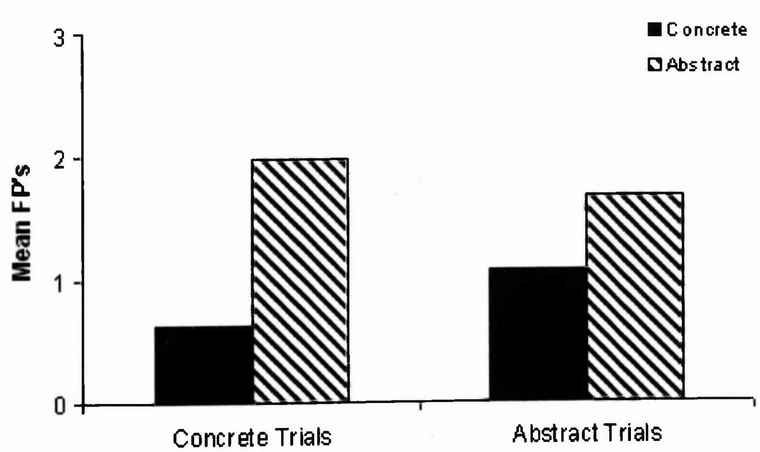

Figure 2.3: Mean number of concrete and abstract FP's made by participants in the trials where concrete and abstract words were played in Experiment 1.

Figure 2.3 shows the number of abstract and concrete false reports within their respective contexts, with more abstract FP's made than concrete ones in both the concrete and abstract trials. These overall data of word-type reports within each word-type context were analysed by a two-factor repeated measures ANOVA, with word type and context as within-subjects variables, and showed a statistically significant main effect of word type, with more abstract word reports overall than concrete ones, $F(1,40) = 22.14$; $p < 0.01$, but no significant effect of the abstract or concrete contexts in which each type of word was reported or an interaction between the two, both $p > 0.1$.

These results fulfilled some of the aims set out for this experiment, but also provided some complications for others both overall and specifically to Experiment 1. Firstly, the experimental technique proved useful in producing hallucination-like experiences in a non-clinical population. Secondly, high UE scorers reported more false word reports than low UE scorers overall. Thirdly, significantly more abstract false reports were made overall than concrete false reports, a finding that was more prominent in high UE scorers than low UE scorers as significantly more abstract words were reported in high UE scorers than in low UE scorers, and significantly more abstract words were reported than concrete ones in high UE scorers. Fourthly however, the number of false reports were not shown to relate to the environmental context within which words were presented, that is, there were no significant differences between abstract or concrete word reports in the concrete or abstract trials overall or between high and low UE scorers. These results suggest a predisposition to report hallucination-like experiences in high UE scorers more so than low UE scorers and that abstract words are more likely to be falsely reported than concrete words regardless of the abstract or concrete context within which words are presented.

2.4 Experiment 2

For Experiment 2, high- and low-imagery words were chosen to allow for further examination of content precedence in hallucination formation. Imagery has been implicated in both hallucination and delusion formation previously, where abnormally intense mental imagery is thought to lead to bizarre interpretations of experiences (Bentall, 1990; Freeman et al, 2002; Maher, 1974; Slade, 1976). As a result, it would be interesting to examine the effect of imagery associated with particular words on hallucinatory content, as words that have an added dimension of imagery may influence hallucinations. Considering that imagery appears to be related to concreteness in some regard (Paivio, 1963, 1965), and also that imagery and concreteness can differ in the degree of relatedness depending on associated word-type factors (Paivio et al, 1968), it may be that imagery would provide an extra insight into the relationship between hallucinations and word-type, moving away from the more rigid dichotomy involved with regard to concreteness.

2.4.1 Method

2.4.1.1 *Participants*

Fifty-four undergraduate students from Swansea University (23 male, 31 female), with a mean age of 22.02 ($\pm$ 3.15) years (range 18 to 34), were employed, having responded to an advert posted through the university subject-pool system. The participants received course credit, and reported no previous history of psychosis or depression.

2.4.1.2 **Measures** – ***Delusions*** In addition to the measures of schizotypy, anxiety and depression outlined in section 2.2.1, the Peter's Delusional Scale (PDS; Peters et al., 2004) was also added for Experiment 2. The PDS measures delusional ideation in the normal population. The 21 items explore experiences by asking an introductory question, for example "do you ever feel as if…" to which subjects are required to respond yes or no. If participants answer yes to these questions there follows a 5-point Likert scale on the question regarding the degrees of distress, preoccupation, and conviction. The PDS produces a total score of delusional ideation, and the internal reliability (Cronbach α) of the PDS is between 0.78 and 0.81, concurrent validity = 0.61. The PDS was included in as an additional means of measuring characteristics associated with, and in support of, the UE subscale of the OLIFE-B, specifically, delusions.

2.4.1.3 ***Procedure***

Following being given informed consent, participants were tested as in Experiment 1, except for the words presented in the recordings. These words were chosen from a list of 925 words, rated on a 7-point Likert-scale for the degree to which they evoked imagery (Paivio et al., 1968). Twelve words, scoring between 1.98 and 2.97 (mean = 2.65), were included as low imagery words (e.g. excuse, concept, increment), and twelve words, scoring between 6.27 and 6.8 (mean = 6.51), were included as high imagery (e.g. policeman, strawberry, elephant; see appendix

A). The only common features of the word sets were their high, or low, imagery characteristics. Average frequency of use for high imagery words was 185, whilst for the low imagery word this was 386 (Hofland & Johansson, 1982). Finally, participants were given a full debrief.

2.4.2 **Results and Discussion**

For each word reported, an imagery score was taken from a separate sample of participants ($N = 50$) who graded each word on the same 7-point likert scales as used by Paivio et al. (1968) originally. The average imagery scores for each word were then used to calculate an average imagery score for the words reported by each participant for each of the high or low imagery trials. In addition, these imagery scores were used to categorise each falsely reported word into high or low imagery groups based on their score relative to the mean (above or below).

As in Experiment 1, a median split was performed on each subscale of the OLIFE-B. For UE, 29 participants were grouped into the low UE group (mean = 1.23 $\pm$ 1), whilst the remaining 25 were placed into the high UE group (mean = 6.24 + 2.09). For CD, 24 participants were placed into the low CD group (mean = 1.54 $\pm$ 1.25), whilst the remaining 30 were placed in the high CD group (mean = 7.03 $\pm$ 2.06). For IA 24 participants were grouped in the low IA group (mean = 0.52 $\pm$ 0.51) whilst the remaining 30 were placed in the high IA scorers (mean = 2.57 $\pm$ 1.65). For IN, 34 participants were placed in the low IN group (mean = 1.69 $\pm$ 1.11) whilst the remaining 20 were placed in the high IN group (mean = 5.1 $\pm$ 1.29) and 38 participants were grouped into the low PDS group (mean = 6.03 $\pm$ 5.53) whilst the remaining 16 were placed in the high PDS scorers (mean = 96.31 $\pm$ 48.03).

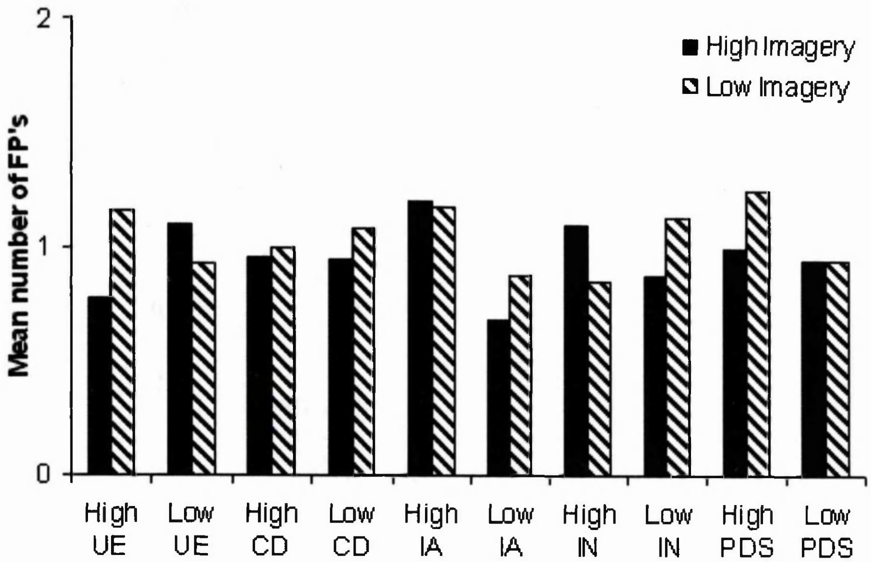

Figure 2.4: Mean number of high and low imagery FP's made by participants scoring high or low on the UE, CD, IA and IN subscales of the OLIFE-B, and the PDS in Experiment 2.

Figure 2.4 shows the number of occurrences of imagery word-types for each of the OLIFE-B subscales and the PDS. These data were analysed using two-factor, mixed-model ANCOVAs, with the number of high or low falsely reported words (high or low) as a within-subjects factor, subscale split (low versus high for each scale separately) as a between-subject factor, and depression and anxiety scores as covariates. These analyses found a statistically significant interaction between the type of word reported and the UE scale, $F(1,32) = 6.32$, $p < 0.025$, as well as a statistically significant interaction between the type of word reported and the IN subscale, $F(1,32) = 5.58$, $p < 0.05$, but no significant main effects or interactions for the PDS scale or the CD and IA subscales, $F < 1$.

Planned comparison analysis showed significantly more low imagery words than high ones in high UE scorers $F(1,32) = 4.27$; $p < 0.05$, whilst the same was not true for low UE scorers $p > 0.05$. However, planned comparisons failed to show any significant differences in the type of words reported in both high and low UE scorers, and in high and low IN scorers.

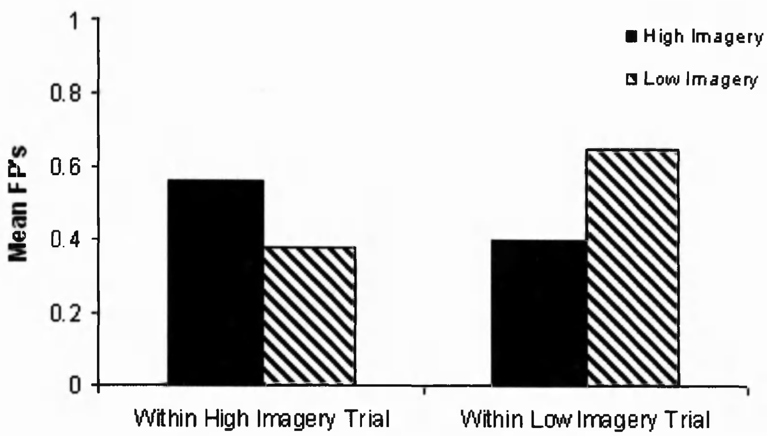

Figure 2.5: Mean number of high and low imagery FP's made by participants in the trials where high and low imagery words were played in Experiment 2.

Figure 2.5 displays the mean number and type of falsely reported words made during the high and low imagery trials. There were more low imagery false reports made during the low imagery trials, than high imagery false reports; and there were more high imagery false reports made during the high imagery trials, than during the low imagery ones. A two-factor, repeated-measures ANOVA (word type x trial type) conducted on these data revealed a statistically significant main effect of word type, $F(1,54) = 7.49$, $p < 0.001$, but no statistically significant main effect of trial type, $F < 1$, or an interaction between the two factors, $p > 0.1$.

Planned comparisons revealed that there were statistically significantly more low imagery false reports made during low imagery trials than during high imagery ones, $F(1,54) = 6.15$, $p < 0.05$, and significantly more low imagery word reports in the low imagery trials than there were high imagery words in the low imagery trial,

$F(1,54) = 5.27$, $p < 0.05$.

These results supported some of the findings from Experiment 1, and the aims overall, but also showed some insight into the context within which low or high imagery words were reported. Firstly, the experimental technique again proved useful in producing hallucination-like experiences in a non-clinical population. Secondly, high UE scorers reported more low imagery false word reports than low UE scorers, supporting the similar findings of the concrete and abstract words in Experiment 1. Thirdly, significantly more low imagery false reports were made within the low imagery trials than both low imagery words reported in the high imagery trials and high imagery words in the low imagery trials. These results suggest a predisposition to make more low imagery false reports than high ones in high UE scorers and that low imagery word reports are facilitated within a context where words of the same type are presented experimentally more so than both high and low imagery reports made within high imagery experimental contexts.

2.5 **General Discussion**

The current study examined the impact of immediate environmental context on false reports of stimuli made within those contexts, and examined the impact of psychometrically-defined traits on the tendency to make false reports. The number of hallucinatory reports suggests that the current method is useful in studying the occurrence of auditory hallucinations in the non-clinical population. In addition, similar patterns between the OLIFE-B and other psychometric scales, with regard to findings using the full OLIFE (e.g. Mason et al., 1995), and the fact that high UE scorers make more false-reports overall than low scorers, support the validity of the OLIFE-B in this experimental context.

The OLIFE-B subscale most associated with hallucinations was unusual experiences (Mason et al., 1995); high UE scorers made more false reports, regardless of type, than low UE scorers in Experiment 1 (see Bentall & Slade, 1985; Tsakanikos & Reed, 2005a, 2005b). However, there were no significant differences between high and low UE scorers in the total number of false reports, regardless of type, in Experiment 2. This could be due to the overall low number of false reports made by the sample in Experiment 2, a function of the median split approach to the dataset, or differences between the characteristics of concrete/abstract word and high/low imagery words.

Experiment 1 showed that abstract false reports were more likely to be made than concrete ones overall, suggesting a bias in hallucinatory content toward more abstract events. Experiment 2 however, showed more low imagery word reports over high ones, but only when presented within the low imagery trials. In addition, in both experiments, there were more abstract or low imagery hallucinatory reports than concrete or high imagery ones, suggesting that abstract or low imagery words are more likely to be emitted regardless, than concrete or high imagery ones. These results support previous findings that question the influence of imagery on the occurrence and content of hallucinations as the majority of false reports made here were abstract or low in imagery scores (Bentall & Slade, 1985; Heilbrun et al, 1983; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972; Posey & Losch, 1983; Slade, 1976).

However, the increased tendency to report abstract or low imagery words was facilitated somewhat by different experimental manipulations between both experiments, namely abstract/concrete or high/low imagery classification. This suggests that the classifications of these types of words may influence hallucinatory content differently, and in relation to the type of context (abstract/concrete versus high/low imagery) in which these types of words are presented, with low imagery word reports more sensitive to the environmental context (i.e. low imagery word presentations) than abstract words. With regard to this, it is worth noting that Paivio et al. (1968) reported several types of word that scored higher in imagery than concreteness, despite not being object orientated, and, similarly, in the present study, words such as "love" were given a high imagery score, on average, in Experiment 2, but would have been included in the abstract condition in Experiment 1. Such differences could possibly account for the cross-experimental findings involving the number of false reports overall, and abstract ones in particular, in high over low UE scorers, through the more dichotomous method of word classification in Experiment 1 (i.e. stimulus bound or not) – with Experiment 2 losing some abstract words to the high imagery category and thus reducing any differences.

Nevertheless, both experiments showed significantly more abstract/low imagery words than concrete/high imagery ones in high UE scorers, suggesting that differences between the likelihood of abstract/low imagery false reports occurring over concrete/high imagery ones is particularly probable in high UE scorers, in turn suggesting a bias toward more abstract or low imagery content when particularly prone to hallucinatory experiences. Without over-generalizing, this could be useful as a basis of future research in understanding hallucinations, as it is often the case that hallucinations are more likely to occur in the presence of little or ambiguous environmental stimuli (Bentall, 1990); in the presence of words that do not provoke high imagery, or are not stimulus bound, possibly due to an inability to ignore irrelevant stimuli in terms of latent inhibition (Shrira & Tsakanikos, 2009).

Although the environmental stimuli employed here were words, the words themselves could be perceived as ambiguous with the interference of the white noise, and abstract or low imagery words in particular could be considered more ambiguous than concrete or high imagery words as they are not accompanied by specific object imagery. It may be that concrete or high imagery words are less likely to be emitted without the presence of the particular stimulus to which each word is bound, or alternatively, the increased likelihood for the emission of abstract words could be associated with possible differences in word frequencies, an interaction between UE, latent inhibition and abstract words (see Shrira & Tsakanikos, 2009), or another audio-graphic dimension. In addition, the majority of research into auditory hallucinations cites their characteristics as being meaningful words and/or sentences directed to the individual experiencing them (see Bentall, Haddock, & Slade, 1994). Such conclusions should be approached with caution however, as cross-experimental differences involving concrete/abstractness versus high/low imagery show a need for more thorough examination involving these two types.

With regard to environmental context, these data suggest that there exists a bias toward emitting a particular type of word, regardless of context in Experiment 1, with more abstract false reports than concrete ones overall, but, in Experiment 2, environmental context seems to play more of a role with the number of low imagery words reported overall in the low imagery trials being more than high imagery words in the same trial, and the number of low imagery words reported in the high imagery trial being more than high imagery words reported in the low imagery trial. Again this could be due to the differences in word classification between the experiments and a product of some abstract words being included as high imagery words in Experiment 2. In addition, it may be useful to consider how context-dependent hallucinations may relate to state-dependent memory - where information is best recalled within the environmental context in which it was first learnt (Overton, 1964); the fact a particular word is more likely to emerge, may be resultant of the context in which it was first learnt.

Although the study produces some interesting findings, there are also some limitations to consider. Firstly, there were more female participants than males giving a gender bias for the study. This may be particularly pertinent considering female subjects have shown an increased frequency of hallucinatory experiences over males (Sharma, Dowd, & Janicak, 1999). Secondly, there is an ethical issue with regard to using a technique to induce hallucinations in healthy subjects, especially when hallucinatory experiences contribute significantly to schizophrenic diagnosis, being one of the symptom categories that must occur alongside another for the majority of 1 month (DSM-IV criteria, APA, 1994). However, in answer to these two issues, the present study merely looked to establish a technique that could be used to examine auditory hallucinations within a simple and specific context, not as a means to manipulate the hallucinatory frequencies, rendering the gender bias of the sample somewhat irrelevant. In addition, the types of hallucinations under scrutiny here were simple instances of one-word auditory presentations within in a particular context, a scenario in which participants were not likely to come across often, and even if hallucinatory experiences were to occur in similar situation anyway, their very nature, accompanied with that of schizotypy, suggests that they would have occurred anyway. Furthermore, participants were not given feedback as to their correct or incorrectly heard words; making it unlikely that distress resultant of a hallucinatory experience would occur.

The present study therefore met the objectives set out in the introduction. Firstly, the technique is useful as a means to examine the formation and content of hallucinations in a non-clinical population. Secondly, similar patterns were found concerning both concreteness and imagery with regard to the hallucination-environment relationship, but cross-experimental differences suggests that concreteness may be more useful in research into hallucinatory content, although more detailed research into concreteness versus imagery words is essential. The present study suggests then, that the formulation of auditory hallucinations, and their content, is dependent on individual schizotypy subscales scores, and also that abstract/low imagery hallucinatory content is somewhat more likely to emerge than concrete/high imagery content.

2.6. Appendix A: List of Experimental Words.

2.6.1. Experiment 1 Concrete recording 1

Field, Cloud, Letter, Chair, Glove, Box.

2.6.2. Experiment 1 Concrete recording 2

Table, Coin, Knife, Desk, Apple, Arm.

2.6.3. Experiment 1 Abstract recording 1

Myth, Abstract, Detail, Deep, Age, Sorrow.

2.6.4. Experiment 1 Abstract recording 2

Abyss, Rhythm, Lose, Recognise, Effect, From.

2.6.5. Experiment 2 High Imagery Recording 1

Headlight, Photograph, Arrow, Magazine, Slipper, Policeman.

2.6.6. **Experiment 2 High Imagery Recording 2**

Strawberry, Letter, Avalanche, Valley, Elephant, Pepper.

2.6.7. **Experiment 2 Low Imagery Recording 1**

Mastery, Event, Magnitude, Exclusion, Belief, Figment.

2.6.8. **Experiment 2 Low Imagery Recording 2**

Attitude, Method, Position, Increment, Excuse, Concept.

Chapter 3: The Effect of Schizotypy on Responding Maintained by Free-Operant Schedules of Reinforcement.

3.1. Introduction

Schedules of reinforcement produce reliable and distinctive patterns of responding (see Ferster & Skinner, 1957), and deviations from these distinctive patterns can offer insight into processes, and deficits, that determine behaviour. For example, variable ratio (VR) schedules produce a high rate of responding, whereas, variable interval (VI) schedules have a lower rate of responding than ratio schedules (Ferster & Skinner, 1957; Peele, Casey, & Silberberg, 1984). This difference in response rate between VR and VI schedules has been taken to reflect learning about specific aspects of the behaviour-environment interaction engendered by exposure to the schedule contingency. For example, it is suggested that ratio schedules produce high rates of responding as the response-reinforcement relationship relies solely on the behaviour of the subject: the faster the subject responds, the greater will be the rate of reinforcement obtained. Thus, there is a direct action-outcome relationship on a ratio schedule. In contrast, interval schedules produce a lower rate of responding, in part due to the action-outcome relationships not being linear; increases of responding do not necessarily lead to an increase in the rate of reinforcement obtained as the elapsing of a particular interval of time is also required for reinforcement to become available (see Baum, 1973; Dickinson, 1989; Reed, 2007; Roberts, Tarpy, & Lea, 1984).

However, experiments examining human performance on schedules of reinforcement often produce varied and different patterns of behaviour to those exhibited by nonhumans; with verbal rule formation, and a variety of learning histories outside the laboratory, thought to contribute to these differences (see Raia, Shillingford, Miller, & Baier, 2000). One potentially important, and little investigated, factor that might contribute to the apparent variety of human schedule performance are individual differences in specific personality characteristics; in this case, with regard to schizotypy (see Chapter 1 and 2). Schizotypal characteristics could affect basic schedule behaviour in a number of ways, for example, high scores in introvertive anhedonia, or impulsive non-conformity, could produce lower rates of responding as these subscales are associated with a lack of motivation, and a tendency to rebel against the norm respectively (Mason et al, 1995). In addition, identifying differences in schedule performance between high and low schizotypy scorers could aid the understanding of the basic mechanisms underlying schizotypal characteristics.

Schizotypy as measured by the O-LIFE scale (Mason et al,1995) consists of four subscales: unusual experiences (UE), consisting of items concerning unusual perceptual experiences or thinking; cognitive disorganization (CD), concerning attention and decision-making difficulties; introvertive anhedonia (IA), reflecting lack of enjoyment in social contact; and impulsive non-conformity (IN), which concerns impulsive, violent and reckless behaviours, and each of these factors could potentially influence schedule performance. However, Chapter 2 showed experimental effects with regard to the UE subscale and, given that the focus of this thesis is on hallucinatory and delusional experiences as measured by the UE subscale, it is this subscale that will receive the most focus here also.

In other experimental tasks, UE has been associated with the mediation of latent inhibition (Gray, Fernandez, Williams, Ruddle & Snowden, 2002), whilst IN has been linked to deficits in logical reasoning (Tsakanikos, 2004). Given that performance on an experimental task arguably involves perceptual (interpretation of stimuli), attentional (attention to relevant stimuli), and motivational (engagement in task), factors, as well as compliance with the experimental instructions, it is reasonable to assume that high scorers across all four subscales of schizotypy could show differing response patterns on a schedule of reinforcement.

The present study aimed to examine any individual difference in behavioural patterns on two schedules of reinforcement. A random-ratio (RR) and a random-interval (RI) schedule were chosen in order to examine any basic differences in a schedule associated with individual responding alone and a schedule where reinforcement also relies on the passage of time.

3.2. General Methodology

3.2.1 Measures

3.2.1.1 *Schizotypy.*

The Oxford Liverpool Inventory of Feelings and Experiences - Brief Version (OLIFE-B; Mason et al., 2005) is a 43 item scale consisting of four subscales (UE, CD, IA & IN) designed to measure schizotypy in the normal population. The scale has an internal reliability (Cronbach α) of between 0.62 & 0.8, and a concurrent validity of between 0.9 and 0.94 (UE $\alpha = 0.8$, validity = 0.94; CD, $\alpha = 0.77$, validity = 0.93; IA, $\alpha = 0.62$, validity = 0.91; IN, $\alpha = 0.63$, validity = 0.9; Mason et al, 2005). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the OLIFE-B was comparable to the range outlined above $\alpha = 0.69$.

3.2.1.2 ***Delusions***

The Peter's Delusional Scale (PDS; Peters et al., 2004) measures delusional ideation in the normal population. The 21 items explore experiences by asking an introductory question, for example "do you ever feel as if…" to which subjects are required to respond yes or no. If participants answer yes to these questions there follows a 5-point Likert scale on the question regarding the degrees of distress, preoccupation, and conviction. The PDS produces a total score of delusional ideation, and the internal reliability (Cronbach α) of the PDS is between 0.78 and 0.81, concurrent validity = 0.61. The PDS was included in as an additional means of measuring characteristics associated with, and in support of, the UE subscale of the OLIFE-B, specifically, delusions.

3.2.1.3 ***Depression***

The Beck's Depression Inventory (BDI; Beck et al., 1961) is a 21-item questionnaire that assesses the clinical symptoms of depression through asking about feelings over the past week. The score is a sum of the positive answers, ranging from 0 to 63. The internal reliability (Cronbach α). of the scale is between 0.73 & 0.92, and a concurrent validity of between 0.55 and 0.73 for non-psychiatric subjects (Beck et al, 1988). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the BDI was comparable to the range outlined above, $\alpha = 0.75$.

3.2.1.4 ***Anxiety***

The Spielberger Trait Anxiety Inventory (STAI-T; Spielberger, 1983) rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (i.e., trait anxiety). Scores for each question range from 1 = never, to 4 = almost always, and the total score can range from 20 to 80. The internal reliability (Cronbach α) of the scale is 0.93, and a concurrent validity = 0.52 to 0.8 (Spielberger, Gorsuch, & Lushene, 1970). Measures of depression and anxiety were included as a controlling measure for statistical analysis on hallucinatory reports and schizotypy scores, given that both are associated with the hallucination formation (Freeman & Garety, 2003). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the STAI was comparable to that outlined above, $\alpha = 0.89$.

3.2.1.5. ***Mood***

The Positive And Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988) is a 20-item questionnaire designed to measure participants' mood. Participants are required to choose the number that corresponds to the intensity of their feeling concerning the item, ranging from 1 = very slightly to 5 = extremely), and the total scores can range from 20-100. The internal reliability (Cronbach α) is 0.85, concurrent validity = 0.51 to 0.74 (Watson et al, 1988). The PANAS was included as exclusion criteria, should subjects score highly negatively on the subscale. This was done to avoid the potential confounds of data given by subjects who may respond adversely due to external negative circumstances.

3.2.2. **Experimental Task**

The experimental task was programmed in Visual Basic (6.0), and incorporated two main features. Firstly, the program incorporated an RR schedule, whereby reinforcement (points) would be delivered for any response with equal probability between one response and twice the number of responses specified by the mean schedule value. Secondly, the program incorporated an RI schedule, whereby reinforcement is delivered for the first response following the elapse of the specified period of time. The two schedules were yoked together, whereby the reinforcer in the RI schedule would be delivered only following the passing of the amount of time that it took for the corresponding reinforcer to be delivered in the RR schedule. Thus, the two schedules only differed on the rule relating responding to reinforcement, not the rate at which reinforcement was delivered. The presentation of each schedule was 4 minutes long, and the program always presented the RR schedule immediately before the corresponding yoked RI schedule, and each pair of schedules (RR then RI) were presented four times.

Before the experiment began, the participants were presented with a set of minimal instructions for the experimental task: "*The next part of the experiment involves completing a computer task. On the screen you will see a coloured box, a box showing how many points you have and a command button stating "Click here". Your task is to click the command button in order to gain as many points as you can. On each click of the button you will either gain or lose points. Begin when you are ready*".

3.3. **Experiment 3**

For Experiment 3, an RR-8, and a yoked RI schedule were used. In the RR schedule, participants received reinforcement, comprising the delivery of 10 points, between every 1 and 16 clicks of the button (mean = 8). During the yoked-RI schedule, participants received 10 points (reinforcement) on the first click that followed the passing of time that accompanied the corresponding reinforcement delivered in the RR-8 schedule. In addition, participants lost 1 point for every click, regardless of whether that click was reinforced (see Reed, 2001).

3.3.1 **Method**

3.3.1.1 ***Participants***

The participants were a convenience sample of 73 undergraduate Psychology students (46 males and 27 females), recruited through the Psychology Department subject-pool system. The age range of participants was 19 to 38 with an average age of 25.16 (SD = 4.28). No participants reported any history of psychiatric problems.

3.3.1.2 ***Procedure***

All participants were seated in a quiet room, in front of a desk and computer (60cms from the monitor), and gave written consent for their participation. Firstly, participants were required to complete the series of questionnaires; this was done to avoid any adverse effects caused by the task influencing participant responses. In Experiment 3, the OLIFE-B, STAI-T, BDI, and PDS questionnaires were administered and counterbalanced across participants.

Participants were then presented with the instructions, before continuing with the computer task. During the computer task, participants were exposed to a RR-8, RI-yoked pair of schedules four times each. Finally, participants were fully debriefed, and paid in subject pool credit.

3.3.2. **Results and Discussion**

One participant was removed from the analysis due to extreme values in response rate. After exclusion of this participant, the mean response rate for the RR schedule was 181.51 (± 101.42) responses per minute, and for the RI schedule it was 136.38 (± 117.97), $t(71) = 5.91, p < 0.01$. This replicates this basic RR versus RI response rate difference in the sample (Ferster & Skinner, 1957; Reed, 2001).

The remaining participants were split above and below the mean on all four OLIFE-B subscales, and for the total score of the PDS. For UE, 47 participants were grouped into the low UE group (mean = 1.14 ± 0.83), whilst the remaining 25 participants, were placed in the high UE group (mean = 5.68 ± 2.22). For CD, 43 participants were grouped into the low CD group (mean = 2.23 ± 1.25), whilst the remaining 29 participants were placed in the high CD group (mean = 6.53 ± 1.25). For IA, 44 participants were grouped into the low IA group (mean = 0.98 ± 0.73), whilst the remaining 28 participants were placed in the high IA group (mean = 4.54 ± 1.78). For IN, 35 participants were grouped into the low IN group (mean = 1.46 ± 0.98), whilst the remaining 37 participants were placed in the high IN group (mean = 5.26 ± 1.31). For proneness to delusion, as measured by the PDS, 20 participants were grouped into the low PDS group (mean = 32.9 ± 16.91), whilst the remaining 30 participants were grouped into the high PDS group (mean = 99.61 ± 33.88). The remaining 23 subjects were removed due to having incomplete PDS questionnaire scores.

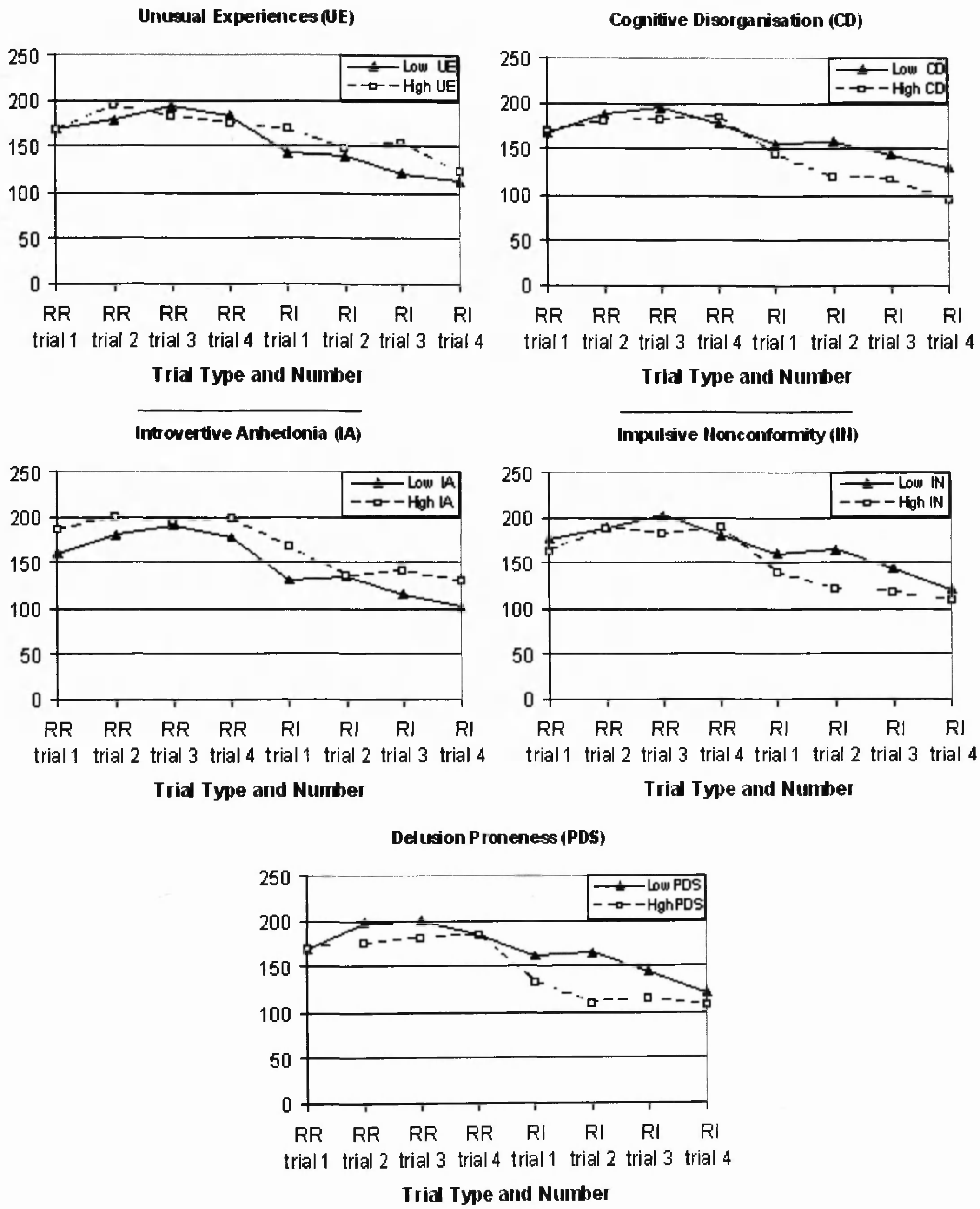

Figure 3.1: Average response rates for high and low scorers on each OLIFE-B subscale and total PDS score in each trial of both the random interval and random ratio schedules (Experiment 3).

The mean response rates across all RR and RI trials, for each of these groups, are shown in Figure 3.1. For each subscale of the OLIFE-B and the PDS, an analysis of covariance (ANCOVA) was performed with trial and schedule (RR or RI) as the within-subjects factor, high and low scorers on each scale as the between subjects factor, and STAI-T and BDI scores as covariates. Following the initial ANCOVAs, which showed no significant effects of STAI-T ($p > 0.1$) or BDI ($p > 0.5$) scores, the pooled error term from each analysis was used in the calculation of planned comparisons to test for specific differences between the high and low scorers on each OLIFE-B subscale and the PDS. Significantly higher response rates were found in the RR than for the RI schedule for low scorers in UE, $F(3,37) = 7.42, p < 0.01; d = 0.59$, but not in high UE scorers, $p > 0.10$ $d = 0.48$. Significantly higher response rates were found for RR than RI schedules for both high, $F(3,72) = 3.50, p < 0.05; d = 0.87$, and low CD scorers, $F(3,83) = 10.50, p < 0.01; d = 0.39$, for high, $F(3,83) = 8.27, p < 0.01; d = 0.78$, and low IA scorers, $F(3,83) = 9.78, p < 0.01; d = 0.67$ for high, $F(3,83) = 10.86, p < 0.01; d = 0.77$, and low IN scorers, $F(3,85) = 4.78, p < 0.01; d = 0.53$. and for high, $F(3,54) = 8.55, p < 0.01; d = 0.77$, and low PDS scorers, $F(3,54) = 3.69, p < 0.05; d = 0.62$.

In summary, this experiment showed that participants typically responded faster on the RR schedule than on the RI schedule, and this replicates numerous demonstrations of this schedule effect in nonhumans (Ferster & Skinner, 1957; Peele et al., 1984), and humans (e.g., Raia et al., 2000; Reed, 2001). That this effect was noted suggests that the current procedure was sensitive to any schedule-induced differences in performance that might emerge. However, this pattern of results was not noted for the participants scoring high on UE.

3.4. **Experiment 4**

The findings from Experiment 3 suggest that high scorers in UE are unable to distinguish between RR and RI schedules of reinforcement. A finding that stands in contrast to the more typical RR advantage in response rate observed in most participants. Prior to further discussion of these findings, Experiment 4 attempted a systematic replication of this novel result, using a higher schedule value for the RR trial, and a higher number of points per reinforcement, in order to extend the generality of the parameters over which the effect was observed.

3.4.1. **Method**

3.4.1.1. **Participants**

Participants were 72 undergraduate psychology students (33 males and 39 females) recruited through the Psychology Department subject pool system. The age range of participants was 18 to 47 with an average age of 21.66 (SD = 4.83). No participants reported any history of psychiatric problems.

3.4.1.2. **Procedure**

The procedure for Experiment 4 was the same as that described for Experiment 3, except that only the UE subscale of the OLIFE-B was analyzed, as this produced the result of interest in Experiment 3, and different RR and RI schedules values were used. In addition, the PANAS was included in order to exclude any participants scoring negatively in mood, motivation and engagement of the task, this was done in order to avoid any experimental confounds that may result from negative values in these factors. All questionnaires were counterbalanced across participants, except for the PANAS, which was always completed first; this was to allow for an accurate as possible measure of the participants' mood before the experiment began.

In Experiment 4, participants were exposed to a RR-30 schedule (whereby reinforcement was delivered between 1 and 60 clicks of the button), yoked to an RI schedule (where delivery of reinforcement occurred in the same ways as in the RI schedule in Experiment 3). In addition, participants received 40 points per reinforcement. All other details were as described in Experiment 3.

3.4.2. **Results and Discussion**

Six participants were removed from the analysis; four due to having extreme values in either their interval or ratio response rates, and two for having extreme negative scores on the PANAS. After exclusion of these participants, the mean rate of the response for the RR schedule was 59.25 ($\pm$ 81.75) responses per minute, and for the RI schedule the mean rate of response was 42.19 ($\pm$ 68.26), $t(66) = 2.9$, $p <$ 0.01, which replicates the RR versus RI response rate difference (see Experiment 3), although with slightly lower rates of response, probably due to the increased ratio value.

For UE, 43 participants (mean = 0.96 $\pm$ 0.8) were grouped into the low UE group, whilst 23 participants (mean = 4.67 $\pm$ 1.88) were placed in the high UE group. For PDS, 37 (mean = 22.5 $\pm$ 8.11) were grouped into the low PDS group, whilst the remaining 29 participants (mean = 60.8 $\pm$ 23.68) were placed in the high PDS group.

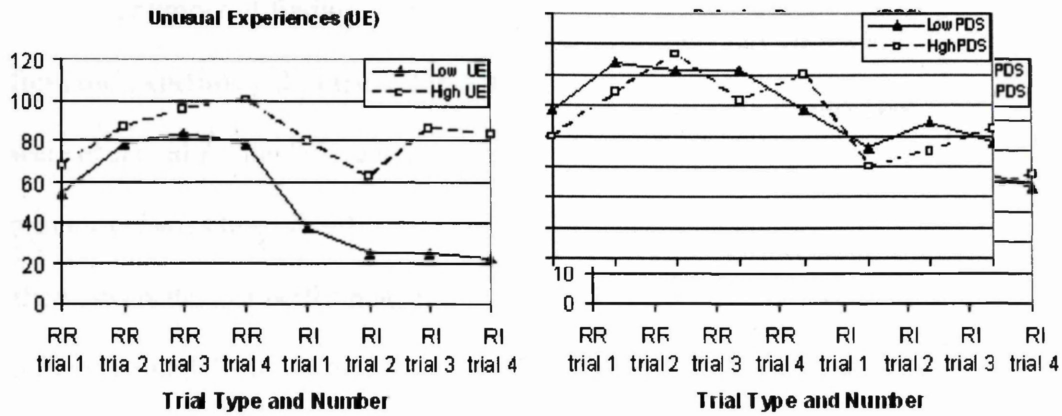

Figure 3.2: Average response rates for high and low scorers on the PDS and UE subscale of the OLIFE-B in each trial of both the random interval and random ratio schedules (Experiment 4).

Figure 3.2 shows the mean response rates for the RR and RI schedules for each group. For the UE subscale of the OLIFE-B, and the PDS, an ANCOVA was performed, with trial and schedule (RR or RI) as the within-subjects factor, high and low scorers on the UE subscale, and PDS, as the between subjects factor, and with STAI-T and BDI scores included as covariates. As for Experiment 3, following the initial ANCOVAs, which did not show a significant effect of the covariate BDI ($p >$ 0.3) and STAI_T ($p > 0.8$) scores, the pooled error term for each was used in the calculation of planned comparisons to test for specific differences between the high and low scorers on the UE subscale, and the PDS. Significantly higher response rates were found in the RR schedule than in the RI schedule for low scorers in UE, $F(3,70) = 15.46$, $p < 0.01$; $d = 0.86$, but this was not found in high scorers, $p > 0.10$ $d = 0.23$ There were significantly higher response rates found in the RR than in the RI schedule for both high, $F(3,74) = 20.12$, $p < 0.01$; $d = 1.2$, and low, $F(3,74) = 3.17$, $p < 0.05$; $d = 0.42$, PDS scorers.

A number of findings emerged from the current study that corroborated those from the Experiment 3. Firstly, the typical higher response rates on RR schedules were observed for the low scorers of the scales used, replicating Experiment 3, and previous studies (e.g., Reed, 2001). Importantly, however, high UE scorers did not show this pattern of performance replicating the effect noted in Experiment 3 using different schedule parameters, and suggesting an effect of some generality.

3.5. **General Discussion**

The current studies demonstrated the typical RR versus RI response rate difference; response rates were higher on the RR than on the RI schedule (Ferster & Skinner, 1957; Peele et al., 1984). Although not a novel finding for humans (see Raia et al., 2000; Reed, 2001), there are certainly fewer clear demonstrations of this effect. Some have suggested that this may reflect species differences in learning (see Lowe, 1979), whereas others have suggested that this might reflect procedural differences (see Raia et al., 2000, for a discussion).

The current results suggest that personality factors related to sub-clinical features of schizophrenia may also play a role in increasing the variance in human responding to schedules of reinforcement, although cross-experimental differences suggest that schedule parameters also contribute, there are several findings of interest. Firstly, Experiment 3 and Experiment 4 both show higher response rates on the RR schedule than on the RI schedule in low but not high UE scorers. This suggests that a proneness to UE could be linked to the ability to perform optimally on RR and RI schedules of reinforcement. Reasons for this could be a result of differences in the sensitivity to timing responses in relation to the previous periods of reinforcement between high and low UE scorers, particularly necessary for optimum performance on an RI schedule as reinforcement relies, in part, on allowing time to pass (see Killeen & Feterman, 1988). Moreover, responses on a VI schedule are deemed to be made based on the time elapsed since reinforcement delivery (Catania, Matthews, Silverman & Yohalem, 1977). Without over-generalising, such timing differences could be linked to theories of source-monitoring that link the formation and maintenance of hallucinations to deficits in distinguishing between internally and externally generated events (Frith, 1987; Frith & Done, 1989); whereby hallucinations are actually mistimed memories and occur in line with 'seepage' theories of hallucinations (see Bentall, 1990).

Similarly, it may be that disconfirmation deficits in high schizotypy scorers are responsible for the distinguishing deficits between the two types of schedule. Disconfirmation deficits have been shown in deluded subjects (Hemsley & Garety, 1986; Huq, Garety & Hemsley, 1988), a key symptom of schizophrenia (Cutting, 1985). In this instance, high scorers in schizotypy may be insensitive to responses that they make where they do not receive reinforcement, and instead lose a point. In line with theories that describe deficits in distinguishing between internal and external events then, it could be that high schizotypy scorers have difficulty in perceiving the relationship between their responses and reinforcement delivery.

Both Experiments 3 and 4 showed higher response rates in the RR schedule than in the RI schedule, in both high and low scorers on the PDS scale. This suggests a lack of a relationship between proneness to delusions and performance on these schedules. Further, in Experiment 3, none of the OLIFE-B subscales showed a differential effect of low or high score on schedule performance, suggesting that this effect is limited to the UE subscale.

In summary, the present study aimed to examine potential relationships between high or low scorers in schizotypy and performance on two schedules of reinforcement. The findings suggest that differences in timing, or perceiving the response-reinforcement relationship, between high and low scorers in UE, could be responsible for deficits in distinguishing between the two schedules of reinforcement.

Chapter 4: Timing Differences between High and low Schizotypal Individuals Manifested in Differential Performance on Schedules of Reinforcement.

4.1. Introduction.

Research reported in Chapter 3, using the short version of the Oxford-Liverpool Inventory of Feelings and Experiences (OLIFE-B) as a measure of schizotypy (Mason et al, 2005), has shown that low scorers on the schizotypy subscale of Unusual Experiences (UE) produce significantly greater rates of responding on random ratio (RR) schedules than on random interval (RI) schedules that are yoked in terms of reinforcement rate. This pattern of behaviour is characteristic of that typically produced on these two types of schedules (Ferster & Skinner, 1957; Raia et al, 2000; Reed, 2001). However, the same experiment demonstrated that there were no reliable differences in response rates between RR and RI schedules for high scorers in UE. This result suggested that those with high schizotypy scores (and specifically those associated with hallucinations and delusions; i.e., unusual experiences) have difficulty in differentiating between the two schedule types. Specifically, higher rates of responding emitted by high UE scorers on the RI schedule, compared to low UE scorers, accounted for the lack of difference between the RI and RR schedules in the high UE scorers (see Chapter 3).

There are several reasons why high scorers in UE could show this pattern of behaviour on RR and RI schedules of reinforcement. One potential reason, that has received very little investigation in the literature, concerns a possible timing differences between high and low schizotypy scorers (and, potentially, affecting schizophrenia sufferers). Such differences may lead them to be less sensitive to the

UNIVERSITY OF WALES SWANSEA LIBRARY

temporal requirements of an interval schedule, which may subsequently impact their performance on that schedule.

Research specifically orientated toward exploring timing in schizophrenic patients, and in those deemed to be at an increased risk of developing schizophrenia, has shown these groups to overestimate the passage of time across different types of tasks (Tysk, 1983; Wahl & Sieg, 1980). Although it might be noted that these findings are dependent on the modality through which the experimental stimuli are presented; with those defined as high-risk to develop schizophrenia showing an increased tendency toward shorter time estimations for visual stimuli, when compared to auditory stimuli presented for the same duration (Penny et al, 2005). Given these findings, it seems that there is some scope for further research into timing differences between high and low UE scorers in order to better understand the influence of timing within a schizotypal framework.

In the context of performance on RR and RI schedules, if the passage of time between deliveries of successive reinforcement is underestimated when an individual is responding on a RI schedule, this would have the result of increasing the rate of response. This prediction follows in accordance with many theories of RI behaviour, such as the Matching Law (e.g., Baum, 1973), which predict that the shorter the interval (i.e., the higher the rate of reinforcement; in this case, the perceived rate of reinforcement), the faster the rate of response. Increased rates of responding on a RI schedule, due to the perception of the interval being shorter than it actually is, and would then reduce the typical RR-RI rate difference, as noted in Chapter 3.

In order to examine potential differences in timing between high and low schizotypy scorers, and given that differences in schedule performance have given rise to these theoretical speculations, it would be useful to further examine human performance on schedules of reinforcement, but specifically those schedules that differ in their required utilization of the factor of time. In fact, in the context of exploring timing behaviour, two schedules have been commonly and extensively used; the fixed interval (FI) schedules, and the differential reinforcement of low rate (DRL) schedules (e.g., Catania, 1970; Gibbon, 1977).

Typically, FI schedules of reinforcement can produce scalloped patterns of behaviour, in which response rates start low immediately after reinforcement, and increase across the trial as the time for the next reinforcement approaches. This pattern is typically seen in nonhumans (Dews, 1978; Reed, 2009). In humans, another common pattern of responding on FI schedules is a constant low rate of responding, in line with participants' perception of a specific amount of time being required to pass before a response is made (see Leslie, 1996, for details of schedule parameters and response patterns). In either of these cases, timing of the reinforcement interval is implicated in the production of the schedule pattern. Similarly, DRL schedules produce low response rates, as they provide for strict control with regard to the consequences of responding. Responding before the required amount of time has elapsed delays the delivery of reinforcement, making timing essential on such schedules.

Given that timing is required for optimum performance on both FI and DRL schedules, it would be useful to examine potential differences between high and low scorers in UE schizotypy on such schedules. Evidence consistent with the timing differences account in high UE scorers, outlined above, could be obtained from analyses of such schedules. Differences in response patterns between high and low UE schizotypy scorers on these schedules could help to outline differences in timing between these populations in terms of under- or overestimation of the passage of time required for optimum performance on these schedules. For example, it could be that high scorers respond later on average on these schedules than low scorers and as such produce lower response rates, or vice versa. Furthermore, comparison of the differences in performance between high and low UE scorers on these two schedules could also highlight any potential influence on schedule performance of other factors, such as 'disconfirmation insensitivity' or 'response-cost' (e.g., Dickinson, 1989; Roper & Zentall, 1999). This view suggests that response rates on schedules of reinforcement are affected by responses that do not directly give reinforcement. This view could also potentially explain the RR and RI response rate differences found between high and low schizotypy scorers reported in chapter 3; increased responding on the RI trial in high schizotypy scorers being a product of insensitivity to responses that are not reinforced, as opposed to low schizotypy scorers maintaining a low response rate, and being more efficient in their responding. Indeed, disconfirmation deficits have been found in deluded subjects (e.g., Hemsley & Garety, 1986; Huq, Garety, & Hemsley, 1988), which is a trait incorporated in the UE subscale of the OLIFE-B (Mason et al, 2005). In the present context, it could be that high and low UE scorers differ in terms of the affect that such non-reinforced responses have on their responding. Differences in performance between FI and DRL schedules, where instances of disconfirmation either do, or do not, delay the reinforcement availability, respectively, could also be highlighted in line with schizotypy scores. If this view is correct, then it would be expected that any disconfirmation differences between high and low schizotypy scorers would be manifest by high schizotypy scorers showing higher response rates than low scorers on a DRL schedule of reinforcement; and more so on an FI schedule of reinforcement, where responding does not delay the availability of reinforcement, but responding before the required interval has passed is not reinforced.

The present studies, therefore, aimed to examine the novel timing hypothesis in high scorers in schizotypy, as measured by the OLIFE-B, on two schedules differing in their response-timing-reinforcement relationship, namely an FI, and a DRL, schedule of reinforcement. It was expected that high scorers in UE would show different response patterns than low UE scorers by underestimating the amount of time that had passed and responding later on average on these schedules. In addition, it was expected that if disconfirmation deficits are responsible for differences in performance between high and low scorers, then this would be evident in the response rate levels between groups. This pattern of results would not be predicted by existing disconfirmation theories (e.g., Dickinson, 1989; Roper & Zentall, 1999).

4.2. **Experiment 5**

Prior to exploration of these potential timing effects, Experiment 5 offered a replication of the impact of UE schizotypy on RR and RI schedules of reinforcement. Previously, those scoring high on the UE scale have shown less differentiation between these schedules in terms of their response rate than low UE scorers (see chapter 3). In addition to replicating this potentially important effect, the current study aimed to explore whether this deficit was also explicit in an inability of high UE scorers to describe the contingencies they had experienced. An ability to describe the contingencies has been linked to the demonstration of the effects in human participants (see Hayes, Brownstein, Haas, & Greenway, 1986). If high UE scorers are predicted not to show the typical RR versus RI response rate effects, and this is related to timing differences in comparison to low UE scorers, then they might be predicted to show less overt ability to describe the RI contingency.

4.2.1. **Method**

4.2.1.1. ***Participants***

The participants were 50 undergraduate Psychology students (25 males and 25 females), recruited through the Psychology Department subject-pool system. The age range of participants was 19 to 25 with an average age of 21.84 (SD = 1.9). No participants reported any history of psychiatric problems.

4.2.1.2. **Measures**

4.2.1.2.1. ***Schizotypy***

The Oxford Liverpool Inventory of Feelings and Experiences - Brief Version (OLIFE-B; Mason et al., 2005) is a 43 item scale consisting of four subscales (UE, CD, IA & IN) designed to measure schizotypy in the normal population. The scale has an internal reliability (Cronbach α) of between 0.62 & 0.8, and a concurrent validity of between 0.9 and 0.94 (UE $\alpha = 0.8$, validity = 0.94; CD, $\alpha = 0.77$, validity = 0.93; IA, $\alpha = 0.62$, validity = 0.91; IN, $\alpha = 0.63$, validity = 0.9; Mason et al, 2005). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the OLIFE-B was comparable to the range outlined above $\alpha = 0.69$.

4.2.1.2.2. ***Depression***

The Beck's Depression Inventory (BDI; Beck et al., 1961) is a 21-item questionnaire that assesses the clinical symptoms of depression through asking about feelings over the past week. The score is a sum of the positive answers, ranging from 0 to 63. The internal reliability (Cronbach α) of the scale is between 0.73 & 0.92, and a concurrent validity of between 0.55 and 0.73 for non-psychiatric subjects (Beck et al, 1988). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the BDI was comparable to the range outlined above, $\alpha = 0.75$.

4.2.1.2.3. ***Anxiety***

The Spielberger Trait Anxiety Inventory (STAI-T; Spielberger, 1983) rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (i.e., trait anxiety). Scores for each question range from 1 = never, to 4 = almost always, and the total score can range from 20 to 80. The internal reliability (Cronbach α) of the scale is 0.93, and a concurrent validity = 0.52 to 0.8 (Spielberger et al, 1970). Measures of depression and anxiety were included as a controlling measure for statistical analysis on hallucinatory reports and schizotypy scores, given that both are associated with the hallucination formation (Freeman & Garety, 2003). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the STAI was comparable to that outlined above, $\alpha = 0.89$.

4.2.1.3. **Procedure**

All participants were seated in a quiet room, in front of a desk and computer (60cms from the monitor), and gave written consent for their participation. Firstly, participants were required to complete the series of questionnaires; this was done to avoid any adverse effects caused by the task influencing participant responses. The

OLIFE-B, STAI-T, and BDI questionnaires were administered and counterbalanced across participants.

Participants were then presented with the instructions before continuing with the computer task. During the computer task, participants were exposed to an RR-30 and RI-yoked pair of schedules four times each. The experimental task was programmed in Visual Basic (6.0), and incorporated two main features. Firstly, the program incorporated an RR-30 schedule, whereby reinforcement (points) would be delivered for any response with equal probability between one response and twice the number of responses specified by the mean schedule value. Secondly, the program incorporated an RI schedule, whereby reinforcement is delivered for the first response following the elapse of the specified period of time. The two schedules were yoked together, whereby reinforcement on the RI schedule would be delivered only following the passing of the amount of time that it took for the corresponding reinforcer to be delivered in the RR schedule. Thus, the two schedules only differed on the rule relating responding to reinforcement, not the rate at which reinforcement was delivered. The presentation of each schedule was 4 minutes long, and the program always presented the RR schedule immediately before the corresponding yoked RI schedule, and each pair of schedules (RR then RI) were presented four times.

Before the experiment began, the participants were presented with a set of minimal instructions for the experimental task: "*The next part of the experiment involves completing a computer task. On the screen you will see a coloured box, a box showing how many points you have and a command button stating "Click here". Your task is to click the command button in order to gain as many points as you can.*

On each click of the button you will either gain or lose points. Begin when you are ready".

After each exposure to a schedule trial, the participants were asked to describe the contingency that they had just experienced. The question was derived from previous research into participants' ability to understand the schedule to which they had just been exposed (e.g., Hayes et al., 1986). This question asked: "*What was the best approach to gaining points in the previous trial?*" The participants then wrote down what they believed to be the best way of scoring points for that trial, and this response was then taken by the experimenter. These responses were later subject to a manifest content analysis. The phases of the content analysis employed were conducted in line with well-established procedures used and recommended by Osborne and Reed (2008), and Vaughn, Schumm, and Sinagub (1996). If the participant's response accurately described the preceding contingency, then 2 points were scored. If the participant's response was thought to partially describe the preceding contingency, then 1 point was scored. Two independent raters completed this procedure to verify the reliability of the coding. A Cohen's kappa analysis was used to check the inter-rater reliability. A high mean level of reliability (0.81) was identified between their separate judgements of the participants' responses.

4.2.2. **Results and Discussion**

Participants were split into high and low scoring groups, according to a median split, for the UE subscale of the OLIFE-B, as described in Chapter 3. A median split design was used, as opposed to a regression analysis, due to the sample size, and also because it is unclear whether or not any relationship between UE and response rates would be linear, or a step function. A group design is neutral with regard to this issue, but a regression analysis assumes a linear relationship which is not certain to be obtained between psychometric functions and performance (see Osborne, McHugh, Saunders, & Reed, 2008). Thirty participants (mean UE score = 0.83 $\pm$ 0.79), were grouped in the low scoring group; the remaining 20 participants (mean UE score = 5.2 $\pm$ 1.1) were placed in the high scoring group.

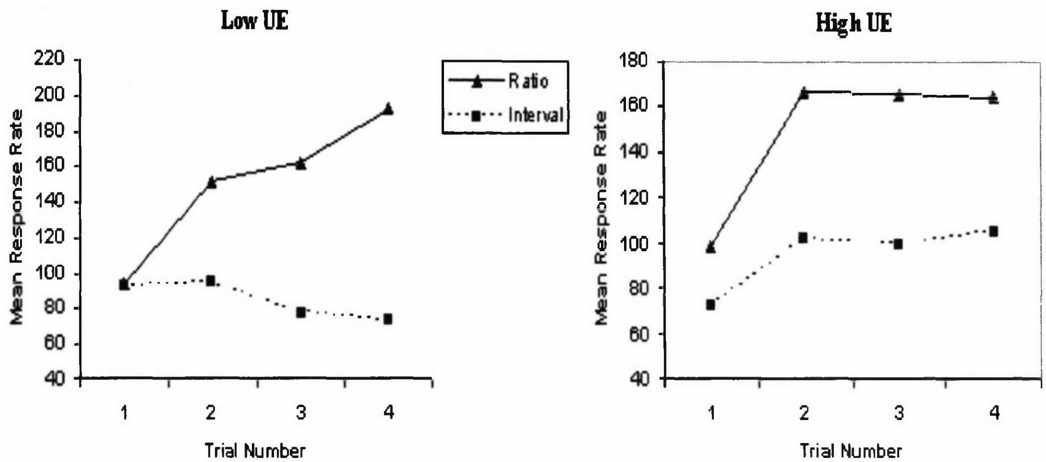

Figure 4.1: Mean number of responses made in each of the 4 ratio and interval trials for low UE scorers (left panel) and high UE scorers (right panel).

Figure 4.1 displays the mean response rates for the four trials of both the RR and the RI schedule for both groups. Inspection of these data shows that, for the low UE group, response rates increased over training for the RR schedule, and decreased for the RI schedule. A similar pattern was seen for the high UE group, but with much less differentiation between the response rates for the two schedules.

A three-way mixed-model analysis of co-variance (ANCOVA) was conducted on the response rates displayed in Figure 4.1, with trial and schedule (RR or RI) as the within-subject variables, group (high UE v low UE) as the between-subject variable, and BDI and STAI-T scores as covariates. This analysis showed a statistically significant main effect of schedule, $F(1,46) = 6.34$; $p < 0.05$, $d = 0.75$, and a statistically significant three-way interaction between schedule, trial, and group, $F(3,138) = 3.58$; $p < 0.05$, $d = 0.56$. There were no other statistically significant main effects or interactions, all *ps* > 0.10, and there were no statistically significant effects of BDI or STAI-T scores as covariates, both *ps* > 0.09.

Planned comparisons were conducted on the RR and RI response rates, collapsed across all trials, for both low and high UE scorers, using the pooled error term from the above ANCOVA, and these comparisons revealed a statistically significantly greater response rate on the RR schedule than on the RI schedule in low UE scorers, $F(1,62) = 6.24$; $p < 0.05$; $d = 0.74$, but no statistically significant difference in response rates between the RR and RI trial for high UE scorers, $p > 0.20$.

The results for the low UE scorers replicate previous findings for response rates maintained by RR and RI schedules matched for reinforcement rate, showing higher response rates for the RR compared to the RI schedule (Raia et al., 2000). They also replicate previous results using these schedules for a high versus low UE comparison, showing schedule differentiation in low, but not high, UE scorers (as in Chapter 3). Thus, the findings that formed the basis of the current investigation were corroborated in this study.

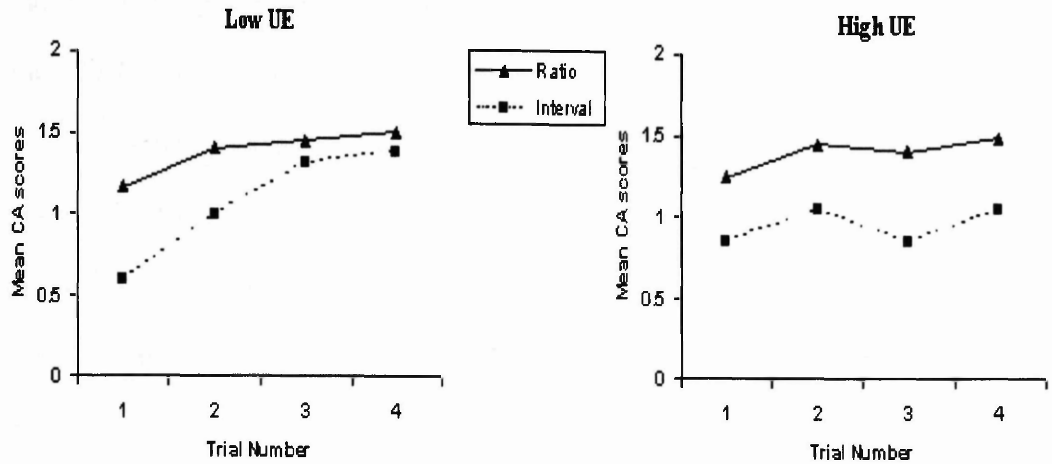

Figure 4.2: Mean contingency awareness scores (CA) made in each of the 4 ratio and interval trials for low UE scorers (left panel) and high UE scorers (right panel).

Figure 4.2 displays the mean contingency awareness scores (CA) across the four trials of each schedule for the two groups. Inspection of these data reveals that, for the low UE group, the CA scores for both schedules grew over the course of training to approximately equal levels. However, for the high UE group, awareness of the RR contingency grew over the course of training, but awareness of the RI contingency did not show this pattern, and levels of contingency awareness remained low relative to that of the RR schedule.

A three-way mixed-model ANCOVA was conducted on the CA scores, with trial and schedule type (ratio or interval) as the within-subject variables, group (high UE v low UE) as a between-subject variable, and BDI and STAI-T score as covariates. This analysis showed a statistically significant two-way interaction between schedule type and group, $F(1,45) = 5.08$; $p < 0.05$, $d = 0.67$, but no statistically significant main effects of schedule or trial, no other statistically significant interactions, and no statistically significant effect of the covariate BDI and STAI-T scores, all *ps* > 0.10.

Planned comparisons carried out on the CA scores, averaged across all four trials, for both low and high UE scorers, and using the pooled error term from the above ANCOVA, showed statistically significantly greater CA scores for the ratio trials than for the interval trials in high UE scorers, $F(1,57) = 4.63; p < 0.05; d = 064$, but there was no statistically significant difference in CA scores between the ratio and interval trials in low UE scorers.

These results show that low UE scorers were able to accurately identify the contingency relating to both the RR and RI schedule. In contrast, high UE scorers were capable of identifying the response-reinforcement relationship on the RR schedule, but had difficulty in doing so on the RI schedule, where allowing time to pass plays a contributory role for optimum performance. Accompanied by the above finding, that the response rates of high UE scorers are not so greatly differentiated on RR and RI schedules, this suggests that high UE scorers have difficulty in both recognizing and incorporating the timing element into their contingency awareness, and RI schedule, performance.

This pattern of results is consistent with the suggestion that high and low UE scorers differ in timing on timing-related tasks. These differences could be in the form of a slower internal clock, memory for the previous periods leading to reinforcement when a response is made or decision-making processes involving comparisons between the current period since reinforcement and previous periods leading to reinforcement, where the periods leading up to reinforcement are judged to be shorter than they actually are by high UE scorers, who then respond sooner accordingly. As a result, response rates that are not differentiable from that of RR schedule performance occurs. It should be noted, however, that the pattern of responding across the RR and RI schedules could also be the product of disconfirmation deficits (although it is unclear why such deficits would specifically impact on contingency awareness related to timing-based schedules). The following experiments turned to more fully examine these theoretical suggestions.

4.3. **Experiment 6**

If high UE scorers have a deficit in their timing performance in comparison to low UE scorers, and this deficit manifests in an underestimation of the passage of time, then it is predicted that high scorers would display lower rates of response on both FI and DRL schedules. However, if a disconfirmation deficit in high UE scorers is the key factor underlying their performance, then it is expected that high scorers would have a greater overall response rate on both the FI, and on the DRL, schedule than low UE scorers; as non-reinforced instances of responding would be more readily discounted, leading to worse schedule control over behaviour.

In addition to the overall rates of response, both of these two schedules of reinforcement allow for a more detailed analysis of the pattern of behaviour displayed, and this more detailed analysis can shed insight into the nature of the temporal control being exerted. FI schedules of reinforcement offer the use of the index of curvature measure (IoC; Fry, 1960), which is a mathematical index of the spread of responding during each FI 'trial'. An IoC value close to 1, indicates that the majority of the responses occurred just before reinforcement, and that responding is being emitted later in the 'trial'; this indicates strong temporal control by the schedule in that responding occurs close to the point at which reinforcement is available. An IoC score of 0 represents exactly even responding throughout the FI interval, and suggests no temporal control of responding. Finally, an IoC score of -1, indicates that the majority of responses occurred just after the previous reinforcement. If there were timing differences for those with high UE scores, in comparison to low scorers, in the form of underestimating the passage of time, as suggested above, it is predicted that higher UE scorers will have lower overall rates of responding, and a higher IoC value, than lower UE scorers.

Inter-response-time (IRT) analysis of DRL schedules, such as that used by Richards and Seiden (1991), which divides the number of responses across a trial into time bins, and then analyzes the mode time bin of responses made, may also shed light on the temporal control seen in this schedule – namely, that a certain amount of time must pass with no responding, before reinforcement becomes available. If high UE scorers do underestimate the amount of time that has passed, then the time bin containing the modal responses will be greater than that in low scorer.

4.3.1. Method

4.3.1.1. Participants and Measures

The participants were 40 undergraduate Psychology students (21 males and 19 females), recruited through the Psychology Department subject-pool system. The age range of participants was 18 to 30 with an average age of 21.28 (SD = 1.83). No participants reported any history of psychiatric problems. The same measures as described in Experiment 5 were employed in Experiment 6.

4.3.1.2. Procedure

All participants were seated in a quiet room, in front of a desk and computer (60cms from the monitor), and gave written consent for their participation in the study. Firstly, participants were required to complete the series of questionnaires; this was done to avoid any adverse effects caused by the task influencing the participants' later questionnaire responses. The OLIFE-B, STAI-T, and BDI questionnaires were administered, in a counterbalanced fashion, across participants. Participants were then presented with the instructions, before continuing with the computer task.

The experimental task was programmed in Visual Basic (6.0), and incorporated two main features. Firstly, the program incorporated an FI 30-s schedule, whereby reinforcement (in the form of points) would be delivered for the first response that occurred whenever 30s had passed since the last reinforcement was delivered (or since the beginning of the trial for the first reinforcement). Secondly, the program incorporated a DRL 10-s schedule, whereby reinforcement was delivered for the first response following the passing of every 10s since the last reinforcement (or since the beginning of the trial in the first instance), providing that no response had occurred within that preceding 10s interval. The presentation of each schedule was 10 minutes long, with each schedule task presented once.

Before the experiment began, the participants were presented with a set of minimal instructions for the experimental task: "*The next part of the experiment involves completing a computer task. On the screen you will see a box showing how many points you have and an instruction informing you to "Press the spacebar to earn points". Your task is to press the spacebar in order to gain as many points as you can. On each click of the button you will either gain or lose points. Begin when you are ready*".

During the computer task, participants were exposed to the FI 30-s schedule followed by the DRL 10s schedule. Finally, participants were fully debriefed, and paid in subject pool credit.

4.3.2. **Results and Discussion**

Participants were split into high and low scoring groups, according to a median split, for the UE subscale of the OLIFE-B as described in Experiment 5. Twenty participants (mean UE score = 1.2 ± 1.06) were grouped in the low scoring UE group; the remaining 20 (mean UE score = 6.1 ± 2.07) were placed in the high scoring UE group.

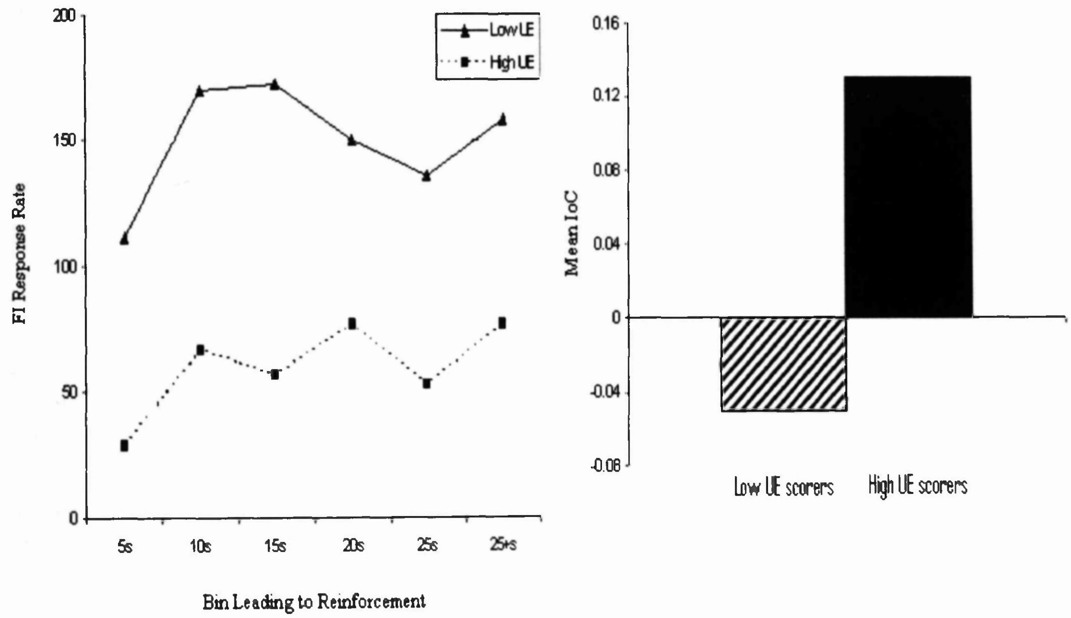

Figure 4.3: Mean number of responses made in each 5 second time bins on the FI schedule for low and high UE scorers (left panel), and the mean IoC for low and high UE scorers (right panel) on the FI schedule in Experiment 5.

Figure 4.3 displays the mean number of responses made in each 5s time bin for the low UE, and high UE scorers (left panel), and the mean IoC for the low and high UE scorers (right panel). Inspection of the left panel of Figure 4.3 shows that responding in both groups tended to start at a relatively low rate (over the first bin), and then become higher across the remaining time bins. In general, the higher UE scores tended to have a lower rate of response than the lower UE scorers, although this effect was not pronounced. An ANCOVA conducted on these data, with the number of responses in each of the six bins on the FI trial as a within-subject variable (trial), UE (high versus low) as a between-subject variable, and BDI and STAI-T score as covariates, showed no statistically significant difference in the number of responses across the six time bins overall, or between high and low scorers in UE, no interactions between the two, and no statistically significant effects of the covariates STAI-T or BDI, all $p > 0.1$.

The mean index of curvature (IoC; Fry, 1960) was calculated using 1s time bins, and this was used as the measure of the spread of responding across each period before reinforcement within the trial. The right panel of Figure 4.3 shows that the mean IoC value was greater for the high UE scorers compared to the low UE scorers; indicating that a greater proportion of the responses emitted by the high UE scorers occurred later in the trial (closer to the time for reinforcement). An ANCOVA was conducted on these data, with UE (high versus low) as a between-subject variable, and BDI and STAI-T scores as covariates, and showed a statistically significantly higher IoC in the high UE scorers than in the low scorers, $F(1,34) = 7.19$; $p < 0.02$; $d = 0.87$, with no statistically significant effect of BDI or STAI-T as covariates, both $ps > 0.80$.

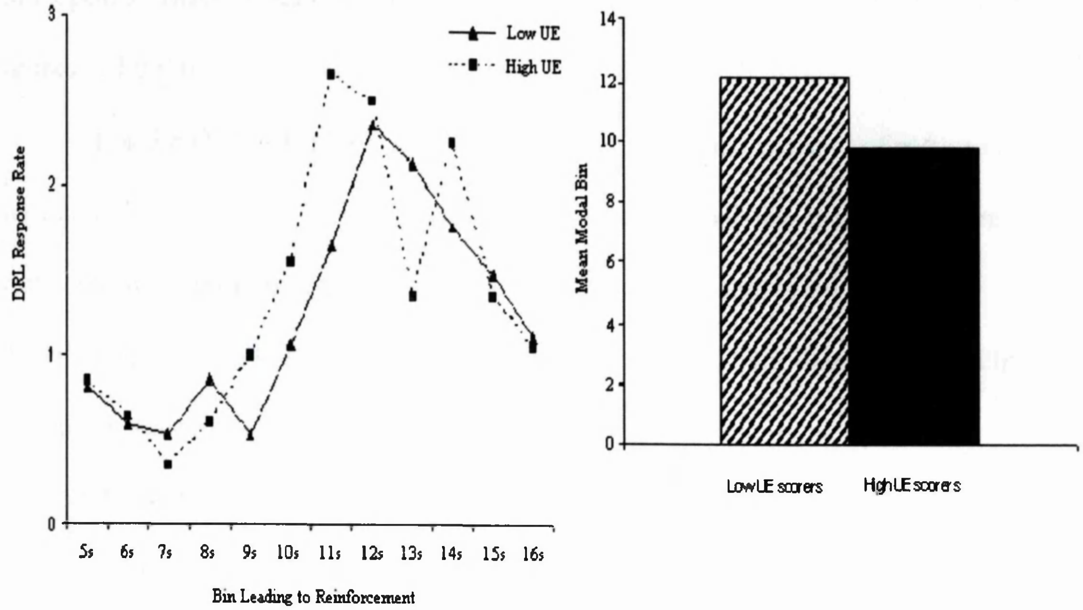

Figure 4.4: Mean number of responses made in each 1 second time bin for low and high UE scorers (left panel) and the mean Mode bin for low and high UE scorers (right panel) on the DRL(10) schedule in experiment 5.

Figure 4.4 displays the mean number of responses made in each 1s time bin for both low and high UE scorers (left panel), and the mean modal bin for both low and high UE scorers (right panel), on the DRL 10-s schedule for Experiment 6. Inspection of the response rate data shown in the left panel reveals an increase in the number of responses made in each bin following the nine-second bin with a peak number of responses emitted in the eleven-second bin for high UE scorers, and a peak in the twelve-second bin for low UE scorers. However, an ANCOVA, with the number of responses made within each of the 1s bins from 5s to 16s as a within-subject variable, UE (high versus low) as a between-subject variable, and BDI and STAI-T scores as covariates, showed no statistically significant effects of the number of responses made in each bin, of UE group, or of the covariates of BDI and STAI-T scores, all $p < 0.3$.

For the DRL 10s phase, the bin containing the modal number of responses was calculated for each individual participant. For this analysis, the 1s to 4s bins were removed in order to avoid the effects of burst responses, as the burst distribution is considered a different characteristic of behaviour than that involving pausing before responding (see Fagen & Young, 1978; Reed, in press). An ANCOVA, with the modal bin in which most responses were made as the dependent variable, UE (high versus low) as a between-subject variable, and BDI and STAI-T scores as covariates, showed no statistically significant difference between high and low scorers in UE, BDI or STAI-T, and the time-bin in which they emitted the mode of their responses, all $p > 0.10$.

Taken together, these results show little support for a disconfirmation view of schedule performance in those with high UE scores. Such a view would predict higher rates of response on the FI and DRL schedules, which was not observed. There was some suggestion of timing differences between high and low UE scorers in these data, with high scorers having a significantly higher IoC for the FI schedule. However, no significant differences in the modal time bin for DRL trial were noted between high and low UE scorers. This lack of a DRL effect could be the result of different mechanisms operating on the DRL and FI schedules, perhaps connected to the stricter temporal parameters for the DRL schedule. In the DRL schedule, premature responses delay the availability of reinforcement, making the response-reinforcement relationship less clear. Alternatively, the lack of an effect on the DRL schedule may simply have been due to the fact that it was presented following the FI schedule. On the FI schedule, responding prior to the time required did not affect the availability of reinforcement, and this learning may have carried through to the DRL schedule (see Reed & Morgan, 2008) making any effects seen on the DRL schedule less clear than they otherwise may have been.

4.4. **Experiment 7**

Experiment 7 sought to replicate Experiment 6, except a counterbalancing procedure was adopted with respect to the orders in which the schedules were presented. This was done in order to reveal if the presentation of one of these schedules before the other plays a role in obscuring potential differences. If this were the case, then a stronger effect for the FI schedule, as described in Experiment 6 (i.e., higher IoC), should be noticed when this schedule was presented first, rather than second. Moreover, an effect of UE on the DRL performance might also be noted if this schedule were presented first, rather than second (as in Experiment 6). Furthermore, if Experiment 7 were to confirm the results of Experiment 6, with respect to response rates, little difference in the overall rates of response should be noted between low and high UE scorers, which would not support a disconfirmation hypothesis interpretation.

4.4.1. **Method**

4.4.1.1. **Participants and Measures**

The participants were 54 undergraduate Psychology students (12 males and 42 females), recruited through the Psychology Department subject-pool system. The age range of participants was 18 to 49 with an average age of 23.17 (SD = 6.26). No participants reported any history of psychiatric problems. The same measures were employed as described in Experiment 5.

4.4.1.2. **Procedure**

The procedure for Experiment 7 was the same as that described for Experiment 6, except that the presentation order for the FI 30-s, and DRL 10-s, schedules were counterbalanced, with 27 participants receiving the FI 30-s schedule before the DRL 10-s schedule and the remaining 27 participants receiving the DRL 10-s schedule followed by the FI 30-s schedule order.

4.4.2. **Results and Discussion**

Participants were split into high and low scoring groups, as described in Experiment 5. Twenty-eight participants (mean UE = 1.61 ± 1.03) were grouped in the low scoring group, whilst the remaining 26 participants (mean UE = 6.31 ± 2.24) were placed in the high scoring group.

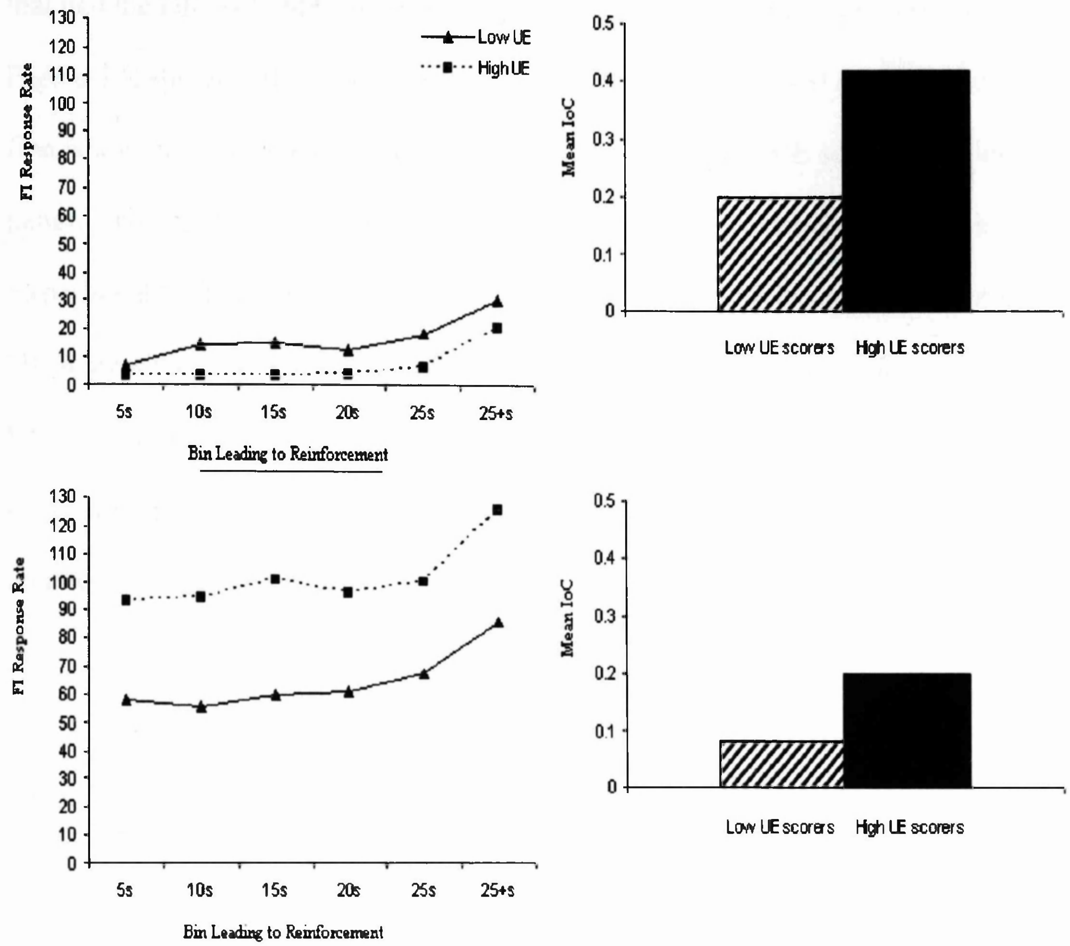

Figure 4.5: Mean number of responses made in each 5 second time bin for low and high UE scorers (left panel), and the mean IoC for low and high UE scorers (right panel), on the FI(30) schedule, for participants presented with the FI schedule before the DRL schedule (top panel) and the DRL schedule before the FI schedule (bottom panel), for Experiment 6.

Figure 4.5 displays the mean number of responses made in each 5s time bin for the low UE, and high UE, scorers on the FI schedule (left panel), and the mean IoC for the low and high UE scorers (right panel). The participants who received the schedules in the FI-DRL order are shown in the top panels of this figure, and those that had the DRL-FI order in the bottom panels. Inspection of the top panels of Figure 4.5, showing the data from those participants who received the FI schedule first, shows a higher response rate on the FI schedule for low UE scorers (top left panel), and a higher mean IoC for high UE scorers (top right panel), as found in Experiment 6. The bottom panels (DRL first) also show a higher mean IoC for high UE scorers (bottom right panel), although the response rates are reversed between the UE groups, and are also larger than the response rates for the FI 30-s first presentation order, compared to the participants who received the opposite counterbalancing order (top left panel).

An ANCOVA conducted on the number of responses emitted, with UE (high versus low) and presentation order (FI – DRL, DRL – FI) as between-subject variables, trial as a within-subject variable, and BDI and STAI-T scores as covariates, showed a statistically significant within subject effect of time bin, $F(1,185) = 3.73$; $p < 0.01$, $d = 0.54$, but no statistically significant effect of UE, $p > 0.4$, the schedule presentation order, $p > 0.8$, or a significant difference between high and low scorers in STAI-T, $p > 0.6$ BDI $p > 0.6$, or any significant interactions between all factors, all $p > 0.4$.

An ANCOVA, with IoC as the dependent variable, the presentation order of the schedules (FI-DRL, DRL – FI) and UE group (high versus low) as between-subject variables, and BDI and STAI-T scores as covariates, showed a statistically significant effect of UE score, $F(1,41) = 4.99$; $p < 0.05$; $d = 0.62$, and presentation order, $F(1,41) = 5.68$; $p < 0.05$; $d = 0.66$, but no statistically significant interactions, or effects of BDI or STAI-T scores as covariates, all $ps > 0.70$. Planned comparison analyses, carried out on IoC scores between high and low UE scorers, for both the FI-DRL presentation order, and the DRL-FI presentation order, showed a statistically significantly greater IoC in high UE scorers, than in low UE scorers, for the FI-DRL presentation order, $F(1,14) = 5.09, p < 0.05, d = 0.9$, but not for the DRL-FI presentation order, $F < 1$.

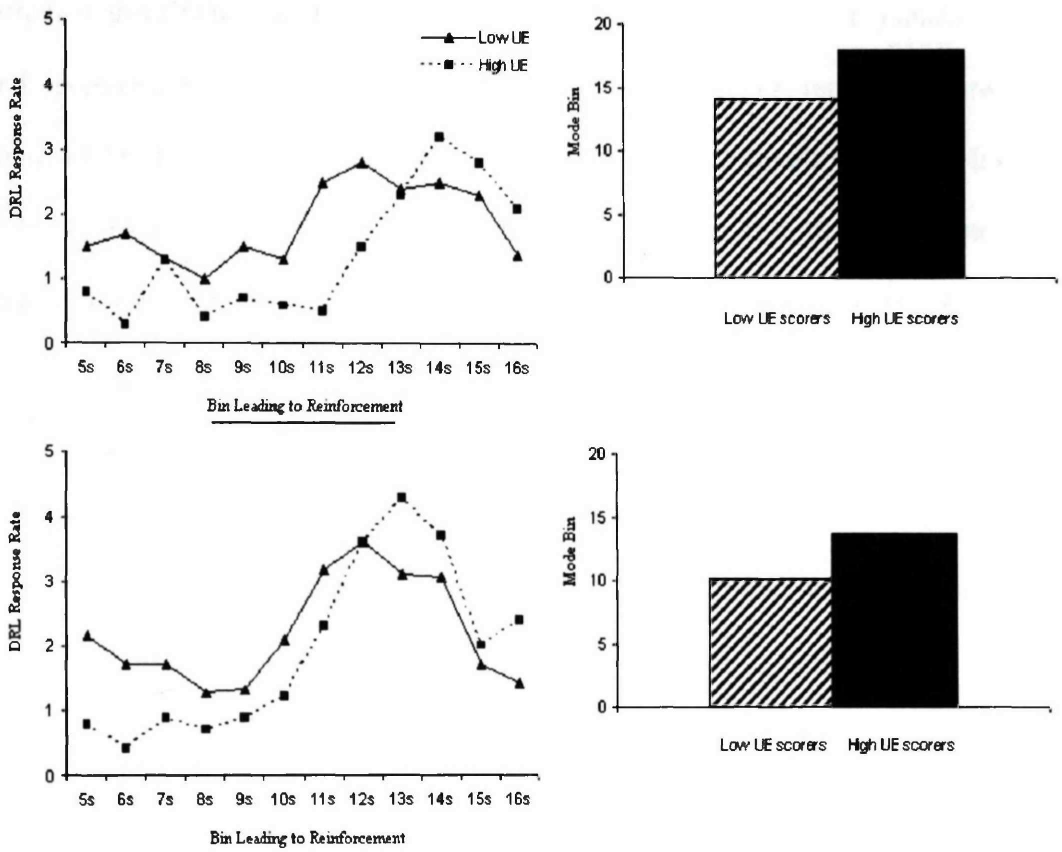

Figure 4.6: Mean number of responses made in each 1 second time bin leading to reinforcement for low and high UE scorers (left panel) and the mean bin in which participants made the mode of their response for low and high UE scorers (right panel), on the DRL(10) schedule, for the FI-DRL presentation order (top panel) and the DRL-FI presentation order (bottom panel) in experiment 6.

Figure 4.6 shows the mean number of responses made in each 1s time bin for both low and high UE scorers (left panel), and the mean modal bin for both low and high UE scorers (right panel), on the DRL 10-s schedule for Experiment 7. The participants who received the schedules in the FI-DRL order are shown in the top panels of this figure, and those that had the DRL-FI order in the bottom panels. As in Experiment 6, the responses made within the first 4s bins were removed in order to avoid the effects of response bursts. Inspection of the left panels show that, for both presentation orders, low UE scorers made more responses until the 12s time bin than high UE scorers, at which point high UE scorers made more responses than low UE scorers.

An ANCOVA, with the time bins from 5s to 16s as a within-subject variable, UE group (high versus low) and the presentation order of the schedules as between-subject variables, and BDI and STAI-T scores as covariates, showed a statistically significant effect of time bin, $F(11,451) = 2.25; p < 0.05, d = 0.42$, but no statistically significant effect of presentation order, UE group, interactions between the two, or BDI or STAI-T scores, on the number of responses in the time bins, all $p > 0.10$.

Inspection of the right panels reveals that high UE scorers made the modal number of responses in a later time bin than low UE scorers for both presentation orders. An ANCOVA conducted on these data, with UE group (high versus low) and presentation order (FI-DRL, DRL-FI) as between-subject variables, and BDI and STAI-T scores as covariates, showed a statistically significant effect of UE on the mean mode-bin, $F(1,41) = 4.1; p < 0.05; d = 0.56$, but no statistically significant effect of the presentation order of the schedules, no interactions between the factors, and no effect of BDI or STAI-T scores, all p's > 0.4. Two planned comparisons analyses, carried out on the mean modal time bin between high and low UE scorers, for both the FI-DRL presentation order, and the DRL-FI presentation order, showed a statistically significantly greater modal time bin in high UE scorers than in low ones for the FI-DRL, $F(1,14) = 6.13$, $p < 0.05$, $d = 0.99$, and for the DRL-FI presentation order, $F(1,14) = 5.4$, $p < 0.05$, $d = 0.93$.

For both the FI and DRL schedule, regardless of the presentation order of trials, there were no significant differences in overall response rates between high and low scorers in UE. This replicates the findings from Experiment 6, and suggests that disconfirmation deficits are not an important factor with regard to differences in performance within the present context. Importantly, however, high UE scorers showed either a significantly higher IoC for the FI schedule, or produced the majority of their responses later on the DRL schedule (an effect that was somewhat more pronounced when that schedule was presented first). This would support the notion of timing differences between high and low UE scorers. The fact that this effect was not observed so strongly when each schedule type was presented second, suggests that with pre-exposure to another schedule confounds the impact of high and low UE scorers. Thus, the current results also suggest (to some extent) that prior learning about one schedule impedes performance on the subsequent schedule (see Reed & Morgan, 2008, for a similar suggestion).

4.5. **General Discussion**

The present series of studies were designed to explore potential reasons for performance differences between low and high scoring UE participants on schedules of reinforcement. The studies produced several findings of interest. Firstly, Experiment 5 replicated the results of the previous chapter (Chapter 3) that show high UE scorers are less able to differentiate between a RR and RI schedule. This attenuated response rate difference was corroborated by the additional, novel, finding of differences in awareness about the RR and RI contingencies; high scorers had significantly lower contingency awareness scores for the RI schedule than the RR schedule. Secondly, Experiments 6 and 7 showed evidence for a timing difference in high UE participants, with high UE scorers making more responses later on an FI 30s schedule, and on a DRL 10s schedule, than low UE scorers; as shown through an IoC analysis, and an IRT analysis, on these schedules, respectively. Thirdly, there were no consistent and reliable differences in response rates between high and low UE scorers on the FI 30s and DRL 10s schedules of reinforcement in either Experiments 6 or 7. This latter result suggests that disconfirmation deficits do not effect responding differentially across high and low UE scorers.

The increased responding on the RI schedule in Experiment 5 in high UE scorers could be explained in terms of differences in timing, whereby high UE scorers, in contrast to low scorers, are unable to recognise the relationship between timing, responding, and reinforcement, and, subsequently, respond more on the RI schedule. Results from Experiments 6 and 7 showed that high UE scorers have a tendency to overestimate time periods, responding later on both schedules than low UE scorers. Together, these results suggest that high UE scorers overestimate the passage of time, and, as such, emit responses later than low scorers do (at least, in the first instance of exposure to a FI or DRL schedule of reinforcement). The timing differences hypothesis is supported by the inability of high UE scorers to accurately describe the RI contingency, despite being able to do so for the RR schedule (Experiment 5). Although somewhat speculative, reasons as to why temporal discrimination occurs in high UE scorers can be suggested.

It is possible that these findings reflect an effectively slower timing mechanism in high UE scorers; with a slower timing mechanism leading to more actual time passing on an FI, and on a DRL, schedule before responding occurred. However, this raises questions regarding learning to time regardless of individual differences in clock speed, as it is possible that these deficits manifest as a result of a breakdown in the processes responsible for comparing the current timed period with previous periods. This is because, regardless of any between-subjects differences noted between high and low UE scorers, in terms of a timing mechanism, the subjective timing experienced by each individual will be the same. For example, if a participant learns that reinforcement will occur following the first response after 30s on a FI 30s schedule, but, due to a deficit in their timing mechanism, they perceive this period as being 25s long, then they will respond accordingly every perceived 25s, which will actually equate to 30s, regardless of this subjective perception. Alternatively, it may be that the timing differences exhibited in the present studies may result from a dysfunction in memory for the amount of time associated with the first reinforcement period, or the decision-making process where comparisons are made between the current timed period and the last period; this will be discussed in more detail later.

Within the context of schizophrenia, it could be speculated that UE-associated traits, such as hallucinations, occur due to a breakdown in the relationship between memory, timing processes, and perception, whereby slower timing interacts with and activates a memory that is misinterpreted as a hallucination in line with source monitoring theories of hallucinations (see Bentall, 2003f). Although this was not the main focus of the current thesis, it is worth noting that several other symptoms of schizophrenia listed in the DSM-IV (APA, 1994) refer to deficits in cognitive processing involving memory and attention, and so complex relationships between misplaced memories manifesting as hallucinations, as a function of timing and perception deficits or bias, such as those shown in experiments involving signal detection theory and word recognition (Bentall & Slade, 1985; Cella et al, 2007), seems to be related to the current findings. Careful consideration of the UE subscale, and associated potential timing differences, may be useful in building a foundation for a better understanding of the influence of timing on hallucinatory content.

Although the present study produces some potentially interesting findings, it is not without its limitations. In Experiment 7, the presentation order of the schedules did affect, to some extent, the findings, but this will be discussed later.

In summary, the present studies demonstrated that high UE scorers showed later responding on FI and DRL schedules, suggesting a tendency toward underestimating the passage of time between reinforcements. In addition, the present experiments failed to show that high UE scorers differed from low UE scorers in terms of disconfirmation - which allows for further research, possibly using different schedule parameters linking timing, performance, and response cost, to explore disconfirmation in schizotypy more thoroughly.

Chapter 5: Testing for Potential Timing Differences Between High and Low Schizotypy Scorers Within Temporal Bisection Tasks.

5.1. Introduction.

In Chapter 3 rates of response were shown to be much higher on a random ratio (RR) schedule than on a random interval (RI) schedule, which was matched for rate of reinforcement, in participants who scored low in schizotypy. However, rates of response did not differ between these two schedules in high schizotypy scorers, particularly for those with high scores on the Unusual Experiences (UE) sub-scale of the OLIFE-B. In Chapter 4, this effect was replicated, and this latter chapter further showed that those who scored high in UE were unable to verbally describe the interval nature of the RI schedule. Moreover, high scorers in UE had different performance profiles to low UE scorers on both fixed interval (FI), and differential reinforcement of low rate (DRL), schedules of reinforcement. In both of these latter schedules, high UE scorers started responding later after the delivery of reinforcement.

The principal difference between the schedules mentioned above relates to their timing properties, that is, whether or not a certain amount of time is required to pass before a response will elicit a reinforcement (RR versus RI in experiments 3, 4 and 5), how much time is required to pass (e.g. 10 or 30 seconds in experiments 6 and 7), and whether or not responding prior to the required time delays reinforcement (e.g. FI versus DRL schedules in experiments 6 and 7). Given the differences between high and low UE scorer's response rates and the differences in the influence of the passing of time on these schedules then, it could be that differences in responding between these groups emerge as a result of differences in the abilities of each group to accurately incorporate timing into schedule performance. Given this suggestion, it would be useful to examine the performance of these groups on timing tasks outside the context of reinforcement schedules, especially as mechanisms, such as response disconfirmation, and reinforcement rates may influence response patterns, over and above the various aspects of timing that could be implicated (cf. Dickinson, 1989; Ferster & Skinner, 1957; Roper & Zentall, 1999). It is also worth noting that, in the schedule tasks used in Chapters 3 and 4, the participants were not necessarily aware of any timing component incorporated in the task. Thus, timing was not an explicitly studied behaviour on those tasks, and any potential deficits in this process are only inferred from patterns of responding, rather than being measured directly. Further, timing while performing on a schedule of reinforcement occurs concurrently with performance on the task, rather than explicitly requiring retrospective timing (see Killeen & Feterman, 1988 for a discussion of the differences induced by these different types of timing tasks). Indeed, several theories of timing suggest that the differences in these two types of task may produce different timing effects (see Wearden, 2001). Given these considerations, it would be prudent to examine any potential differences on a timing task by employing a procedure that removes many other influences on behaviour, and allows for a clearer examination of performance on a timing task between these groups.

Such an approach to the examination of performance on a timing task in high UE populations would be to examine timing *post-hoc*, that is, through the post-presentation judgements of the presentation length of stimuli. One such approach involves the use of a temporal bisection task, such as that developed by Church and Deluty (1977; see also Wearden & Ferrara, 1995, 1996). In these tasks, stimuli are presented for short (S), or a long (L) standard durations during a training phase. In the subsequent experimental phase, the same stimuli are presented for lengths ranging between, and including, these S and L stimuli. The participants are required to press a button corresponding to SHORT or LONG for each of the stimuli in the experimental phase, and the bisection point is then calculated (i.e. the point at which 50% LONG responses are made, or the point at which the probability of making a SHORT or LONG response is equal). Typically, bisection experiments in humans have shown that timing is accurate, although where the bisection point is located depends on the ratio of the S and L range used: stimulus ranges of an L/S ratio of 2:1, or less, tend to show that the bisection point falls closer to the geometric mean than to the arithmetic mean; whilst ranges with a ratio of greater than 2:1, show that the bisection point is to be found closer to the arithmetic mean (Allan & Gibbon, 1991, Wearden, 1991b; Wearden & Ferrara, 1996). In addition to the location of the bisection point, temporal bisection experiment data also allow for the calculation of the Weber Ratio (WR), essentially a measure of timing sensitivity, where smaller values indicate greater temporal sensitivity and can be used as an index of the variability of participants clock speed through the variability of their SHORT or LONG responding for the presented durations (Ferrara, et al, 1997; Wearden, 2004; Wearden, et al, 1997). This stems from the notion proposed by scalar expectancy theory (SET; Gibbon, 1977), of a Poisson emitter where the pacemaker emits pulses at random, but the rate at which this occurs is, on average, accurate (see also, Wearden, et al, 1998). As a result of this assumption, slower pacemaker rates have been shown to produce more variable temporal estimates from trial to trial and as such can be used as an index of pacemaker speed provided that this assumption is maintained (Gibbon, 1977; Wearden et al, 1998).

Performances on several timing tasks have shown differences in the timing behaviour between participants according both to their age and their IQ (Droit-Volet & Wearden, 2001; Wearden, Wearden, & Rabbitt, 1997). Such findings suggest that individual differences may be influential for this aspect of human performance. In addition, research has suggested that schizophrenic subjects display timing deficits on tasks requiring verbal estimates of presentation durations, compared to controls; specifically in the direction of a tendency to overestimate the passage of time across different types of task (Tysk, 1983; Wahl & Sieg, 1980), and also on similar temporal bisection tasks to the ones described above (Carroll et al, 2008; Elevag, et al, 2003). Participants defined as being at 'high-risk to develop schizophrenia' also show an increased tendency toward shorter time estimations for visual stimuli, compared to auditory stimuli presented for the same duration (Penny et al., 2005). Given this, and given that previous research suggests a timing difference exists between high and low scorers in UE (Chapters 3 and 4), it seems that there is some scope for further research into the performance on timing tasks of high UE scorers.

Thus, the present series of studies aimed to examine differences in timing judgements between high and low UE scorers on a series of experiments using a temporal bisection task. Given the previous results noted above (Carroll et al, 2008; Elevag et al, 2003; Tysk, 1983; Wahl & Sieg, 1980; Rammsayer, 1990), and those reported in Chapters 3 and 4, the expectation was that, if timing differences between high and low UE scorers do exist, these would manifest in differences in the observed bisection point of these two groups, and/or differences in the temporal sensitivity displayed on this task, as shown by the Weber Ratio values. In addition, it is predicted that the bisection point location difference between high and low UE scorers would depend on the ratio of the shortest to the longest stimuli that were employed as 'anchor' points. A larger ratio provides the potential for greater differentiation between the longest and shortest stimuli.

These aims were examined through three experiments, utilizing a suitably large ratio size (4:1) of the stimulus used to test for bisection point location differences between high and low UE scorers (Experiment 8), testing the impact on the bisection point of a reduction of the ratio size across two conditions within the same sample (3:1 & 2:1; Experiment 9), and, finally, using a further reduced ratio size (1.6:1) to examine potential disappearance of any differences between high and low UE scorers as the ratio size decreases (Experiment 10). The three larger ratios have been used in the temporal bisection literature previously (e.g., Wearden & Ferrarra, 1996), whilst the additional ratio choice of 1.6:1 was added by the present authors to provide for a ratio size below 2:1.

5.2. **Experiment 8**

Experiment 8 sought to test for differences in bisection point location through the use of a relatively large ratio size (4:1) of the stimulus range used. This value was therefore employed to examine whether this large ratio produces clear differences in the performance on a timing task between high and low schizotypy scorers across a sufficiently clear range of stimuli durations, given that stimulus spacing and range effects can affect the bisection point location(Wearden & Ferrara, 1995; 1996). It was predicted that high UE scorers would differ from low UE scorers in the location of their bisection point if differences in the underlying timing processes of high UE scorers do exist.

5.2.1. **Method**

5.2.1.1. **Participants**

Fifty participants were recruited from the undergraduate population (13 males and 37 females) through the Psychology Department subject-pool system, and all received course credit for their participation. The age range of participants was 18 to 39, with an average age of 21 (SD = 3). No participants reported any history of psychiatric problems.

5.2.1.2. **Measures**

5.2.1.2.1. ***Schizotypy***

The Oxford Liverpool Inventory of Feelings and Experiences - Brief Version (OLIFE-B; Mason et al., 2005): is a 43 item scale consisting of four subscales: Unusual Experiences (UE), Cognitive Disorganization (CD), Introvertive Anhedonia (IA), and Impulsive Nonconformity (IN), designed to measure schizotypy in the normal population. The scale has an internal reliability (Cronbach α) of between 0.62 & 0.8, and a concurrent validity of between 0.9 and 0.94 (UE $\alpha = 0.8$, validity = 0.94; CD, $\alpha = 0.77$, validity = 0.93; IA, $\alpha = 0.62$, validity = 0.91; IN, $\alpha = 0.63$, validity = 0.9; Mason et al, 2005). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the OLIFE-B was comparable to the range outlined above $\alpha = 0.69$.

5.2.1.2.2. ***Depression***

Beck's Depression Inventory (BDI; Beck et al., 1961): is a 21-item questionnaire that assesses the clinical symptoms of depression through asking about feelings over the past week. The score is a sum of the positive answers, ranging from 0 to 63. The internal reliability (Cronbach α) of the scale is between 0.73 & 0.92, and a concurrent validity of between 0.55 and 0.73 for non-psychiatric subjects (Beck et al, 1988). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the BDI was comparable to the range outlined above, $\alpha = 0.75$.

5.2.1.2.3. *Anxiety*

The Spielberger Trait Anxiety Inventory (STAI-T; Spielberger, 1983): rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (i.e., trait anxiety). Scores for each question range from 1 = never, to 4 = almost always, and the total score can range from 20 to 80. The internal reliability (Cronbach α) of the scale is 0.93, and a concurrent validity = 0.52 to 0.8 (Spielberger et al, 1970). Measures of depression and anxiety were included as a controlling measure for statistical analysis on hallucinatory reports and schizotypy scores, given that both are associated with the hallucination formation (Freeman & Garety, 2003). For the current thesis, across the entire sample, the internal reliability (Cronbach α) of the STAI was comparable to that outlined above, $\alpha = 0.89$.

5.2.1.3. **Procedure**

All participants were tested individually in a quiet room, in front of a desk and computer (60cms from the monitor), and gave written consent for their participation. Firstly, participants were required to complete the series of questionnaires; this was done to avoid any adverse effects caused by the task influencing participant later responses. The OLIFE-B, STAI-T, and BDI questionnaires were administered in a counterbalanced fashion across participants.

Participants were then presented with the instructions, before continuing with the computer task. Before the experiment began, the participants were presented with a set of minimal instructions for the experimental task:

"*The next part of the experiment involves completing a computer task. For the first part you will see a square appear for either a "short" or "long" amount of time, your task is to watch these presentations and familiarise yourself with them. In the second part of the experiment you will be presented with more squares, but this time your task is to choose "short" or "long" in line with how long you feel each square was presented for. This process will repeat five times. Begin when you are ready*".

The experimental task was programmed in Visual Basic (version 6.0), and incorporated two main phases. In the training phase, participants were presented with a blank, white screen for 1s. This was followed by the presentation of either the word "Short", or the word "Long", for 1s, immediately before the presentation of a black square on the screen. The square was 86mm x 54mm in size, and was presented in the centre of the screen. The presentation lasted either for 0.2s (following the word "Short"), or 0.8s (following the word "Long"), for five presentations each. The order of the presentations of the short and long stimuli was random. Presentation lengths of less than 1s were used to avoid the effects of chronometric counting (see Wearden, 1991a).

Following the training phase, participants were exposed to the experimental phase. In this phase, following a 1s presentation of a blank white screen, the same square as described above was presented to participants for a time that varied between 0.2s to 0.8s, at 0.1s second intervals (i.e. 0.3s, 0.4s, etc.). Each of the seven possible presentation lengths occurred at random, until each had been presented 10 times. In addition, for each presentation, the words "Short" and "Long" were presented at the bottom of the screen, beneath the letters "z" and "m", indicating the buttons to press if the participants thought the stimulus was either short or long; with "z" and "m" being counterbalanced across participants as to which corresponded to S or L choices.

This training-experimental phase process was then repeated four times for each participant.

5.2.2. **Results and Discussion**

Participants were split into high and low scoring UE, CD, IA and IN groups, according to a median split procedure employed on the entire dataset of the thesis. A median split was used, as opposed to a regression procedure, due to the sample size, and also because it is unclear whether, or not, any relationship between schizotypy and bisection point location would be a linear, or a step function. A regression analysis assumes the former, but a median split is theoretically neutral with respect to this assumption, and so is statistically more conservative (see Osborne et al., 2008, for discussion).

Twenty-six participants were grouped in the low scoring UE group (mean UE = 1.04 $\pm$ 0.81), and the remaining 23 participants were placed in the high scoring UE group (mean UE = 5.79 $\pm$ 2.25 SD). The UE subscale was used for the current analysis alone, as it is this subscale that shown consistent findings with regard to timing performance on the earlier schedule work throughout the thesis.

The bisection point (the point at which 50% LONG responses were made) was calculated for each individual participant using the regression method outlined by Wearden and Ferrara (1996); regressing the data points producing the line of steepest slope, so to provide an objective method to determine individual bisection points, as opposed to the alternative methods of mean interpolation, or individual interpolation of bisection points by eye. LONG responses were used as opposed to SHORT responses as this has been traditional preference in the vast majority of temporal bisection tasks (Allan & Gibbon, 1991; Church & Deluty, 1977; Wearden, 1991b; Wearden & Ferrara, 1995, 1996).

AM = 500, GM = 400	Mean Bisection Point	Mean Weber Ratio
High UE	423.83 (SD = 42.07)	0.3 (0.03)
Low UE	408.68 (SD = 28.16)	0.29 (0.03)

Table 1

Table 1 shows the arithmetic and geometric means of the stimulus range used for this experiment, as well as the bisection point, and Weber ratio values, for high and low UE scorers. The current bisection point location for the L/S ratio of 4:1 was similar to those found in other temporal bisection experiments that have used the same ratio and range of durations (0.2 seconds to 0.8 seconds at 0.1 second spacing; see Wearden, 1991b; Wearden & Ferrara, 1995, 1996), whilst the Weber ratio value in the current experiment is higher for both groups when compared to previous experiments that have calculated this value (e.g. Wearden, 1991b), indicating less temporal sensitivity for both high and low UE scorers on this experiment. These data also indicate that high scorers held numerically greater values for both the mean bisection point and Weber ratios than low UE scorers, and both groups' bisection points fell nearer the geometric mean than the arithmetic mean.

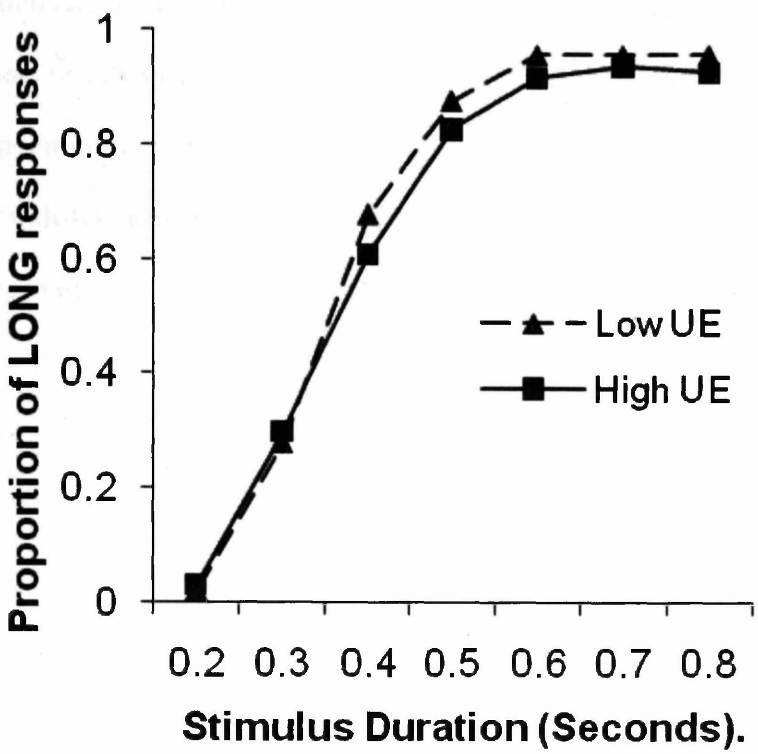

Figure 5.1: Mean proportion of LONG responses plotted against stimulus duration for low (triangle, dashed lines) and high (square, solid lines) UE scorers for a L/S ratio of 4:1.

Figure 5.1 shows the psychometric function (the relation between the proportion of LONG responses made to a stimulus and stimulus duration) for high and low UE scorers.

Separate analyses of covariance (ANCOVA) were conducted on the bisection-point, and Weber Ratio, values with the high and low UE scoring group as the independent variable, and BDI and STAI-T scores as covariates. The ANCOVA conducted on the data from the UE subscale showed no statistically significant differences between high and low UE scorers in their bisection-point location, or Weber Ratio value, and there were no significant effects of depression and anxiety as covariates on either value ($p > 0.15$ for the Weber Ratio, $p > 0.45$ for the bisection point location and $p > 0.3$ for both depression and anxiety scores) .

These results suggest that there are no statistically significant differences in bisection-point location between high and low UE scorers, and as such shows no evidence for differences in timing processes between these groups, at least when the L/S stimulus ratio is 4:1. However, there were numerical differences in the bisection point location between high and low UE scorers and reasons why statistical significance was not found could relate to a larger variance (as indicated by the standard deviations shown in table 1, in the bisection point location for high UE scorers than for lows, although the same was not true for the Weber Ratio scores between these groups.

5.3. **Experiment 9**

Experiment 9 sought to further examine the relationship between schizotypy and timing as assessed by bisection point location, by reducing the ratio of the stimulus range to 3:1, and further still to 2:1, across two conditions. This manipulation was used to extend the generality of the findings noted in Experiment 8. It was expected, in line with previous research showing that a reduced ratio provides for some ambiguity in the bisection point location (see Wearden & Ferrarra, 1996), that the bisection point difference would occur for the 3:1 ratio condition, but that it would be reduced, if present at all, in the 2:1 ratio condition.

5.3.1. **Method**

5.3.1.1. **Participants and Measures**

The participants were 50 undergraduate Psychology students (13 males and 37 females), recruited through the Psychology Department subject-pool system, as described in Experiment 8. The age range of participants was 18 to 27 (mean = 21.17; SD = 2.26). No participants reported any history of psychiatric problems. The materials and stimuli were as described in Experiment 8.

5.3.1.2. **Procedure**

The procedure for Experiment 9 was the same as that described for Experiment 8, except that all participants performed under two conditions (and, hence, the received twice as many presentations of stimuli in total): one consisting of a 2:1 ratio for the presentation lengths of the stimulus range; and one consisting of a 3:1 ratio. The stimulus range was 0.4s to 0.8s for the 2:1 ratio condition, and 0.3s to 0.9s for the 3:1 ratio condition. The presentation of the 2:1 and 3:1 ratio conditions were counterbalanced across participants.

5.3.2. **Results and Discussion**

As in Experiment 8, participants were split into higher and lower scoring UE, according to a median split, with 28 participants grouped in the low scoring group (mean UE = 1.07 ± 0.86), and the remaining 22 participants placed in the high scoring group (mean UE = 4.82 ± 2.22). The UE subscale was used for the current analysis alone as it is this subscale that shown consistent findings with regard to timing performance on the earlier schedule work throughout the thesis. The bisection point (50% LONG responses) for each individual participant, in both the

2:1 and 3:1 ratio conditions, was calculated using the same regression method as described in Experiment 8.

2:1 AM = 600, GM = 565.68 3:1 AM = 600, GM = 519.62		Mean Bisection Point	Mean Weber Ratio
High UE	2:1	579.49 (SD = 34.84)	0.18 (0.03)
	3:1	561.48 (SD = 32.97)	0.23 (0.02)
Low UE	2:1	551.33 (SD = 42.56)	0.19 (0.3)
	3:1	541.49 (SD = 36.25)	0.23 (0.03)

Table 2

Table 2 shows arithmetic and geometric means of the stimulus range used for this experiment, as well as the bisection point, and Weber ratio, values for high and low UE scorers for both the L/S ratio 2:1 and 3:1 conditions. In comparison with other temporal bisection experiments that have used an L/S ratio of 2:1 and the same range of durations (0.4 seconds to 0.8 seconds at 0.1 second spacing) the bisection point values in the current experiment are much similar for both high and low UE scorers (e.g. Wearden & Ferrara, 1996;) whilst the Weber ratio value for the L/S ratio 2:1 condition in the current experiment is higher for both groups in comparison with previous experiments (e.g. Wearden et al, 1997). The bisection point location for the L/S ratio condition of 3:1 are less comparable with other studies, as these have used a stimulus range both smaller (Wearden & Ferrara, 1996) and larger (Penney, Allan, Meck, & Gibbon, 1998), and, thus, report a smaller and larger bisection point values respectively. High UE scorers showed a greater bisection point value than low UE scorers, whilst the Weber ratio was shown to be identical for both high and low UE scorers in the 3:1 ratio condition, but slightly higher for low UE scorers in the 2:1 ratio condition.

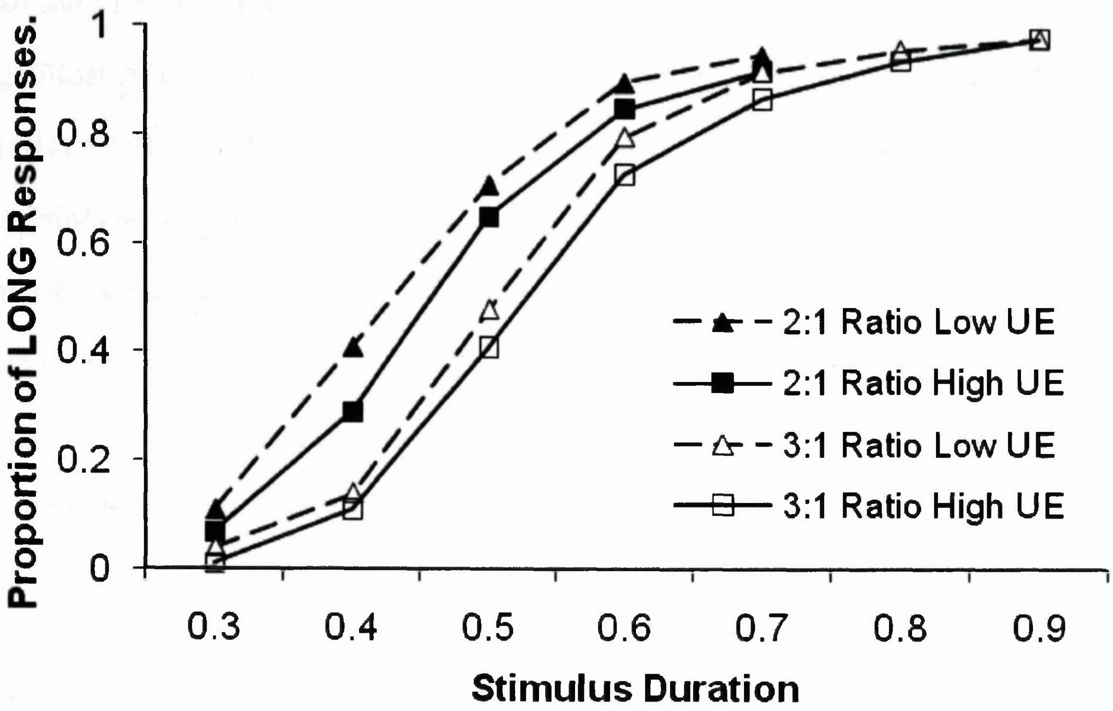

Figure 5.2: Mean proportion of LONG responses plotted against stimulus duration for low (triangle, dashed lines) and high (square, solid lines) UE scorers in both the 2:1 (solid shapes) and 3:1 (hollow shapes) ratio conditions.

Figure 5.2 shows the psychometric function) for high and low UE scorers in the 2:1 and 3:1 ratio conditions. Examination of Figure 5.2 show a slight rightward shift in the psychophysical functions for high UE scorers compared to low, for both the L/S ratio 2:1 and 3:1 conditions. This means that high UE scorers reach the point at which SHORT and LONG responses occur with equal probability (the bisection point) at later durations than do low UE scorers.

A multivariate analysis of covariance (MANCOVA), with the bisection point and Weber ratio values for each of the L/S ratio 2:1 and 3:1 conditions as the four dependent variables, UE score (high versus low) as the between-subject factor, and

BDI and STAI-T scores as covariates was performed and revealed a statistically significant difference in the bisection point location for both the L/S ratio 2:1, $F(1,42) = 7.91; p < 0.01, d = 0.82$; and 3:1, $F(1,42) = 4.95; p < 0.05, d = 0.65$ conditions between high and lows UE scorers. Two follow-up Planned comparison analyses showed a significantly greater bisection point value for high UE scorers than in low UE scorers for both the L/S ratio 2:1, $F(1,42) = 6.49; d = 0.77$, and 3:1 $F(1,42) = 4.26; d = 0.63$, conditions. However, there were no significant differences in Weber Ratio value between high and low UE scorers in either condition.

These results suggest there were differences in the performance of high and low UE scorers on this task; high UE scorers showed less tendency toward responding LONG for shorter durations than low UE scorers, which could be a reflection of differences between these two groups in the degree to which they over- or under-estimate timed durations of a particular length. For example, it appears that low UE scorers judge shorter durations to be longer than they actually are, whilst high UE scorers judge longer presentations to be shorter than they actually are. The reasons as to why this may be the case can be explained in line with theories of timing, which will be discussed later.

5.4. **Experiment 10**

The fact that the L/S ratio conditions of 2:1 and 3:1 used in experiment 9 showed significant differences in the location of the bisection point between high and low scorers, but that this was not so in Experiment 8, where the L/S ratio was 4:1, could mean that the differences in performance on such tasks between these groups only emerge when the L/S ratio is sufficiently low. Experiment 10, therefore, sought to further explore the influence of the ratio of the stimulus range in order to discover whether a high versus low UE difference would manifest as the ratio of the stimulus range decreases below an L/S ratio of 2:1. If the differences shown in the bisection point location shown in experiment 9 do emerge, this could have implications for the environmental contexts in which the timing difference between high and low UE scorers emerge, namely when the timing factors are below a particular threshold.

To this end, a ratio of 1.6:1, with a stimulus range of 0.5s to 0.8s was chosen, and it was expected that high UE scorers would produce a later bisection point location than low UE scorers once again, if the effect was present. In contrast, a difference in bisection point location would not be expected if this range were sufficiently small to allow participants to distinguish between the stimuli used (with just four presentation lengths, and a difference between S and L being just 0.3s). This prediction is consistent with the above theoretical interpretation, because where a reduction in ratio size, difference in the corresponding stimulus range, or subsequent differentiation between the stimuli within the range has been employed previously; bisection point location has markedly shifted (Wearden & Ferrara, 1995, 1996).

5.4.1. **Method**

5.4.1.1. **Participants and Measures**

The participants were 50 undergraduate Psychology students (10 males and 40 females), recruited through the Psychology Department subject-pool system, as described in Experiment 8. The age range of participants was 18 to 35 (mean = 23; SD = 4.33). No participants reported any history of psychiatric problems. The materials were the same as described in Experiment 8.

5.4.1.2. **Procedure**

The procedure for Experiment 10 was the same as that described for Experiment 8, except that the ratio for the stimulus range was 1.6:1, with the presentation lengths ranging from 0.5s to 0.8s. This range was chosen in order to provide a ratio as close as possible to 1.5:1, but also far enough away from 1s to avoid the potential influence of chronometric counting (see Wearden, 1991a).

5.4.2. **Results and Discussion**

As in Experiments 8 and 9, participants were split into high and low scoring groups; 27 participants were placed in the low scoring UE group (mean UE = 1 $\pm$ 0.88), and the remaining 23 participants were placed in the high UE scoring group (mean UE = 5.35 $\pm$ 2.21). The UE subscale was used for the current analysis as it is this subscale that shown consistent findings with regard to timing performance on the earlier schedule work throughout the thesis. The bisection point (50% LONG responses) for each individual participant was calculated, using the regression method used by Wearden and Ferrara (1996), as in the previous experiments reported here.

AM = 650, GM = 632.45	Mean Bisection Point	Mean Weber Ratio
High UE	640 (SD = 0.06)	0.16 (0.08)
Low UE	649.2 (SD = 0.06)	0.16 (0.07)

Table 3

Table 3 shows arithmetic and geometric means of the stimulus range used for this experiment, as well as the bisection point and Weber ratio values for high and low UE scorers. An L/S ratio of 1.6:1 has not apparently been used in temporal bisection experiments previously, but a comparable study is that of Allan and Gibbon

(1991), which showed that the Weber ratio value is considerably lower for an L/S ratio of 1.5:1 than that presented here. Unfortunately, the study by Allan & Gibbon (1991) used durations ranges of differing lengths to those presented here, making bisection point location comparisons difficult. Inspection of these data also shows that low UE scorers had a greater bisection point value than high UE scorers, whilst the Weber ratio was shown to be identical for both high and low UE scorers.

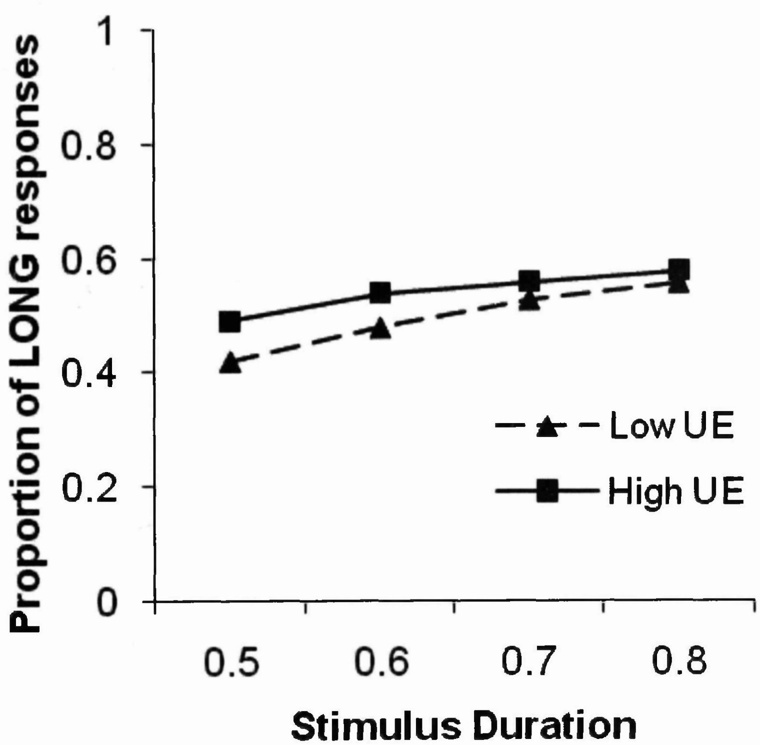

Figure 5.3: Mean proportion of LONG responses plotted against stimulus duration for low (triangle, dashed lines) and high (square, solid lines) UE scorers for a L/S ratio of 1.6:1.

Figure 5.3 shows the psychometric function (the relation between the proportion of LONG responses made to a stimulus and stimulus duration) for high and low UE scorers.

A MANCOVA was conducted with the bisection-point, and Weber Ratio values as the dependent variables, high and low UE scoring group as the independent variable, and BDI and STAI-T scores as covariates and showed no statistically significant differences between high and low UE scorers in their bisection-point location or Weber Ratio value (both P's > 0.3) as well as no significant effect of depression and anxiety as covariates on either value (both P's > 0.3).

These results suggest that there are no differences in bisection-point location between high and low UE scorers and as such shows no evidence for differences in timing processes between these groups, at least when the L/S stimulus ratio is 1.6:1.

5.5. **General Discussion**

The current series of experiments sought to investigate whether high UE scorers differ in terms of their performance on an explicit timing task compared to low UE scorers. This followed from the results of several studies that implied that such a difference might exist (see Carroll, Boggs, O'Donnell, Shekhar & Hetrick, 2008; Elevag, McCormack, Gilbert, Brown, Weinberger & Goldberg, 2003; Tysk, 1983; Wahl & Sieg, 1980; Rammsayer, 1990; Chapters 3 and 4). The present results produced several findings of potential theoretical significance with regard to: the bisection point location differences between higher and lower UE scorers; and the relationship between the ratio of the stimulus range used.

For the majority of the L/S ratio conditions presented in Experiments 8, 9 and 10 the bisection point was located nearer to the geometric mean than to the arithmetic mean for both high and low UE scorers, except for when the L/S ratio was 2:1 and 1.6:1, with high UE scorers had a bisection point closer to the arithmetic mean. The location of the bisection point in the current series of experiments is similar to those that have used the same L/S stimulus ratios and range, and which have also noted that the location of the bisection point generally falls somewhere between the geometric and arithmetic means (Wearden, 1991b; Wearden & Ferrara, 1996).

There were no statistically significant differences in the Weber ratio values between high and low UE scorers in the current series of experiments suggesting that there are no differences in the variability of timing between high and low UE scorers. However, the Weber ratio value did decrease as the L/S ratio did in line with previous research implying that timing becomes more sensitive as the ratio decreases (Ferrara, Lejeune & Wearden, 1997; Wearden, Rogers & Thomas, 1997). High UE scorers typically had a greater bisection point location than low UE scorers, although this was only statistically significant when the L/S ratio was 2:1 and 3:1 (Experiment 9). This means that high UE scorers are more likely to reach the point that SHORT and LONG responses occur with equal probability later than low UE scorers, and that high UE scorers show less of a tendency toward responding LONG, a finding typically reported on this type of task where timing has been examined within the general population and between-subjects differences such as personality characteristics have not been considered (Wearden, 1991a, 1991b; Wearden & Ferrera, 1995, 1996). In turn, this suggests that there may be conditions under which there are differences in the temporal perception of high and low UE scorers. However, the fact that only the L/S ratio 2:1 and 3:1 conditions showed a statistically significant difference limits the conclusions that can be drawn from the current series of studies as the evidence put forward here relates to very specific and limited circumstances.

Nonetheless, there is a relatively consistent pattern of a higher bisection point value in high UE scorers over low UE scorers on temporal bisection performance when the L/S ratio is 2:1, 3:1 and, although not statistically significant, when it is 4:1, which warrants speculation as to why these differences emerge. According to SET, timing takes place through a series of processes, including a clock process, a memory process, and a decision-making process (Gibbon, 1977; see also Allan & Gibbon, 1991; Wearden, 1991a, 1991b). The clock process itself is made up of a pacemaker, which generates pulses at some high rate, a switch activated in the presence of a timing signal, which allows these pulses to flow to an accumulator, which accrues the pulses emitted for a to-be-timed duration, the value for which is then transferred to a working memory component and compared with the representations of S and L in reference memory. In addition, this model operates on the assumptions that the memories for the S and L standards are on average accurate, but have the form of Gaussian distribution of values for each, which may differ from the mean, and from each distribution a representation of s* and l* is sampled (Wearden, 1991b).

The current findings cannot be attributed to differences in clock speed given the lack of differences shown between groups in the Weber ratio value, suggesting no differences in the variability of clock speed between high and low UE scorers (Ferrara et al, 1997; Wearden, 2004; Wearden et al, 1997). Differences in the Weber ratio value would point toward more variable accumulator values in the current experiments, which, in turn, would suggest a greater variation in clock speed between high and low UE scorers (Gibbon, Church & Meck, 1984; Droit-Volet & Wearden, 2001).

On a temporal bisection task, the decision to respond SHORT or LONG is made by comparing the current value in working memory with the memory representation for the standards s* and l* in reference memory, where the similarities of the current duration to the standards are then compared accordingly; if the similarity ratio of s* to T is less than the similarity of T to l* then the subject responds LONG and vice versa (Wearden, 1991b). Although there does also appear to be some bias toward responding LONG on these types of task (Wearden, 1991b; Wearden & Ferrera, 1995). Expressed formally, a SHORT response occurs when:

$$D(s^*,T) < D(T,l^*)$$

Where D(s*, T) is a difference judgement between the memory representation for the SHORT standard, s*, and the current duration, T, and the memory representation for the LONG standard, l*, and T. Similarly, a LONG response then occurs when

$$D(T,l^*) < D(s^*,T)$$

Explanations as to why difference in the location of the bisection point exist between high and low UE scorers can be explained in line with the memory and decision making processes of the SET model. Based on the above equations a greater bisection point location would be found if participants are selecting a longer memory representation from the s* memory distributions, or shorter memory representations from the l* memory distributions, when making the comparison with T. If either of these are occurring, then the differences between l* and T, or s* and T, will be reduced leading to inaccurate SHORT or LONG responses, accordingly. Given that the bisection point locations for all of the L/S ratio conditions used in the current experiment fell below the arithmetic mean – meaning that LONG responses are more likely to emerge for shorter durations (i.e. below the arithmetic mean) – it is more likely that the latter of these are occurring, that is; a tendency toward sampling shorter values from the l* memory distribution, but slightly less so in high UE scorers, who exhibit the emergence of LONG responding for slightly longer stimuli durations.

An alternative explanation centres on a bias toward responding LONG when the differences between s* or l* and T are unclear, such that subjects respond LONG when:

$$|D(s^*,T) - D(T,l^*)| < x$$

Where x is some kind of ambiguity value, where a greater x reflects greater ambiguity in the similarities of s* and l* to T, and results in more LONG responses, and, thus, lower bisection point values (Wearden, 1991b). With regard to the current series of data, this would mean that high UE scorers have a lower value for x than low UE scorers and thus produce a higher bisection point by showing less of a bias toward responding LONG. Moreover, the bias toward responding LONG in the study by Wearden (1991b) was unexplained, and the current results could offer one potential explanation for this bias in terms of memory sampling. One approach toward answering exploring this notion could be to compare high and low UE scorer's performance on a temporal generalization task (Church & Gibbon, 1982; see also Wearden 1991b, 1992). Temporal generalization experiments operate similarly to temporal bisection experiments, but, as opposed to identifying the shortest and longest durations of a range as the standards and then making comparisons between their representations of these durations and the other durations between them, the mid-point duration of a range is identified as the standard and participants are then required to judge whether the rest of the durations above, below and equal to the standard are the same, or not (Church & Gibbon, 1982; see also Wearden 1991b, 1992). Conventional analysis of temporal generalization tasks using the "modified Church and Gibbon" model (MSG; Wearden, 1992 from Church &Gibbon, 1982) utilizing the temporal generalization gradient (proportion of "yes" or "same" responses against stimulus duration) of the data identify differences in performance on this task as resulting in either differences in the memory representation of the standard duration or in a decision threshold of the comparison between the standard and current duration (Wearden, 2003). Temporal generalization experiments conducted between groups in line with age and IQ show that very old and very young participants show less accurate performance on this task than participants in between whilst participants with a low IQ also show less precise timing than those with a high IQ (Wearden, 2003; Wearden, Wearden & Rabbitt, 1997). Moreover, these results are attributed to differences in the memory representation for the standard (Wearden, 2003; Wearden, Wearden & Rabbitt, 1997), as a result, if high and low UE scorers differ in timing due to similar differences in the memory representation for the standard then similar results on a temporal generalization task would be expected.

A third explanation involves an alternative suggestion as to what individuals are actually comparing the current time, T with; namely, some memory representation of the central tendency of all the durations presented as opposed to those of the standards S and L (Wearden & Ferrara, 1995). Here, subjects respond LONG when:

$$\frac{t - M}{t} > b$$

where t is the current duration, M is a measure of the central tendency of all the stimuli durations and b is a fixed threshold value. Subjects then respond SHORT when:

$$\frac{t-M}{t} < -b$$

With regard to those instances of ambiguity between t and M the model then responds LONG and SHORT with equal probability when:

$$-b < \frac{t-M}{t} < b$$

If comparing the current duration T with a measure of the central tendency of all the stimuli durations, then it would be expected that high and low UE scorers differ in their representation of that central tendency (M), or again in their ambiguity threshold value (b). For example, if high UE scorers have a greater ambiguity threshold value, then they would make less LONG responses than low UE scorers. Alternatively, it could be that the ambiguity threshold value for both high and low UE scorers is the same, but their measure of central tendency differs where, for example, a lower value of M for low UE scorers leads to a greater likelihood of a LONG responses being emitted for shorter durations.

Whatever the exact nature of the timing processes occurring on temporal bisection tasks, it seems that high and low UE scorers show some evidence of differing in the memory and/or decision making processes used in performing timing judgements on a temporal bisection task. Although this is a potentially interesting avenue for further research, the current series of experiments leave several questions unanswered. Firstly, if timing differences occur as a result of differences in an ambiguity threshold value, then the question remains as to why this may differ between high and low UE scorers? Secondly and similarly, if low UE scorers show more of a tendency toward selecting a shorter value from the l* memory distribution then again why should this tendency occur and why should high UE scorers show a less of a tendency toward this affect? Finally, if subjects are comparing the current duration with a central tendency value for all of the durations as opposed to the standard S or L values then why should these central tendency values differ?

There is no obvious answer from the current data for any of these questions, which are also made more complicated by the conflict between different theories of timing, and further still by debate as to the underlying mechanisms for each theory in turn. For example, the Learning to Time theory (LeT; Killeen & Feterman, 1988; Machado & Keen, 1999), argues that timing occurs in terms of a chain of behavioural states initiated by environmental stimuli, with each state holding associative links with available responses (see Machado & Keen, 1999). In terms of the present bisection task, these associative links are argued to differ in strength between each behavioural state and the responses available (i.e., SHORT and LONG), with earlier behavioural states in the chain more strongly linked to the SHORT response, whilst later behavioural states are more strongly linked to the LONG response. In this context, it seems that high UE scorers show stronger associative links between the SHORT response and behavioural states later in the chain, than low UE scorers, suggesting interesting potential for research into the relationship between schizotypy levels and the strength of associative links between behavioural states and responding. This suggestion, again, may be useful to examine in terms of decision-making as research into delusions have shown that deluded subjects make probabilistic judgments more quickly, and with less evidence, than non-deluded subjects (Huq et al., 1988), but can also be excessive in changing their choices on reasoning tasks (Garety et al., 1991). This apparent deficit in high scorers regarding underlying mechanisms that link responses to other factors could extend to the relationship between the strength of associations between behavioural states and the SHORT and LONG responses made on a temporal bisection experiment, although without further examination of this concept, this link should be regarded with caution.

However, there is some scope for an exploration of timing in the context of SET and schizotypy given that SET proposes memory and decision-making components for timing processes and deficits in these areas have been shown in schizotypy scorers (Bentall et al., 1991; Brebion et al. 1998, 2000a, 2000b; Rankin & O'Carroll, 1995; Heilbrun, 1980; Lenzenweger & Gold, 2000; Morrison & Haddock, 1997; Tallent & Gooding, 1999). For example, memory deficits have been found in studies using participants with both schizotypal personality disorder (Lenzenweger & Gold, 2000), and non-clinical schizotypals (Tallent & Gooding, 1999). Moreover, a number of studies have shown that individuals prone to hallucinations, such as high UE scorers, have difficulty in remembering their own previously emitted statements (Heilbrun, 1980), sometimes attributing them to be those of others (Allen et al, 2006; Johns & McGuire, 1999), have mistaken the experimental phase in which stimuli have been presented (Bentall et al., 1991; Brebion et al., 1998, 2000a, 2000b; Rankin & O'Carroll, 1995), and have given lower confidence ratings that they emitted previously generated words (Morrison & Haddock, 1997). Given then that memory and decision making deficits occur in other experimental areas in individuals prone to hallucinations, it could be that similar processes are at work when these individuals compare their memories for previously timed durations with the current one. Indeed, studies of temporal bisection performance between schizophrenics and non-clinical controls have implicated the memory component of SET in performance differences on these tasks (Carroll, Boggs, O'Donnell, Shekhar & Hetrick, 2008; Elevag, McCormack, Gilbert, Brown, Weinberger & Goldberg, 2003).

Although producing some interesting findings, there are some further questions produced by the present studies that need to be mentioned. The S and L standards for each of the experiments were not anchored, with the S standard ranging from 0.2s to 0.5s, and the L standard being either 0.8s or 0.9s. This was done to allow for the ease of manipulation of the ratio values required for the experiment, whilst remaining consistent with the 0.1s stimulus spacing for each experiment. Anchoring S and L standards would have resulted in differing stimulus spacing between each experiment, which would have made the findings difficult to interpret, given the influence of stimulus spacing effects on bisection-point location (see Wearden & Ferrarra, 1996). This could be a potentially interesting avenue for further research.

However, the present study did show consistent bisection point location differences between high and low UE scorers which may suggest an avenue for further research to benefit the schizotypy field and the timing field also – it could be that different groups of subjects perform timing tasks in different ways and examination of this notion could lead to a clearer idea of exactly which processes are correct when measuring temporal bisection performance. On the other hand, the statistical differences between high and low UE scorers found here were only present under very specific circumstances, namely when the L/S ratio conditions were 2:1 and 3:1. Why these differences might occur may benefit from further experimental manipulation of the bisection procedure used, such as by manipulating the spacing or range of the durations presented between the standards whilst keeping the L/S ratio values the same.

Chapter 6: General Discussion.

1. Aims of the thesis

The present thesis aimed to explore potential for differences in timing between high and low scorers on a self-report measure of schizotypy, the OLIFE-B, with particular focus on the unusual experiences (UE) subscale. This investigation was conducted within the context of exploring hallucinations and delusions through a neo-realist framework of consciousness, albeit at a tentative foundation level. This view suggests that properties of past experiences are strongly temporally linked to the current environment, with these properties interacting with those of the current environment to produce hallucinations.

Chapter 2 aimed to illustrate the usefulness of the OLIFE-B, within the current context, as a tool for examining differences in the number of false word reports (a model for hallucinations) between high and low scorers on the UE subscale, and the potential relationship between the concreteness/imagery context of the presented words, and the content of the false word reports.

Chapter 3 explored differences between random ratio (RR) and random interval (RI) schedule response rates between high and low schizotypy scorers when performing on yoked RR-RI schedules of reinforcement. In addition, this chapter aimed to investigate differences between high and low UE scorers in terms of their schedule contingency awareness, as a means of examining the extent to which behaviour, within a temporal context, is overtly recognised by individuals, or occurs without awareness of the environmental contingency.

Chapter 4 aimed to expand on the findings of Chapter 3 by exploring UE differences on two schedules of reinforcement with a strong temporal element (fixed interval, FI, and differential reinforcement of low rate, DRL). These schedules were employed to establish whether any differences that were noted were, indeed, the result of timing differences, as opposed to other deficits implicit in RR and RI performance, such as disconfirmation, as the primary factor responsible for any response rate differences noted within the schedule context in Chapter 3.

Chapter 5 then aimed to explore differences in timing performance between high and low UE scorers by removing the schedule context, and focusing on performance within a 'pure' timing task, in order to highlight the nature of timing differences with relation to the Weber ratio and bisection point.

The overall aim of the thesis, thus, was to show that high schizotypy scorers differ in their performance on temporal tasks from low schizotypy scorers. As noted above, this possibility was examined within a framework of hallucinations and delusions, designed to provide a foundation for the future research into these experiences, in line with temporal differences in high schizotypy scorers, as a contributory mechanism linking previous experiences to the current environment, and facilitating hallucinatory and delusional experiences.

2. Results from the thesis.

Chapter 2 examined the occurrence, and content, of auditory hallucinatory experiences in non-clinical participants, scoring high or low on the OLIFE-B measure of schizotypy. Participants listened to 10, one-minute recordings of white noise, some of which contained embedded concrete or abstract words (Experiment 1), or high or low imagery words (Experiment 2), and the participants recorded the words that they thought that they had heard. In Experiment 1, high scorers on the UE scale of the OLIFE-B reported hearing more words that were not actually present, relative to low scorers. In addition, high scorers in UE showed a bias toward making hallucinatory reports of an abstract type, over a concrete type, of word, compared to low UE scorers. In Experiment 2, more low visual imagery false reports were made than high ones in high UE scorers, but there were no significant differences between high and low UE scorers. In summary, the results from the current Chapter 2 suggest a bias toward more hallucinatory reports in high scorers in schizotypy, particularly of an abstract or low imagery type. These results are somewhat consistent with other reports in that individuals more prone to hallucinations make more false reports (Barber & Calverley, 1964; Bentall & Slade, 1985; Johns & McGuire, 1999), and they are, at least, in line with research that calls into question the relationship between imagery and hallucinatory experiences (Bentall & Slade, 1985; Heilbrun et al, 1983; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972; Posey & Losch, 1983; Slade, 1976). Regardless of imagery levels, however, such differences are usually found in the number of hallucinatory reports between high and low schizotypy scorers (Bentall & Slade, 1985; Cella et al, 2007; Merckelbach and van de Ven, 2001; Posey & Losch, 1983; Tsakanikos & Reed, 2004, 2005a; Tsakanikos, 2006).

These findings satisfy the aims of Chapter 2, set out above, in that high scorers on the UE subscale of the OLIFE-B were more likely to make false reports than low scorers, showing the usefulness of the OLIFE-B in this context. These results also shed some light on the relationship between hallucinatory reports and imagery/concreteness, with low imagery/abstractness seemingly more associated with the tendency to hallucinate.

Chapter 3 examined differences between high and low scorers on four schizotypy subscales (unusual experiences, cognitive disorganisation, introvertive anhedonia, and impulsive non-conformity) when responding on RR, and yoked RI, schedules of reinforcement, as a means to explore the relationship between the personality characteristics of schizotypy and performance on schedules of reinforcement. The results obtained from these studies showed, overall, a higher rate of responding on the RR, than the RI schedule, consistent with differences in performance normally observed between these schedules (Catania, Matthews, Silverman & Yohalem, 1977; Ferster & Skinner, 1957; Peele et al, 1984).

However, these response rate differences were dependant on whether or not the participants scored higher or lower on the schizotypy subscales, as well as the specific schedule parameters between the schedules. Specifically, high scorers on the UE subscale of the OLIFE-B were the only group in Experiment 3 not to show differences in schedule performance, suggesting high scores on this subscale are linked to altered RR and RI performance. Experiment 4 explored this finding further using different schedule parameters, and confirmed that high scorers in UE did not differ in response rates between the two schedules. In particular, this failure to display response rate differences was produced by higher rates of responding on the RI schedule in high UE scorers. These findings fall in line with theories of hallucinations and delusions that argue that these experiences are determined by a deficit in distinguishing between internally and externally generated events (Bentall et al, 1991; Bentall et al, 1994; Frith, 1992; Kinderman & Bentall, 1996), as high schizotypy scorers are unable to distinguish between a reinforcement schedule where reinforcement depends entirely on their own responding, and one where reinforcement depends on an external element that is not under their control. Given that the external element required for optimum schedule performance on the RI schedule is the passing of time, it could be that the increased likelihood of hallucinatory reports to be made in high schizotypy scorers is influenced by deficits in timing.

Chapter 4 further explored the issue of timing differences between individuals with high and low UE scores within the context of reinforcement schedules. Experiment 5 corroborated the results found in Chapter 3, that performance on RR and RI schedules of reinforcement differed in participants who scored high and low on UE. High scorers showed less differentiation between the schedules, and, in addition, it was noted that they could not explicitly describe the interval-based (RI) schedule contingency. This means that, not only are high UE participants unable to distinguish between schedules that require allowing time to pass from those dependent solely on their own responding for optimum performance through their response rates, but that these participants are also unable to overtly describe reinforcement contingencies with a temporal element, whereas they remain capable of doing so for a contingency that relies solely on their own responding. This suggests that high UE scorers are less sensitive to the influence of time on such schedules, and that this deficit extends beyond response rate differences to conscious awareness of temporal requirements.

Experiments 6 and 7 in Chapter 4 further explored the relationship between schizotypy, timing and behaviour, by examining responding on both a FI, and a DRL, schedule of reinforcement. Index of curvature analysis for the FI schedule, and inter-response time analysis for the DRL schedule, demonstrated that high scorers in UE responded after a longer period of time had passed than low scorers (although this finding was dependent on the presentation order of the schedules). Taken together these results are consistent with a timing difference between high and low scorers in UE because, in both of the schedules exerting temporal control, high

UE scorers tended to respond later during the periods leading toward reinforcement, suggesting that these participants allow more time to pass before judging that it is appropriate to respond. Timing differences were also thought to be a possible result of a deficit in the memory or decision-making processes associated with comparing the current timed period with those presented previously.

Chapter 5 found, in further examining the nature of timing in high UE scorers, as postulated through the differences established in the previous chapters, that high scorers in UE showed some evidence of a temporal difference in performance when compared to low UE scorers. Stimuli ratio manipulations were made across three experiments, and the results showed that high UE scorers on the OLIFE-B held a significantly greater bisection point than low UE scorers, but only when the stimuli ratio manipulations were 2:1 and 3:1 (Experiment 9). No differences were found between high and low UE scorers in the Weber ratio values thus indicating that there were no differences in the speed of the internal clock between these populations. These findings suggest that high UE scorers have a tendency to make less LONG response for shorter timed periods and were discussed in line with the scalar expectancy theory of timing (Gibbon, 1977), and the memory and decision-making processes that this theory advocates (Wearden, 1991a, 1991b; Wearden & Ferrara, 1995).

Performance on the pure timing tasks presented in this chapter provide some support for the notion of timing differences between high and low UE scorers, as high UE scorers reached the point at which SHORT and LONG responses are made with equal probability later than low UE scorers, as shown by the psychophysical functions presented in chapter 5. This suggests that, when timing stimuli observations, high UE scorers show less of a tendency toward responding

LONG for shorter stimuli than low UE scorers do. These results were taken to reflect potential differences in the way in which memory and decision-making processes for the current and previously timed periods occur, through either differences in the memory representations of the standard or the decision threshold for the current versus previous period comparison. However, it is also important to note that the results found in this chapter occurred under a very specific set of circumstances, that is, when the stimuli ratios were 2:1 and 3:1, but not when they were 1.6:1 or 4:1.

3. Main Conclusions

The current thesis provides some potential indicators regarding several points regarding unusual experiences and timing, supporting some areas of previous research, and forwarding thinking regarding some existing discrepancies within the literature.

3.1 *Schizotypy and hallucinations*

The experiments presented in Chapter 2 support previous research into the occurrence of hallucinatory experiences in a population that report a heightened proneness to such experiences as measured by the UE subscale (Mason et al., 2005; Stirling, Barkus & Lewis, 2007). In particular, these experiments reflected previous findings that utilised a white noise, or similar procedure, that provides perceptual ambiguity, and stimulation of the environment, in examining the occurrence of hallucinatory experiences. That is; subjects more prone to hallucinatory experiences make more hallucinatory reports, compared to those less prone to such experiences, within ambiguous sensory situations (Cella et al, 2007; Margo et al,1981; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972).

Consideration of the specific effects of different types of word shown in Chapter 2 allows some speculation about the nature of such false positive reports. Abstract or low imagery words were more likely to be emitted in their absence than concrete or high imagery words, and that this tendency was more pronounced in high UE scorers. This suggests that hallucinatory content holds a bias toward being of an abstract/low imagery kind. This finding is in line with previous research that has called into question the importance of high imagery as an influence on the content of hallucinatory experiences (Bentall & Slade, 1985; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972; Posey & Losch, 1983). Moreover, it seems, given the present results from Chapter 2, that there may be a bias toward hearing words that are not tied to the 'highly visual' for their meaning (i.e. words which do not activate precise visual representations); the added stimulus-bound, or visual, dimension of concrete or high imagery words, did not increase the likelihood of 'hallucinating' these types of words. Indeed, auditory hallucinations are the most common types of hallucinations (Bentall, 2004), and can be experienced under varying complexity, such as in the form of meaningful sentences (Stephane et al,, 2003), requiring a number of abstract/low imagery words, as opposed to concrete/high imagery words, which would mean hallucinations occurring in the form of lists of objects.

These data also support previous findings that suggest that hallucinations occur as a result of a bias toward interpreting internally generated verbal events as perceptual experiences within the specific experimental context, possibly as a function of a "supra-modality" mechanism (Tsakanikos & Reed, 2005b). Although found in different modalities to previous work (e.g., Tsakanikos & Reed, 2005b), the current experimental context demonstrated a bias toward reporting verbally represented words that were not present, within the same word context (i.e. abstract hallucinations in the context of abstract words), suggesting a bias toward self-generated words over those presented. Such a supra-modality mechanism would suggest a pre-existing bias toward attributing self-generated events to perceptual experiences, which, in turn, has implications for the influence of an individual's previous experiences. It could be that previous experiences of making such false attributions account for the re-occurrence of such experiences, which suggests an influence of past events on current hallucinatory experiences.

In addition, Chapter 2 further validated the OLIFE-B as a measure of schizotypy within this context, illustrating that high UE scorers make more hallucinatory-like experiences than low UE scorers, which would be expected. This is a useful finding for the OLIFE-B, as it has yet to be thoroughly validated in terms of novel experimental contexts, in which high scores would be expected to facilitate the occurrence of hallucinatory-like experiences, such as within the current white-noise context (cf. Cella et al, 2007; Margo et al, 1981; Merckelbach and van de Ven, 2001; Mintz & Alpert, 1972; Skirrow et al,, 2002).

3.2 *Timing deficits*

Previous research into timing with schizophrenic patients has argued that these patients tend to overestimate the passage of time during prospective timing tasks, such as those requiring the subject to respond when they believe a specified amount of time has passed (see Tysk, 1983; Wahl & Seig, 1980). During these tasks, the patients tended to overestimate the amount of time that had passed (allowing more time to pass than that specified), which has been taken as evidence of a slower timing mechanism in the schizophrenic populations (Tysk, 1983; Wahl & Seig, 1980). Such a slower timing mechanism in high UE scorers would mean that these subjects allow more time to pass during periods before responding than would normally be expected.

However, although the results from Chapters 4 and 5 support the notion of timing differences between high and low UE scorers in that the high UE scorers tended to respond later in the periods prior to reinforcement on the timing schedules in Chapter 4 than low UE scorers, whilst Chapter 5 showed that high UE scorers tend to make less LONG responses than low UE scorers for SHORT stimuli presentations, these results cannot be attributed to clock speed. This is because there were no differences in the WR values of the bisection experiments in Chapter 5 between high and low UE scorers and thus no evidence for clock speed variability between groups and in therefore, no evidence for clock speed differences between groups.

However, the findings of Chapter 4 may also be taken to reflect a memory, or a decision-making, deficit in high UE scorers, with regard to comparing the current timed periods with those presented previously, rather than a slower internal timing mechanism *per se*, as the subjective timing experience of each individual would be the same across the schedule employed, regardless of UE score. This would suggest that memory and decision-making processes associated with comparing previously timed experiences with current ones are influential in producing a timing difference in high UE scorers. For example, it could be that high UE scorers over-estimate previously timed periods, and match current timed periods accordingly, resulting in later responding on temporal schedules of reinforcement. Alternatively, it may be that high UE scorers show a bias toward over-estimating timed periods in comparison to those presented previously through a tendency to "jump to conclusions" in a similar way to delusion formation (Fear & Healey, 1997; Peters et al,, 1997; Huq et al, 1988; Garety et al, 1991; Garety & Hemsley, 1994)

The use of the SET model in explaining timing includes a decision-making component, exploration of which might allow for some indication of the similarities between decision-making on timing tasks and in terms of delusions. The results from Chapter 5, in accordance with arguments derived from SET accounts of temporal bisection performance (Wearden, 1991b; Wearden & Ferrara, 1995) offer three potential explanations for a greater bisection point in high UE scorers than in lows. Firstly, if participants are responding SHORT when

$$D(s^*,T) < D(T,l^*)$$

and LONG when

$$D(T,l^*) < D(s^*,T)$$

where D(s*, T) is a difference judgement between the memory representation for the SHORT standard, s*, and the current duration, T, D(T, l*) is a difference judgement between the memory representation for the LONG standard l* and the current duration T, then a greater bisection point for high UE scorers could be due to less of a tendency for high UE scorers to sample shorter durations from the l* memory distribution than low UE scorers, where this specific explanation it more likely given that all the bisection point locations for the L/S ratios fell below the arithmetic mean and thus made LONG responses were more likely to be made for shorter durations. Secondly, if participants are responding LONG when

$$|D(s^*,T) - D(T,l^*)| < x$$

where an ambiguity value x is included in the formal equation; with a greater x reflecting greater ambiguity between the two difference judgements (Wearden, 1991b), then the results observed in Chapter 5 could be due to a lower ambiguity value x which results in less of a tendency to respond LONG for SHORT durations. A third explanation involves an alternative explanation to what individuals are comparing the current duration with on temporal bisection tasks, where the comparison of the current time, T, are thought to be made with some central tendency value, M, of the whole range of stimuli. Here, individuals respond LONG when

$$\frac{t - M}{t} > b$$

or SHORT when

$$\frac{t - M}{t} < -b$$

where t is the current duration, M is a measure of the central tendency of all the stimuli durations and b is a fixed threshold value. Here, if high UE scorers have a greater threshold value, b, or a greater value of M, than low UE scorers, then less LONG responses for shorter durations would emerge. However, these speculations as to what could be occurring during temporal bisection performance between high and low UE scorers in line with the SET model of timing leave more questions than answers. Nonetheless, there is some evidence for timing differences between high and low UE scorers and exploration of differences between high and low UE scorers on the specifics of these tasks may highlight, or eliminate, the potential for a relationship in the underlying mechanisms of decision-making in terms of delusion formation and timing.

Indeed, considering the results of Chapter 5 in line with SET highlights possible differences in the memory and decision-making processes associated with the SET model and suggest that high and low UE scorers may differ in their memory representations for previously timed periods when comparing those periods with that in the current environment. More specifically, it could be that, on temporal bisection tasks, high UE scorers differ from low UE scorers by having a lower ambiguity threshold for LONG responses thus making more LONG responses. Alternatively, it could be that, alternatively to comparing the currently timed period with the S and L standards, both high and low UE scorers are comparing the currently timed period with some central tendency value of the stimuli range, with low UE scorers exhibiting a lower central tendency and thus allowing them to make more LONG responses for shorter durations than high UE score.

It is also worth noting that there are differences in the types of timing occurring between the types of task in these chapters: with schedule performance (Chapter 4) requiring participants to respond at the end of a timed period and without prior instructions to time; whilst the bisection task (Chapter 5) requires participants to view a timed presentation and then make a judgment post-hoc according to a prior timing instruction (i.e. to make a SHORT or LONG response in line with how long they felt each square was presented for)..

With regard to previous findings in schizophrenic patients, only the former type of task was found to highlight a timing deficit in patients, whilst the latter type of task has shown mixed results (cf. Tysk, 1983; Wahl & Seig, 1980). However, in these previous experiments, participants were asked to estimate, when asked, how much time had passed since they had entered the room, during which time they had been required to complete several other tasks (Tysk, 1983; Wahl & Seig, 1980). The nature of this particular task actually involves no active measuring of time by the participant, and may have been influenced by the cognitive demands of the concurrent tasks (Wahl & Sieg, 1980). Indeed, cognitive demands such as the attention to a situation have been implicated in affecting the perception of time (see Wearden, 2001).

The present methodology used in this thesis holds an advantage over these previous studies as they implement stricter controls over additional variables that may influence temporal processes on timing tasks; for example, by examining timing at a level below that of chronometric counting, whereby participants have a pre-existing representation of a time period, such as 1s. Longer periods of time estimation, as used previously, have different variance properties of timing mechanisms than those implied by SET (Rakitin, Gibbon, Penney, Malapani, Hinton, & Meck, 1998), and are considered unique to human timing (Wearden, Denovan, Fakhri, & Haworth, 1997).

3.3. ***Neo-realism and other views of bizarre events***

The current studies provide some initial support for the, admittedly speculative, neo-realist account for consciousness put forward by Tonneau (2004). This view suggests that conscious experiences are strongly linked to the importance of the objects of attention, their multiple properties, their placement on the temporal path (when they were attended to), and the temporal links between these properties and the current environment. Similarly, other theories of hallucinations and delusions also argue for the influence of previous and current environmental properties, albeit using different terminology and slightly different theoretical methodologies (e.g. Frith, 1979; Grossberg, 2000).

The results obtained in Chapter 2 illustrated the influence of the current environment on the types of hallucinatory reports, in the terms of word context; with abstract/low imagery words being more likely to be reported overall, and, particularly, low imagery words being more likely to be reported within the trials containing low imagery presentations (see Section 3.1 above). This seems to suggest that environmental properties, such as the degree of concreteness, or imagery for words in this instance, has some affect on the types of false reports made. However, although these findings provide some positive support for this neo-realist (and similar approaches), much more exploration is required to give a thorough, and convincing, explanation of the influence of environmental properties on hallucinatory content, not least because of the limitations of these findings, which will be discussed later (section 4.1). Nevertheless, in support of theories that highlight the interaction between the current environment and previous experiences, the findings presented in Chapter 2 do provide some scope for future research into the influence of environmental properties on hallucinatory content.

Secondly, the evidence obtained from Chapters 4 and 5 shows temporal differences between high and low UE scorers potentially in the form of differences in memory and decision-making processes associated with the SET model of timing. This may shed light on the neo-realist account for hallucinations (Tonneau, 2004) in two ways. Firstly, it could be that the same types of memory and decision-making processes regarding the properties of previous experiences and their relationship with the current environment may be involved in timing processes. Secondly, it could be that differences in the memory and decision-making processes involved with timing between high and low UE scorers contribute to the formation of hallucinations and delusions by affecting the interpretation of the current environment and facilitating the interference of the properties of previous experiences. This would relate to previous explanations of hallucinations, such as that internally generated events are mistaken for those of current perceptual experiences in terms of a supra-modality mechanism (Frith, 1979; Tsakanikos & Reed, 2005b; West, 1962, 1975). Support for this view come in the form of memory and/or decision-making deficits between past and present properties possibly facilitating earlier cross-modal experiences emerging within the current environment.

The current findings also have implications for other explanations of hallucinations. The temporal factor implicated for UE by the current results provides an explanation of how hallucinatory content is determined that is in line with 'seepage theories' of hallucinations; whereby, preconscious material intrudes into consciousness. Additionally, these data could be construed as support for subvocalisation theories that argue for the influence of internal speech on auditory hallucinatory content (Frith, 1979; West, 1962, 1975; Gould, 1948, 1949, 1950; Green & Preston, 1981; McGuigan, 1966). In both cases, and with reference to the current experimental context, it could be that preconscious internal speech intrudes on current environmental perceptions, as facilitated by stronger temporal links between the current environment and properties of previous experiences.

Perhaps the theory for hallucinations that most benefits from the current research however is Grossberg's (2000) top-down (cognitive representations through sensory perception) approach. This theory argues for hallucinatory occurrence as a breakdown in the comparison between previously learned mental representations and the current environment, where decreased vigilance during the learning of these mental representations influences that comparison and subsequent hallucination formation. This is somewhat akin to the properties approach of the neo-realist account for consciousness, albeit from the internal standpoint of mental representations, and attempts to account for how some mental representations are more likely to give rise to hallucinations through vigilance during the learning of those representations. However, more detailed analysis of Grossberg's (2000) model would require some exploration of the strength of participant's mental representations of particular content, which may prove difficult to measure.

The remaining theories of hallucinations mentioned in Chapter 1, such as the simple conditioning, and imagery, theories, are not as well supported by the current findings. Simple conditioning theories of hallucinations suggest that such experiences can be learned. The current findings do little to support this suggestion, but there could be some scope for future examination in line with a temporal perspective, in terms of the potentially reinforcing effects of the re-occurrence of particular themes or content of hallucinations. Although elaborating on this suggestion, at this stage, would be purely speculative. Imagery theories are let down somewhat by the tendency for high UE scorers in Chapter 2 to report words that were more abstract, or lower in imagery, than concrete of high imagery words. This seems to suggest that imagery has little to do with the occurrence of hallucinations, at least in the auditory modality, although some researchers have suggested that although vivid imagery may not be a sufficient explanation alone for hallucinations, it is a necessary component (Merckelbach & van de Ven, 2001; Mintz & Alpert, 1972). With this in mind, it may be that imagery simply does not feature as an important contributor to hallucinations within the current context, but, of course, it may feature more prominently in other contexts.

The current thesis also allows some discussion of other views of bizarre experiences in terms of human schedule performance, especially in relation to the influence of the effects of 'disconfirmation' or 'response cost' (Dickinson, 1989; Roper & Zentall, 1999). The findings reported here could not be regarded as advantageous to theories of disconfirmation, but rather, the present series of results, suggest that timing processes more influential than disconfirmation in human schedule performance, certainly within the context of UE schizotypy.

This suggestion follows most strongly from the findings reported in Chapter 4, in that response rates did not differ between high and low UE scorers on FI and DRL schedule performance, but there were differences in the spread of responding, with high UE scorers making the majority of the responses on these schedules later than low UE scorers. This is particularly important with regard to the DRL schedule, as each response that is not reinforced has a higher response-cost, as it delays the delivery of the next reinforcement. As a result, if high UE scorers were affected by a disconfirmation deficit, in contrast to low UE scorers, then they would have performed less well on the DRL schedule. However, the fact that response rates did not differ between high and low UE scorers suggest no differences between the effects of disconfirmation on performance, whilst differences in the spread of responding between both groups add support for an increased influence of timing within this context.

3.4 ***Schedules of reinforcement***

Beyond the findings in terms of unusual experiences and timing, the current series of studies also sheds some light on human performance on reinforcement schedules. Although schedules of reinforcement produce consistent and reliable behaviour patterns in non-humans (Ferster & Skinner, 1957), results from experiments with human subjects have shown less consistent results (see Raia et al., 2000; Reed, 2001).

However, the findings from Experiments 3 and 4 in Chapter 3, and Experiment 5 in Chapter 4, showed greater response rates on the RR than on RI trials, as is typical of response patterns on these schedules in the non-human literature (Ferster & Skinner, 1957; Nevin, Grace, Holland, & McClean, 2001; Peele et al, 1984). Although schizotypy, and the temporal element of the RI schedule, have been argued to be a causal factor of the response rate differences, there are several other procedure factors employed in the current studies that may have helped to promote this pattern of responding in the human participants. The use of a discriminative contextual stimulus, in the form of a different coloured square for the RR and RI schedules, may have aided differentiation between the two contingencies (Dack, McHugh, & Reed, 2009; Raia et al, 2000). In addition, schedule differentiation, at least in the low UE scorers in Experiments 3, 4 and 5, most likely made use of meaningful reinforcers in the form of points, negative response cost for those responses not reinforced, and minimal instructions given to participants at the beginning of the study, all of which have been shown to affect human performance on reinforcement schedules (Hayes et al, 1986; Lowe, Beasty & Bentall, 1983; Raia et al, 2000; Reed, 1999, 2001; Rosenfarb, Newland, Brannon & Howey, 1992), whilst one or more of these features may be inhibited somehow in high UE scorers. However, the lack of differences in response rates between high and low UE scorers on the DRL and FI schedules used in experiments 6 and 7 in Chapter 4 suggest that the contributions of the above mentioned schedule features may be more complex in DRL and FI schedules performance in high and low UE scorers.

In general, however, schedule performance was consistent with other experiments using human participants when the schedule contingencies were RR yoked to RI, and other influences of schedule performance such as response cost and minimal instructions were controlled for (Hayes et al, 1986; Lowe et al, 1983; Raia et al, 2000; Reed, 1999, 2001; Rosenfarb et al, 1992). These response patterns were also consistent with those of non-human species (Ferster & Skinner, 1957; Peele et al., 1984).

However, evidence from the current thesis also suggests that differences in personality constructs, such as schizotypy (and its underlying mechanisms), may account for some inconsistencies in human performance in schedules of reinforcement. Chapter 3 showed that low UE scorers could differentiate between a RR and RI yoked schedule of reinforcement, in terms of their response rates, having a significantly higher response rate for the RR schedule than the RI schedule. However, this chapter also showed that high UE scorers could not so differentiate the schedules. On the surface, this implies that high UE scorers hold some underlying deficit that accounts for an inability to perform accordingly to reinforcement schedule parameters. However, it is also important to note here that the level of UE score may not be the cause of this tendency to under-perform on reinforcement schedules, but this may be a 'knock on' effect of some other underlying mechanism, such as, in this case, timing processes.

In addition to the observations concerning response rates on these schedules, a further discrepancy in terms of the literature on human and nonhuman schedule performance is also addressed with regard to the contingency awareness scores seen in Chapter 3. One of the reasons put forward as an explanation of the lack of consistent and reliable performance on reinforcement schedules in humans is that of the influence of verbal rule formation, over and above contingency shaped behaviour (see Hayes et al, 1986). In this context, low UE scorers were able to accurately describe the schedule contingencies following their performance within those schedules, whilst high UE scorers were only able to accurately describe the RR contingency. Taken together, this may suggest that verbal rules are formed as a result of contingency shaped behaviour (Rosenfarb et al, 1992; Shimoff et al, 1986), and that high UE scorers are unable to correctly describe reinforcement contingencies that have a temporal element. Although this seems to support the notion that verbal explanations of contingencies are shaped by schedule contingencies themselves, further exploration is required beyond the schedule context used here and particularly with regard to behaviour and contingency awareness across trials. It could be that initial contingency awareness or verbal rule formation prior to, or resulting from the first exposure to one type of schedule contributes to moderate changes in behaviour upon the next exposure, which, in turn, strengthens the verbal explanation, which, again, strengthens performance, and so on, providing more of an interactive relationship between contingency shaping and verbal rule formation to influence performance (Bentall, Lowe & Beasty, 1985; Catania, Matthews & Shimoff, 1982; Hayes et al, 1986; Lowe et al, 1983; Raia et al, 2000; Rosenfarb et al, 1992; Shimoff et al, 1986).

4. Limitations and Future Studies

The limitations of the current thesis relate to the interpretation of data as hallucination-like (see Section 4.1), unanswered questions regarding the mechanisms of theories of timing (see 4.2), the theoretical relationship between timing and the environment (see 4.3), and with regard to some existing debate on methodological issues regarding the categorising of high and low schizotypy scorers (see 4.4). Although these concerns are presented as limitations, they do not invalidate the current thesis, because, regardless of their interpretation, the studies here shed light on the different processes at work in schizotypy scorers, and provide some scope and suggestions to further explore the unanswered questions more thoroughly.

4.1 ***Hallucinations***

Findings reported in Chapter 2 suggest that high UE scorers make more false reports of words than low UE scorers. This finding has some merit, but requires further exploration before drawing firm conclusions. This is because there are some issues underlying the validity of participant's responses, and in defining them as 'hallucinations' in the strictest sense of the word.

Although these false reports appear hallucination-like, in that they are reports of words heard that are not actually presented, the underlying mechanisms of the occurrence and maintenance of these reports may be more complex than initially thought. Each false report occurs as a direct result of a presented word embedded within white noise. As a result, and in contrast to the false report being a hallucination *per se*, it could be that false reports are generated as a result of mishearing the presented words, and, although participants were given the instruction not to guess if they were unsure of the presented word, the results here could simply reflect the kind of jumping-to-conclusions bias associated with delusions and the UE subscale (Fear & Healey, 1997; Peters et al, 1997; Huq et al, 1988; Garety et al, 1991; Garety & Hemsley, 1994), or another cognitive deficit involved with processing auditory stimuli. In addition, simply instructing participants not to guess may not be sufficient to prevent them from doing so, and, indeed, if cognitive processing deficits are at work here, participants may not even be aware that they are guessing the words they are hearing.

Furthermore, any conclusions made about the nature of hallucinations as a whole are limited, as the words presented in the current Chapter 2 did not occur 'naturally', but within a specific environmental context, and generalising these findings to hallucinatory occurrences outside the laboratory is, therefore, should be undertaken with some caution.

4.2 ***Timing Studies***

Although the present series of studies highlighted potential timing differences in relation to levels of proneness to UE, these findings are restricted in that, although there is a timing difference, they do little to shed more light on competing theories of timing that may provide the precise nature of timing differences in high UE scorers. However, examining individual differences in timing dependent on schizotypy levels could add support to some timing theories, specifically, in a number of ways as outlined below.

Firstly, several existing timing theories attempt to account for the influence of Weber's Law, exemplified, in this case, by the requirement that the standard deviation of the time estimates made by the participants increases as a linear function of the mean (see Wearden, 2003). With this in mind, it would be useful to examine the relationship between the standard deviation and the mean time estimates in high UE scorers, in comparison with those seen in low UE scorers. This could be done by comparing time estimates along larger time scales than used in the current study between high and low UE scorers. This could shed light on the existence of a linear relationship between the mean and standard deviation in high UE scorers relative to low scorers. It could be that any linear relationship is distorted in high UE scorers, possibly dependent on the size of the time scales that are used, and this would suggest that differences in timing between high and low UE scorers may be dependent on the size of the temporal task under scrutiny. For example, differences in temporal performance between high and low UE scorers may differ between timing tasks that have small time periods, such as those used in the bisection task here, and with larger time periods that require timing across seconds or minutes. Alternatively, it may be that an interaction between the Weber's Law function and schizotypy could provide a new dimension in human timing research

The present studies do not account for the learning of similarly timed periods, such as the presentations of stimuli for the same length on more than one occasion in the bisection task here (e.g., learning that each 0.3 second period are the same), and it may be that discrepancies between high and low UE scorers arise due to a deficit in high UE scorers learning about novel time presentations. It could be that high UE scorers will make time estimates closer to that of low UE scorers with greater exposure to the experimental presentation lengths, but, although there is some evidence for deficits with regard to some types of learning, such as emotion-based learning (Cella, Dymond & Cooper, 2009), learning and UE scores remain an unexplored area.

Further examination of the initial timing differences between high and low schizotypy scorers are necessary to establish the ecological validity of the current finding; that is, how far do these timing differences extend to everyday situations, such as keeping appointments, and allocating time for tasks? Indeed, the current findings may be usefully explored in terms of the types of prospective memory tasks that have shown to be affected by high schizotypy scores (Wang et al., 2008). In addition, further exploration of timing differences between high and low scorers in more ecologically valid tasks may shed light on the circumstances under which these differences emerge and effect behaviour. This is particularly pertinent given the very specific set of circumstances under which timing differences were found in chapter 5; when the L/S stimulus ratio were 2:1 and 3:1.

Finally, although the present thesis used the SET model of timing (Gibbon, 1977) in exploring the data in Chapter 5, it was not the intention to use the findings of the thesis to support a particular theory of timing. However, exploring timing within a context of schizophrenia/schizotypy may be useful in examining specific theories of timing, such as SET (Gibbon, 1977), or BeT (Killeen & Feterman, 1988), as this may have implications for the nature of schizotypy, and also schizophrenia, as a timing deficit may underpin some of the perceptual and cognitive deficits noted in these populations. For example, differences in timing may explain why hallucinations occur, with current perceptual inaccuracies being a product of hallucination sufferers needing more time to accurately understand the current environment, or to make comparisons between the current perceptual environment and properties of previous experiences, or self-generated events (Frith, 1979; Tsakanikos & Reed, 2005a; West, 1962, 1975). In addition, there are some points that arise from these data that are worth a brief note in this regard. Firstly, three of the five timing theories discussed in the introduction incorporate a memory function in describing the timing process (MTS, Staddon & Higa, 1999; TTM, Staddon et al, 2002; SET, Gibbon, 1977). Although these theories differ in terms of the exact nature of the memory function, the findings from Chapter 2 could be argued to suggest a role for a memory component; hallucinatory experiences were in the form of actual words that were known to participants but which were not present in the environment – more recently presented words influenced false reports. The fact that participants made such false reports suggests that hallucinatory reports may, to some extent, be dependent on the participant's vocabulary, which may, in turn, depend on memory for timed periods, such as that described by SET (Gibbon, 1977). According to SET (Gibbon, 1977), judgements of time are made by comparing the current timed period with previous periods. If timing is affected in the same way as false reports of words that are not presented, but are actual words previously presented, then it could be that memory for timed periods of differing lengths interferes with the correct timed perception, and the wrong judgements are made as a consequence. This is somewhat supported by the findings of chapter 4, where later responding in high UE scorers on FI and DRL schedule performance may reflect a deficit in the memory or decision-making processes involved in comparing the current timed period since reinforcement and those periods that have occurred previously. It could be, then, that the memory and decision-making deficits thought to be responsible for hallucinations could also manifest during timing tasks. In the case of SET (Gibbon, 1977), then, it may be interesting to attempt to tease apart the influence of the memory and decision-making components involved with timing, although this approach may be methodologically complex in distinguishing between these processes.

4.3 ***Timing and the environment***

Although other theories of timing also consider the relationship between the current environment and previous experiences (e.g. Grossberg, 2000), the neo-realist account of consciousness is the only one to put an emphasis on the role of timing in the occurrence and content of hallucinations. However, in terms of the development of future research into the neo-realist account of consciousness, although it appears that high UE scorers show evidence for differences in timing, it remains unclear how this may interact with the current environment, and the properties of previous experiences, to influence hallucinations. This produces questions regarding which properties are important in the relationship between the current environment and those previously experienced, and why this relationship is important. Chapter 2 used stimuli that differed in degrees of concreteness and imagery, yet abstract words, and low imagery scoring words, were reported more than concrete, or high imagery, words. As a result, one potentially interesting avenue for addressing this issue could be to explore similarities of previously presented stimuli on later hallucinatory content, perhaps by presenting participants with words differing in degrees of concreteness/imagery prior to a task that facilitates hallucinatory-like experiences, and then examining similarities in concreteness/imagery with the words reported. However, a procedure that deliberately manipulates hallucinatory content in individuals who are prone to experiencing them raises ethical questions, particularly if the emotional salience of the words are important, as previously suggested (Birchwood et al, 1992; Docherty, Van Kammen, Siris, & Marder, 1978; Freeman & Garety, 2003; Yung & McGorry, 1996;).

Clarification of the role of the temporal link and its relationship with the properties of previous experiences is required, especially in terms of how and why memory and decision-making processes mediate the infusion of properties of previous experiences and the current environment. The relationship between the temporal link, and past and present environmental properties, as currently suggested by the neorealist approach, is unclear; specifically, in terms of which properties of previous experiences are of most importance when imposing on current environmental perceptions, and how this relationship may occur through the role of the temporal link, and particularly, the placing of events along the temporal path.

Issues regarding the influence of current environmental stimulation also remain open. The fact that a neo-realist, and other (e.g. Grossberg, 2000), explanations for hallucinations puts a large degree of importance on both current, and previously, experienced events, has implications for those instances where hallucinations occur with little, or no, environmental stimulation (Cella et al., 2007; Margo et al, 1981; Merckelbach & van de Ven, 2001; Mintz & Alpert, 1972). This approach seems to be counter-intuitive as on the one hand, the importance of environmental properties is thought to be an important influence on hallucination-formation, whilst on the other, an absence of any such properties is considered to facilitate hallucination formation. However, the neo-realist account for consciousness argues for a number of different types of properties as important in the make-up of conscious experience, included in the neo-realist account for consciousness, some beyond the realm of physicality, such as when the experience takes place, or even the experience of sensory deprivation itself. As a result, the experimental manipulation of such abstract properties would be extremely difficult to perform, and, therefore, prohibit more detailed exploration of a properties-hallucinations relationship.

4.4 *Methodological issues*

In addition to the theoretical issues, and unanswered questions, addressed above, there are some methodological limitations to the current set of experiments presented in this thesis. A general issue involves the likelihood of the reports of schizotypy amongst the student samples for each experiment was in fact a model of drug use in this population, given that use (and abuse) of recreational drugs have been found to be more pronounced in student samples (Webb, Ashton, Kelly & Kamali, 1996), or young adults generally (Williams & Parker, 2001), with the effects modelling the symptoms of clinical disorders including psychosis (Arendt, Rosenberg, Foldager, Perto & Munk-Jorgensen, 2005; Barkus & Lewis, 2008; Cohen, Buckner, Najolia & Stewart, 2010; Miller, Lawrie, Hodges, Clafferty, Cosway & Johnstone, 2001). However, although the effects of drug use in a student sample may have influenced the results accordingly, it is unlikely that the effects of drug use on both the self-reports of schizotypy and related performance on the tasks across the thesis is mutually exclusive. That is, where drug use effects task performance, it should also effect participants self-reports of schizoptypy accordingly, and, as a result the characteristics and behaviours that drug use influences should still model schizotypal self-report and associated task performance. Moreover, it is also unlikely that drug use has influenced the results of the current thesis over and above that of schizotypy, especially given the low median split of the entire sample (3) relative to the range of the UE subscale (possible total = 12).

All of the experiments reported in this thesis used a median split approach to the dataset; defining high UE scorers as those scoring above the median, and low UE scorers as those scoring below the median. This method was chosen as it is unclear, at this stage, whether or not the progression of the UE subscale, and its relationship with experimental findings, are the product of a linear, or a step function. It could be that the median-split approach is not without merit in this context, but this point will be revisited later. Although this approach did not produce great variation in the scores of the groups defined as low and high scorers between experiments (an aim of cross-experimental consistency), its use does present an issue that, in one experiment, participants scoring around the median may have been included within the low UE group, whilst, for other experiments, a participant with the same score, may have been included within the high UE group.

One disadvantage of the median split approach is that the range of scores for each group may be skewed, with one group (high or low) incorporating a larger range of scores relative to the whole UE subscale. This could then mean that relatively low (or high) UE scorers are included within the high (or low) UE group. This, of course, is problematic in terms of the internal validity of the findings, with generalisations of the results to the high and low UE sub-groups, perhaps, not being strictly accurate in an absolute sense. Moreover, several researchers argue that dichotomising data by categorising continuous variables into high and low scoring groups has some statistical disadvantages; such as the loss of statistical power, and the increase of type I error probabilities (see Irwin & McClelland, 2003, Maxwell & Delaney, 1993; although this argument is not universally accepted, see O'Kearney & Nicholson, 2008).

However, a median split approach to the dataset can also be argued to be more advantageous for several reasons. Importantly, as noted above, it is unclear whether the relationship between UE and timing ability is linear, or better represented as a step function. Statistical procedures, such as regression, which are based on an assumption of continuous variables, make the former assumption (of linearity), but testing differences between high and low scoring groups, does not make any such assumptions, and removes the possibility of violating the basic assumptions required for the use of such statistical tests; a violation which would negate the above argument concerning power. In fact, as there are no reasons to suggest that a particular cut-off point would be advantageous, and the sample sizes used within the current study were too small to be confident in the power of a regression analysis (see Osborne et al, 2008), the median split approach is favoured

Another methodological issue that would benefit from more detailed consideration concerns order effects of the schedule presentation in Chapter 4 as presentation of the DRL schedule prior to the FI resulted in proactive interference (see also Reed & Morgan, 2008) on responding on the FI schedule, resulting in no differentiation between the IoC scores for the FI schedule between high and low UE scorers. This would suggest that prior exposure to the DRL schedule affects the later influence of the temporal factors of the FI schedule. This could be a result of early presentation of the strict parameters of the DRL schedule, namely the delaying of reinforcement following a non-reinforced response, producing a shift toward later responding on the FI schedule in low UE scorers, whilst high UE scorers continue to respond at a late stage on the FI schedule. It could be then that prior exposure to a DRL schedule reinforces and shifts responding to later on the FI schedule in low UE scorers, but simply reinforces the already late responding in high UE scorers, producing no shift. With this in mind, it could be that the timing difference in high UE scorers is complex, especially where reinforcement contingencies are involved. That is, timing may be affected by reinforcement, whereby reward for accurate timing influences later temporal performance; this may be further affected by the instances where responding delays reinforcement, such as on a DRL schedule, and, as a result, later responding across both schedules is reinforced on the whole. Further exploration of the interacting effects of the schedule may therefore shed more light on this issue.

A final methodological question that requires addressing concerns the anchoring of the S and L standard presentation times, and the spacing of the experimental presentations between the standards in Chapter 5. Bisection task methods have found that experimental manipulations, such as the difference and ratio between the S and L standards, influence bisection point production, as do stimulus spacing of the experimental stimuli between the two (Wearden & Ferrara, 1995, 1996). Manipulating the ratio sizes produced inconsistent differences between the S and L standards, meaning that the range of presentation times for the experimental stimuli differed between experiments (e.g. 0.6 seconds between the S and L in Experiment 8, 0.3 seconds in Experiment 10), and although not of direct interest, the differences in the range between the S and L standards may have further influenced timing judgements. In addition, maintaining a 0.1s stimulus spacing of the experimental presentations between the standards meant that linear versus log linear spacing effects were also not considered (Wearden & Ferrara, 1995, 1996). It would be useful then to consider these methodological factors in future bisection experiments with schizotypal subjects, to give a fuller evaluation of timing differences. However, such manipulation all of these factors was beyond the scope of the current thesis, with the S and L ratio was the sole focus here.

5. **Further Implications.**

Further implications from the current thesis are both methodological and theoretical, in nature, and concern topics such: as the median-split approach to the dataset, the nature of the relationship between schizotypy scores and performance on the experimental task (linear or step), speculation about the Weber's Law in timing judgements, decision making processes, and human schedule performance, both in general, and in relation to schizotypy, and the nature and influence of environmental properties, and the temporal link within the neorealist context.

5.1 ***Schizotypy***

It might be noted that the UE subscale is not strictly continuous, as it includes six questions regarding hallucinations, and six regarding delusions. This means that there is some scope for participants to have the same (for scores of six or below), or similar scores, but these scores will reflect subtly different constructs. Although the focus in this thesis is on the underlying mechanisms of both hallucinations and delusions, which are treated as one factor accordingly, it could be that the underlying timing differences highlighted in the present thesis may be more strongly associated with hallucinations over delusions, or vice versa. For example, the neo-realism approach to consciousness specifies how this may apply to hallucinatory occurrence, but not to delusion formation (Tonneau, 2004). In this respect, high scores on the OLIFE-B reflect an increased probability of including the underlying factors most associated with altered timing, but it may also be that these factors are reflected in more conservative scoring in some low UE scorers on questions tapping altered timing processes.

The use of the median-split approach to the dataset therefore allows for some variation in the spread of low and high UE scorers between experiments, whilst remaining true to the use of equal (or as close to as possible) high versus low UE groups within each experiment. With this in mind, it may be useful to examine scores on the UE subscale in more detail, possibly in terms of separating the items most associated with hallucinations and delusions individually or including other scales that examine these factors alone, to assess whether one of these constructs is more important than the other.

Returning to the issue of using a median split approach, specifically the nature of the relationship between scores on the UE subscale of the OLIFE-B and hallucinatory experiences, it could be that this relationship is of a step, rather than a linear function. If this is true, then it would mean that the frequency of hallucinatory reports made during an experimental task would not occur as a linear function of an increase in UE score, but would instead remain constant until a certain point on the scale, following which the likelihood of hallucinations occurring would increase. This approach of course veers close to the traditional 'categorical' model for schizophrenia, if considered in terms of the frequency of such experiences. However, it could be that the intensity of the hallucinatory experiences is the key factor here, in terms of the difference between maximum intensity hallucinations, such as the kind reported by schizophrenic patients, and lesser, but similar, hallucination-like experiences, such as mistaking a stranger for someone you know at a glance, occurring across the schizotypal continuum (van de Ven & Merckelbach, 2003).

This has methodological implications in terms of the probabilities of including participants that have valid experiences to the task. For example, individuals who score low on the UE subscale may only have ever experienced one hallucination-like experience, in one modality, the intensity of which may have been strong, but no measure of this is included in the OLIFE-B. In contrast, a high UE scorer may have had a large number of hallucination-like experiences, across a variety of modalities, but all of which were of low intensity. With these examples in mind, it could be that the former individual is a more useful research participant in examining the mechanisms of hallucinations, as their experience is closer to a hallucination *per se*.

Increased scores on the UE subscale of the OLIFE-B, then, do not necessarily point toward optimum participants linearly, as subjects at the high end of the subscale do not necessarily reflect hallucinatory experiences akin to those presented in a given task. However, the UE subscale of the OLIFE-B does measure hallucinatory proneness in accordance with a continuum of psychosis (Mason et al., 2005), with higher scores indicating an increased likelihood to experience hallucinations, and, although a greater probability does not necessarily mean hallucinations are certain to occur, higher scores do represent a greater likelihood of hallucinatory experiences.

Given all of the above, grouping these participants through a high versus low method (step) may be more beneficial in obtaining participants who have experienced a hallucination of the necessary type, and strength, directly associated with the task, and increases the probability of including those participants most likely to experience strong hallucination, whilst avoiding the pitfalls that may come with a linear approach. Similarly, it may also be that the association between deficits in an underlying timing mechanism, and hallucinatory experiences, exist in line with particular hallucination intensities, and, thus, may be better explored within the context of a step function.

The implications of a step function model, discussed thus far, have been of a methodological nature; however, there are also theoretical implications for the study of hallucinations if a step function is indeed operative. Firstly, a step function suggests that a point is reached prior to which hallucination-like experiences have been reported, but are of less significance, then, following this point, a jump occurs toward more significant hallucinatory experiences. Although speculative, at this point, the significance of this suggestion is in terms of hallucinatory intensity, whereby hallucination-like experiences reach a point that contribute to greater intensity of these experiences, shifting the relationship between frequency reports, and hallucinatory experiences perceived through task performance, accordingly.

Secondly, a step function would explain the relationship between hallucinations and contributory negative emotional factors, such as stress and anxiety (Freeman & Garety, 2003; Honig et al., 1998; Morrison et al, 2003; Read & Argyle, 1999), suggesting a point at which stress leads to break down in 'normal' mental functioning, and, potentially, lead to psychosis. Certainly, there is some element of understanding one's experiences, as measured by the OLIFE-B, with each question orientated to the participants' understanding of experiences of misperception, as opposed to unawareness of hallucinatory experiences, for example "In the dark do you sometimes see shapes and forms even though you know nothing is there?" (Mason et al., 2005).

5.2 ***Specific timing deficits***

Each of the theories of timing (see section 5.2.1 and 5.2.2) incorporates an explanation for the phenomenon of Weber's Law, typically found in timing experiments (see Lejeune et al., 2006), as discussed in section 5.2.2, concerning the standard deviation increasing as a function of the mean for time estimations and levels of UE.. Alongside insights into differences between high and low UE scorers, the exploration of the relationship between timing differences in line with schizotypy score may also add a new dimension to the occurrence of this phenomenon in the timing literature.

Discussion of the Weber's law function associated with timing tasks leads to the question of how the results here reflect on real-world timing situations, such as arriving on time for appointments, or allocating time to perform tasks to deadlines. In relation to Weber's law, as the time period increases, so to does the mean and standard deviation of the timed estimations (Lejeune et al., 2006). Taken at face value, given that high UE scorers show some evidence of timing deficit on the current set of studies that use stimuli presentations of less than 1s, it would be expected that, during longer real-world timing scenarios, this deficit would become more pronounced. Although there is some evidence for poor time keeping in schizophrenic patients (Tysk, 1983; Wahl and Sieg, 1980), more detailed analysis is required to uncover further information of the extension of a timing deficit across larger timed periods and in high scorers in schizotypy. In addition, the timing differences between high and low UE scorers in the current thesis were only found under very specific circumstances, when the presentation length ratio of the temporal bisection experiments were 2:1 and 3:1, but not at 1.6:1 and 4:1 (Chapter 5). With relation to Weber's law then, and that differences between high and low UE scorers should become more pronounced across longer durations, it may be interesting to explore timing differences between these groups where the ratio values of 2:1 and 3:1 are maintained, but across stimuli presented for larger durations. If these differences still occur and are perhaps more pronounced when the 2:1 and 3:1 ratios are maintained but are presented across longer presentation lengths, then this may shed light on the circumstances under which hallucinations are likely to occur; that is, when under specific conditions of duration presentation, timing differences between high and low UE scorers emerge or are more pronounced, and hallucinations become more likely to manifest.

Chapters 3 and 4 have implications for learning in high UE scorers, according to their performance on reinforcement schedules incorporating a temporal element. On the RR-RI yoked schedules, used in Chapter 3, high UE scorers were unable to incorporate the temporal element of the contingency in order to perform optimally on the RI schedule, nor were they able to accurately describe the contingency in comparison to their own scores on the RR schedule. This would suggest that high UE scorers are deficient in learning about the behaviours typically associated with these types of schedules, and, although this would account for inconsistent performance in human responding on reinforcement schedules (see Section 3.4 above), this finding holds further implications for learning and behaviour, extending to timing behaviours beyond the current experimental setting, as well as having implications for reinforcement-dependent learning in high UE scorers.

For example, inconsistencies between humans and non-humans in performance on reinforcement schedules often have been attributed to verbal rule formation, which is deemed to shape behaviour independently of reinforcement contingencies (see Hayes et al., 1986). With this in mind, it could be that the same types of mechanisms that are associated with the kind of processes thought to influence hallucinations and delusions, namely inaccurate interpretations of the immediate environment (Bentall, 1990; Bentall et al, 1991; Bentall, et al, 1994; Frith, 1992; Kinderman & Bentall, 1996), could also be involved in the verbal rule formation that contributes to response patterns on these schedules (Hayes et al., 1986). That is, inaccurate verbal rules for schedule performance may be formed through the same mechanisms that facilitate inaccurate environmental interpretation in the form of delusions. This would suggest that poor performance on schedules of reinforcement in humans may be a result of deficits in the processes associated with verbal rule formation, over and above contingency shaping, but further research would be required using the same techniques that separate contingency shaped behaviour and verbal rule following on schedule work that have been used previously (Hayes et al, 1986; Shimoff et al., 1986).

An alternative explanation, however, would be that high schizotypy scorers have a diminished ability to learn about operant conditioning on reinforcement schedules, especially when timing is involved. One reason why this may be the case comes from a second argument regarding why humans perform differently on reinforcement schedules to non-humans; that is, because the reinforcement histories of humans cannot be controlled (Lattal & Neef, 1996; Lowe, 1979). This would imply that high schizotypy scorers have always had a difficulty in operant learning within this context, and, previously, in real-life contingencies, when compared to low scorers, with this deficit extending to the current schedule response patterns. As a result then, it could be that responding based on previous real-life reinforcement contingencies may influence the way in which an individual may perform on the types of reinforcement schedules used in laboratory experiments. Exploration of reinforcement histories, however, would be incredibly difficult to perform, but it may be useful to explore differences between high and low schizotypy scorers on reinforcement schedules that use real-life factors, especially with a temporal element, such as taking medication, or performing other specific tasks at different times of the day. It would be useful, then, to further examine timing, in terms of reinforcement schedules, but also in real-life timing scenarios, as well as the effects of reinforcement on high UE scorers, to shed further light on the potential deficits in, and influence of, timing, on individuals scoring high in schizotypy.

5.3 ***Decision-making and schizophrenia***

Theories of timing that suggest a memory component tend to express this in terms of comparing memory for a timed period with that of a current environmental event (Dragoi et al., 2003; Gibbon, 1977, 1991; Lejeune et al., 2006; Staddon and Higa, 1999; Staddon et al, 2002; Wearden, 2003). A deficit in such a memory component could lead to inaccurate timing, when subjective memories for a timed period do not match the current period in question, despite the fact that they are actually the same length. Similarly, it could be argued that high UE scorers, who tend to make more hallucinatory reports then low UE scorers, are comparing the presentation of current words with that of existing words previously presented to them, with the remembered word being preferred in the subsequent report production. This would suggest an increased tendency in high UE scorers toward favouring properties of previous experiences over current environmental stimulation. If such considerations were extended to the memory component implicated in theories of timing, then, in the bisection task as used in Chapter 5, it could be that memory for the short standard is favoured over the current time period, which results in a tendency toward reporting longer time presentations compared to short presentations. Similarly, later responding on the FI and DRL schedules in Chapter 4 is thought to be more reflective of a memory or decision-making deficit in comparing current and previously timed periods as the subjective timing experience would be constant throughout the schedule regardless of differences in a timing mechanism between high and low UE scorers. In this case, it could be that the decision-making deficit produces a bias toward later responding as the current timed period is favoured over memory for those previously presented.

Moreover, the SET model of timing also incorporates a decision making process between the number of 'pulses' for the current timed period stored in the accumulator and those stored for timed periods in memory. This process is similar to those implicated in the manifestation of hallucinations, in that a decision regarding the interpretation of the current environment is made based on sensory input, and internally generated properties (more specifically, for delusions, where those prone to UE jump to conclusions, or make incorrect inferences about the environment; Fear & Healey, 1997; Peters et al, 1997; Huq et al1988; Garety et al, 1991; Garety & Hemsley, 1994). It may be then that the same kind of processes involved in 'jumping to conclusions', biases, and incorrect environmental interpretations, are associated with timing; in that high UE scorers 'jump to conclusions' when making timing judgements. That is, when presented with the option to classify one of several timed presentations as SHORT or LONG; high UE scorers tend to make quick, inaccurate judgements of the length of the current presentation in the same way that they make quick and inaccurate judgements of their environment in line with delusions. As a result, decision making processes associated with comparing timed periods in high UE scorers may effectively produce a deluded perception of those timed periods.

The specific findings of Chapter 5, depending on the exact nature of the comparisons being made between the current timed period and memory for the standards (i.e. S, L or some central tendency of the range), suggest that the bisection point differences between high and low UE scorers may emerge due to either differences in memory sampling from the s* and l* range when making a comparison with the current timed period, some form of an ambiguity threshold value for comparing difference judgements for the current timed period T, with the s* and l* memory representations or a central tendency value for the L/S range, or a greater central tendency value itself (see Chapter 6, section 3.2). Relating these results to a "jumping to conclusions" bias in high UE scorers would perhaps suggest that these individuals are "jumping to conclusions" when selecting s* and l* memory samples or perhaps the notion of an ambiguity threshold value for decision-making between the current and previously timed periods extends to the thought processes involved with hallucination and delusion formation; that is, it could be that, individuals highly prone to hallucinations and delusions could hold altered threshold values that somehow mediate the accuracy of environmental interpretations.

Given the existing implications of memory and decision-making issues in schizotypy, exploration of these factors in line with SET (Gibbon, 1977; Wearden, 2003), may shed light both on the underlying processes at work in individuals prone to UE, and to the SET model of timing. Similarly, the ATM, MTS and TTM models may also benefit from research into the relationship between schizotypy, memory, and timing, though these models do not emphasize a decision-making process (Dragoi, Staddon, & Palmer, 2003; Lejeune et al., 2006; Staddon & Higa, 1999; Staddon et al, 2002). Moreover, research into schizotypy, memory, decision-making processes and timing may also help to clarify which of the timing models mentioned above is most accurate in explaining human timing.

5.4 ***Neo-realism***

Evidence for a timing difference broadly supports the notion of hallucination formation and maintenance according to the neo-realist account of consciousness (Tonneau, 2004), but the relationship between this account, and how, and why, hallucinations occur, remains somewhat cloudy. Presumably, in line with the neo-realist account, hallucinations occur as a result of stronger temporal links between properties of the current environment and previous experiences, and these properties of previous experiences are then inaccurately favoured in interpreting the current environment. However, further research into the specifics of the relationship between past and present properties, and their temporal link, is required in several areas.

Firstly, in terms of why some properties of previous experiences, and not others, contribute to hallucinations if the temporal link does not discriminate between different properties of an experience, and provides a strong link with all previous experiences, then why do some properties seem to be favoured during re-occurrence of hallucinatory experiences, such as when auditory hallucinations follow a specific theme (Romme & Escher, 2003). It could be that differing properties somehow carry more weight than others, perhaps through more strength or salience at the time they are experienced, due to differences in the temporal links between different properties, and, as such, are more likely to contribute to hallucinations. Certainly, individual differences in emotional states have been implicated in contributing to hallucinations formation previously (Birchwood et al, 1992; Docherty et al, 1978; Yung & McGorry, 1996; Freeman & Garety, 2003). However, these findings provoke an additional question regarding how these properties acquire weightings, or how stronger temporal links are acquired for certain properties in the first instance.

Secondly, and similarly, if the temporal link provides a strong link with all previous experiences, then why do hallucinations only occur in some situations, and not others? Again, this could be a result of differences in the weightings of properties of previous experiences and their relationship to those of the current environment which further suggest the need for more research into the relationship between past and present properties of events, currently not included in the current neo-realist account.

Thirdly, the nature of the temporal path, defined as the timeline on which the organism's previous experience rests, needs addressing within this context, in terms of whether the relationship between previous experiences is a linear or a step function. If linear, it could be that the strength of the temporal links between the current environment and previous experiences later on the temporal path (and subsequently closer to the current environment), are stronger than experiences earlier along the temporal path. This would suggest that later properties, more closely linked (temporally) to the current environment, are more likely to contribute to hallucinations. In turn, this could provide insight into the episodic and themed nature of hallucinatory occurrences in the schizophrenic population (APA, 1994; Bentall, 1990; Romme & Escher, 1993; Skirrow et al, 2002). For example, it could be that, following the first hallucinatory occurrence, properties of that experience will hold strong temporal links with the current environment, and increase the likelihood of those properties, leading to hallucinatory re-occurrence, which, in turn, leads to stronger temporal links of those properties, and so on. However, although interesting theoretically, this approach does little to explain how the first hallucinatory experiences occurs, and, moreover, how an episode of hallucinatory experiences would come to end. Moreover, the application of events on the temporal path imply some influence of an internal timing mechanism, such as a clock, that is responsible for a subjective timeline between the current environment and recent events. However, the experiments in Chapter 5 showed no differences in the Weber ratio values between high and low UE scorers on the bisection task, therefore showing no evidence for differences in clock speed between these two groups. This implies that any differences in timing performance, or hallucinatory and delusional reports between these groups is not related to clock speed, again raising the question of how and why particular properties of previous experiences come to merge with the current environment when they do.

Alternatively, the relationship between properties of previous experiences on the temporal path and hallucinatory content could be in the form of a step function, which would also account for the episodic nature of hallucinations in schizophrenic patients, as a number of properties from a portion of the temporal path would be equally as likely to contribute to hallucinatory content, possibly with the current environment dictating which properties would contribute. Tentatively, a step function for the temporal elements could also explain the first and last occurrences of hallucinations of each episode, should the step function for temporal links between properties coincide with a similar function related to episodes of psychosis themselves.

6. <u>Summary</u>

In summary, the present series of studies provide some interesting findings with regard to individual differences in UE within a timing context, along with some scope for further exploration of hallucinatory like experiences and environmental properties. Chapter 2 illustrated that high UE scorers made more false reports of the words within white noise recordings than low UE scorers. In addition, the importance of the context (i.e. concrete/abstract, high/low imagery) of the presented words was also shown to relate to hallucinatory reports, albeit with some cross-experimental differences between concreteness/imagery characteristics. This latter finding implies a role for the environmental context in influencing hallucinatory content, possibly with regard to further word-properties not scrutinized here, but that provide an interesting avenue for future research. Chapter 3 showed that high UE scorers were not able to make the distinction between a RR and RI schedule of reinforcement, whilst low UE scorers were; having a significantly higher response rate on the RR schedule than on the RI schedule. This difference between schedules suggested either a disconfirmation (lack of sensitivity to those responses that did not receive reinforcement), or a timing issue with regard to allowing enough time to pass on the RI schedule for reinforcement to become available. Chapter 4 found evidence for the influence of timing, as opposed to disconfirmation, as response rates on the FI and DRL schedule used did not differ, whilst more complex analysis on the spread of participants' responses within each schedule showed that high UE scorers tended to make more of their responses later within each reinforcement period than low UE scorers. Chapter 5 then removed the timing exploration from the schedule context, and found that, on a 'pure' timing task, high UE scorers had a greater bisection point than low UE scorers, but only when the L/S stimuli ratios were 2:1 and 3:1, highlighting less of a tendency to judge shorter time presentations as LONG than low UE scorers. Exploration of this finding through the SET model of timing suggested that the differences may lie in some aspect of the memory and decision-making processes involved with comparing current durations to those previously presented. However, these results were not held when the L/S ratio was 1.6:1 and 4:1, limiting the generality of the effect.

Overall, the present thesis shows some evidence for timing differences between high and low UE scorers, which could contribute to the occurrence and content of both hallucinations and delusions. These differences are largely considered within a neo-realist account of consciousness, and how and why UE may occur within this framework. Although future research is required to shed more light on the relationship between differences in timing, properties of the past and present environments, and the occurrence of hallucinations and delusions, the present series of studies provide a foundation for this research to continue from a timing perspective.

References.

Abi-Dargham, A. & Moore, H. (2003). Prefrontal DA Transmission at D1 Receptors and the Pathology of Schizophrenia, *The Neuroscientist*, 9 (5), 404-416.

Allan, L. G. & Gibbon, J. (1991). Human Bisection at the Geometric Mean. *Learning and Motivation*, 22, 39 – 58.

Allen, P., Freeman, D., Johns, L. & McGuire, P. (2006). Misattribution of Self-Generated Speech in Relation to Hallucinatory Proneness and Delusional Ideation in Healthy Volunteers, *Schizophrenia Research*, 84, 281-288.

American Psychiatric Association (1994). Schizophrenia. *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV.* Washington, DC: American Psychiatric Publishing Inc.

American Psychiatric Association (2000). Schizophrenia. *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV-TR.* Washington, DC: American Psychiatric Publishing Inc.

Applegate, E., El-Deredy, W. & Bentall, R. P. (2009). Reward Responsiveness in psychosis-prone groups: Hypomania and negative schizotypy, *Personality and Individual Differences*, 47 (5), 452-456.

Arendt, M., Rosenberg, R., Foldager, L., Perto, G. & Munk-Jorgensen, P. (2005). Cannabis Induced Psychosis and Subsequent Schizophrenia-Spectrum Disorders: Follow-Up Study of 535 Incident Cases, *British Journal of Psychiatry*, 187, 510 – 515.

Bannister, D. (1968). The Logical Requirements of Research Into Schizophrenia, *British Journal of Psychiatry*, 114, 181-188.

Barber, T. X., & Calverley, D. S. (1964). An Experimental Study of "Hypnotic"

(Auditory and Visual) Hallucinations. *Journal of Abnormal and Social Psychology,* 63, 13-20.

Barkus, E. & Lewis, S. (2008). Schizotypy and Psychosis-Like Experiences from Recreational Cannibis in a Non-Clinical Sample, *Psychological Medicine*, 38, 1267 – 1276.

Barnes, J. & David, A. S. (2001). Visual Hallucinations in Parkinson's Disease: A Review and Phenomenological Survey, *Journal of Neurology, Neurosurgery and Psychiatry*, 70, 727-733.

Baron, A., Perone, M. & Galizio, M. (1991). Analysing the Reinforcement Process at the Human Level: Can Application and Behaviouristic Interpretation Replace Laboratory Research? *The Behaviour Analyst*, 14, 95 – 105.

Barrett, T. R. & Etheridge, J. B. (1992). Verbal Hallucinations in Normals I: People Who Hear "Voices", *Applied Cognitive Psychology*, 6 (5), 379-387.

Bassiony, M. M., Steinberg, M. S., Warren, A., Rosenblatt, A., Baker, A. S. & Lyketsos, C. G. (2000). Delusions and Hallucinations in Alzheimer's Disease: Prevalence and Clinical Correlates, *International Journal of Geriatric Psychiatry*, 15 (2), 99-107.

Battaglia, M., Cavallini, M. C., Macciardi, F. & Bellodi, L. (1997). The Structure of DSM-III-R Schizotypal Personality Disorder Diagnosed by Direct Interviews, *Schizophrenia Bulletin*, 23 (1), 83 – 92.

Baum, W. M. (1973). The Correlation-Based Law of Effect. *Journal of Experimental Animal Behaviour*, 20 (1), 137 – 153.

Beck, A. T., Steer, R.A., & Garbin, M.G. (1988). Psychometric Properties of the Beck Depression Inventory: Twenty-Five Years of Evaluation. *Clinical Psychology Review*, 8, 77 – 100.

Beck, J. C. & Van Der Kolk, B. (1987). Reports of Childhood Incest and Current Behaviour of Chronically Hospitalized Psychotic Women, *American Journal of Psychiatry*, 144, 1474-1476.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, 4, 561-571.

Belensky, G. L. (1979). Unusual Visual Experiences Reported by Subjects in the British Army Study of Sustained Operations, Exercise Early Call, *Military Medicine*, 144 (10), 695-696.

Bentall, R P. (1990). The Illusion of Reality: A Review and Integration of Psychological Research on Hallucinations. *Psychological Bulletin.* 107(1), 82-95.

Bentall, R. P. (2003a). Fool's Gold. *Madness Explained, Psychosis and Human Nature* (pp. 72–73). London: Penguin Books Ltd.

Bentall, R. P. (2003b). The Great Classification Crisis. *Madness Explained, Psychosis and Human Nature* (pp. 41–66). London: Penguin Books Ltd.

Bentall, R. P. (2003c). Them and Us. *Madness Explained, Psychosis and Human Nature* (pp. 118–145). London: Penguin Books Ltd.

Bentall, R. P. (2003d). After Kraepelin. *Madness Explained, Psychosis and Human Nature* (pp. 19–40). London: Penguin Books Ltd.

Bentall, R. P. (2003e). The Boundaries of Madness. *Madness Explained, Psychosis and Human Nature* (pp. 19–40). London: Penguin Books Ltd.

Bentall, R. P. (2003f). The Illusion of Reality. *Madness Explained, Psychosis and Human Nature* (pp. 347–377). London: Penguin Books Ltd.

Bentall, R. P. (2003g). Abnormal Attitudes. *Madness Explained, Psychosis and Human Nature* (pp. 293–329). London: Penguin Books Ltd.

Bentall, R. P. (2004). Abandoning the Concept of Schizophrenia. In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 195-208). Hove: Brunner-Routledge.

Bentall, R. P., Baker, G. A. & Havers, S. (1991). Reality monitoring and psychotic hallucinations. *British Journal of Clinical Psychology,* 30, 213–222.

Bentall, R. P., Claridge, G. S., & Slade, P. D. (1989). The multidimensional nature of schizotypal traits: A factor analytic study with normal subjects. *British Journal of Clinical Psychology, 28,* 363-375.

Bentall, R.P., Corcoran, R., Howard, R., Blackwood, N., & Kinderman, P. (2001). Persecutory Delusions: A Review and Theoretical Integration. *Clinical Psychology Review*, 21 (8), 1143–1192.

Bentall, R. P., Haddock, G., & Slade, P.D., (1994). Cognitive Behaviour Therapy for Persistent Auditory Hallucinations: From Theory to Therapy, *Behaviour Therapy*, 25, 51-66.

Bentall, R. P., Jackson, H. F. & Pilgram, D. (1988). Abandoning the Concept of Schizophrenia: Some Implications of Validity Arguments for Psychological Research into Psychotic Phenomena, *British Journal of Psychiatry*, 173, 198-202.

Bentall, R. P., Kaney, S. & Dewey, M. E. (1991). Persecutory delusions: An attribution theory analysis. *British Journal of Clinical Psychology*, 30, 13-23.

Bentall, R. P., Kinderman, P. & Kaney, S. (1994). The self, attributional processes and abnormal beliefs: Towards a model of persecutory delusions. *Behaviour Research and Therapy*, 32, 331-341.

Bentall, R. P., Lowe, C. F. & Beasty, A. (1985). The role of verbal behaviour in human learning: II. Developmental differences. *Journal of the Experimental Analysis of Behavior,* 43, 165–181.

Bentall, R. P. & Morrison, A. P. (2002) More harm than good: the case against using antipsychotic drugs to prevent severe mental illness. *Journal of Mental Health*, 11, 351-365.

Bentall, R. P., & Slade, P. D. (1985). Reality testing and auditory hallucinations: a signal detection analysis. *British Journal of Clinical Psychology*, 24,159-169.

Bentall, R. P. & Young, H. F. (1996). Sensible hypothesis testing in deluded, depressed and normal subjects. *British Journal of Psychiatry*, 168, 372-375.

Bergida, H. & Lenzenweger, H. F. (2006). Schizotypy and Sustained Attention: Confirming Evidence from an Adult Community Sample, *Journal of Abnormal Psychology*, 115 (3), 545-51.

Blacker, D. & Tsuang, M. D. (1992). Contested Boundaries of Bipolar Disorder and the Limits of Categorical Diagnosis in Psychiatry, *American Journal of Psychiatry*, 149, 1473 - 1483.

Birchwood, M., MacMillan, F., Smith, J., (1992). Early Signs of Relapse in Schizophrenia: Monitoring Methodology. In: Kavanagh, D. (Ed.), *Schizophrenia: An Interdisciplinary Handbook.* Chapman and Hall, London.

Boyle, M. (1990). *Schizophrenia: A Scientific Delusion?* London: Routledge.

Brebion, G., Amador, X., David, A., Malaspina, D., Sharif, Z. & Gorman, J. M. (2000a). Positive Symptomatology and Source-Monitoring Failure in

Schizophrenia — An Analysis of Symptom-Specific Effects, *Psychiatry Research*, 95 (2), 119-131.

Brebion, G., Smith, M. J., Gorman, J. M., Malaspina, D., Sharif, Z. & Amador, X. (2000b). Memory and Schizophrenia: Differential Link of Processing Speed and Selective Attention with Two Levels of Encoding, *Journal of Psychiatric Research*, 34 (2), 121-127.

Brebion, G., Smith, M. J., Amador, X., Malaspina, D., & Gorman, J. M. (1998). Word Recognition, Discrimination Accuracy, and Decision bias in Schizophrenia: Association with Positive Symptomatology and Depressive Symptomatology. *Journal of Nervous and Mental Diseases*, 186, 604-609.

Buchanan, R.W., Freedman, R., Javitt, D.C., Abi-Dargham, A., Lieberman, J.A., (2007). Recent Advances in the Development of Novel Pharmacological Agents for the Treatment of Cognitive Impairments in Schizophrenia. *Schizophrenia Bulletin*, 33, 1120–1130.

Burns, A., Jacoby, R. & Levy, R. (1990). Psychiatric Phenomena in Alzheimer's Disease. I: Disorders of Thought Content, *The British Journal of Psychiatry*, 157, 72-76.

Butzlaff, R. L. & Hooley, J. M. (1998). Expressed Emotion and Psychiatric Relapse, *Archives of General Psychiatry*, 55, 547 – 552.

Cannon, T. D., Cadenhead, K., Cornblatt, B., Woods, S. W., Adlington, J., Walker, E., Seidman, L. J., Perkins, D., Tsuang, M., McGlashan, T. & Heinssen, R. (2008). Prediction of Psychosis in Youth at High Clinical Risk: A Multisite Longitudinal Study in North America, *Archives of General Psychiatry*, 65 (1), 28 – 37.

Carlsson, A. & Lindqvist, M. (1963). Effect of Chlorpromazine or Haloperidol on Formation of 3-Methoxytyramine and Normetanephrine in Mouse Brain, *Acta Pharmocologica and Toxicologica*, 20(2), 140-144.

Carlsson, A., Waters, N., Waters, S. & Carlsson, M. L. (2000). Network Interactions in Schizophrenia – Therapeutic Implications, *Brain Research Reviews*, 31, 2-3

Carroll, C. A., Boggs, J., O'Donnell, B. F., Shekhar, A., Hetrick, W. P. (2008). Temporal Processing Dysfunction in Schizophrenia, *Brain and Cognition*, 67, 150-161.

Catania, A. C. (1970). Reinforcement Schedules and Psychophysical judgments: A Study of some Temporal Properties of Behavior. In Schoenfeld, W. N. (Ed.), *The Theory of Reinforcement Schedules*. New York: Appleton-Century-Crofts, 1-42.

Catania, A. C., Matthews, B. A. & Shimoff, E. (1982). Instructed Versus Shaped Human Verbal Behaviour: Interactions with Nonverbal Responding, *Journal of the Experimental Analysis of Behaviour*, 38, 233-248.

Catania, A. C., Matthews, T. J., Silverman, P. J., & Yohalem, R. (1977). Yoked Variable-Ratio and Variable-Interval Responding in Pigeons. *Journal of the Experimental Analysis of Behavior, 28,* 155–161.

Cella, M., Dymond, S. & Cooper, A. (2009). Impairment in Flexible Emotion-Based Learning in Hallucination- and Delusion-Prone Individuals, *Psychiatry Research,* 170, 70–74.

Cella, M., Taylor, K., & Reed. P. (2007). Violation of expectancies produces more false positive reports in a word detection tasks in people scoring high in unusual experiences scale. *Personality and Individual Differences*, 43 (1), 59 – 70.

Chadwick, P. & Birchwood, M. (1994). The Omnipotence of Voices: a Cognitive Approach to Auditory Hallucinations. *British Journal of Psychiatry*, 164, 190 – 201.

Chadwick, P. & Birchwood, M. (1995). The Omnipotence of Voices II: The Beliefs About Voices Questionnaire (BAVQ), *British Journal of Psychiatry*, 166, 773 – 776.

Chapman, L. J., & Chapman, J. P. (1980). Scales for rating psychotic and psychotic-like experiences as continua. *Schizophrenia Bulletin, 6,* 476-489.

Chapman, L. J., & Chapman, J. P., Kwapil, T R., Eckblad, M. & Zinser, M. C. (1994). Putatively Psychosis-Proneness Subjects 10 Years Later, *Journal of Abnormal Psychology*, 103 (2), 171-183.

Chapman, L. J., Chapman, J. P., Numbers, J. S., Edell, W. S., Carpenter, B. N. & Beckfield, D. (1984). Impulsive Nonconformity as a Trait Contributing to the Prediction of Psychotic-Like and Schizotypal Symptoms, *Journal of Nervous and Mental Disease*, 172 (11), 639-700.

Chapman, L. J., & Chapman, J. P. & Raulin, M. L (1976). Scales for Physical and Social Anhedonia, *Journal of Abnormal Psychology*, 85 (4), 374-382.

Chapman, L. J., & Chapman, J. P. & Raulin, M. L (1978). Body-Image Aberration in Schizophrenia, *Journal of Abnormal Psychology*, 87 (4), 399-407.

Church, R. M. & Deluty, H. Z. (1977). The Bisection of Temporal Intervals. *Journal of Experimental Psychology: Animal Behaviour Processes*, 3, 216–228.

Claridge, G., (1990). Can a Disease Model of Schizophrenia Survive? In R. P. Bentall (ed.), *Reconstructing Schizophrenia.* London: Routledge, pp. 157 – 83.

Claridge, G., & Beech, A. (1994). Fully and quasi-dimensional concepts of schizotypy. In A. Raine, T. Lencz, & S, Mednick (Eds.), *Schizotypal Personality Disorder.* Cambridge: Cambridge University Press.

Claridge, G. & Blakey, S. (2009). Schizotypy and Affective Temperament: Relationships with Divergent Thinking and Creativity Styles, *Personality and Individual Differences*, 46 (8), 820-826.

Claridge, G., & Broks, P. (1984). Schizotypy and Hemisphere Function I: Theoretical Considerations and the Measurement of Schizotypy. *Personality and Individual Difference*, **5**, 633 – 648.

Claridge, G., McCreery, C., Mason, O., Bentall, R., Boyle, C. l., Slade, P. & Popplewell, D. (1996). The factor structure of 'schizotypal' traits: A large replication study. *British Journal of Clinical Psychology*, 35, 103 – 115.

Cohen, A. S., Buckner, J. D., Najolia, G. M. & Stewart, D. W. (2010). Cannabis and Psychometrically-Defined Schizotypy: Use, Problems and Treatment Considerations, *Journal of Psychiatric Research*, 1-7.

Comer, N. L., Madow, L. & Dixon, J. J. (1967). Observations of Sensory Deprivation in a Life Threatening Situation, *American Journal of Psychiatry*, 124, 164-169.

Cooklin, R., Sturgeon, D. Leff, J. (1983). The Relationship between Auditory Hallucinations and Spontaneous Fluctuations in Skin Conductance in Schizophrenia, *British Journal of Psychiatry*, 142, 47-52.

Corcoran, R., Cahill, C. & Frith, C. D. (1997). The Appreciation of Visual Jokes in People with Schizophrenia: A study of `Mentalizing' Ability. *Schizophrenia Research*, 24, 319-327.

Corcoran, R., Mercer, G. & Frith, C. D. (1995). Schizophrenia, Symptomatology and Social Inference: Investigating ` Theory of Mind' in People with Schizophrenia. *Schizophrenia Research*, 17, 5-13.

Coyle, J.T., Tsai, G. Goff, D. (2003). Converging evidence of NMDA receptor hypofunction in the pathophysiology of schizophrenia, *Annals of the New York Academy of Science*, 318–327.

Craig, T. & Hwang, M. Y. (2000). Co-morbidity in Schizophrenia, *Psychiatric Annals*, 30, 76-78.

Crow, T. J. (1981). Positive and Negative Schizophrenia Symptoms and the Role of Dopamine, *British Journal of Psychiatry*, 139, 251–254.

Crow, T. J. (1990). The Continuum of Psychosis and its Genetic Origins, *British Journal of Psychiatry*, 156, 788-797.

Crowne, D. P., & Marlowe, D. (1960). A New Scale of Social Desirability Independent of Psychopathology, *Journal of Consulting Psychology*, 24(4), 349-354.

Cutting, J. (1985). *The Psychology of Schizophrenia.* London: Churchhill Livingstone.

Dack, C., McHugh, L. & Reed, P. (2009). Generalization of Causal Efficacy Judgements after Evaluative Learning, *Learning and Behaviour*, 37, 336-348.

Dagnall, N. & Parker, A. (2009). Schizotypy and False Memory, *Journal of Behavior Therapy and Experimental Psychiatry*, 40 (1), 179-188.

Davey, G. (1988). Trends in Human Operant Theory, In Davey, G. & Cullen, C. (Eds.). *Human Operant conditioning and Behaviour Modification* (pp. 1- 14). New York: Wiley.

Davies, P. (1974a). Conditioned Visual Afterimages I, *British Journal of Psychology*, 65, 191-204.

Davies, P. (1974b). Conditioned Visual Afterimages II, *British Journal of Psychology*, 65, 377-393.

Davies, P. (1976). Conditioning Afterimages: A Procedure for Minimizing the Extinction Effect of Normal Test Trials, *British Journal of Psychology*, 67, 181-189.

Davies, P., Davies, G. L. & Bennett, S. (1982). An Effective Paradigm for Conditioning Visual Perception in Human Subjects, *Perception*, 11, 663-669.

Davis, K., Kahn, R., Ko, G. & Davidson, M. (1991). Dopamine in Schizophrenia: A Review and Reconceptualization, *American Journal of Psychiatry,* 148, 1474–1486.

Densen, M. E. (1977). Time Perception in Schizophrenia, *Perception and Motor Skills,* 44, 436–438.

Dews, P. B. (1978). Studies on Responding Under Fixed Interval Schedules of Reinforcement: II. The Scalloped Pattern of the Cumulative Record. *Journal of the Experimental Analysis of Behavior*, 29, 67-75.

Dickinson, A. M. (1989). The Detrimental Effects of Extrinsic Reinforcement on "Intrinsic Motivation." *The Behavior Analyst*, 12, 1-15.

Dilling, C. A. & Rabin, A. L. (1967). Temporal Experience in Depressive States and Schizophrenia, *Journal of Consulting Psychology*, 31 (6), 604-608.

Docherty, J. P., Van Kammen, D. P., Siris, S. G. & Marder, S. R. (1978). Stages of Onset of Schizophrenic Psychosis, *American Journal of Psychiatry*, 135, 420-426.

Doering, S., Miller, E., Kopcke, W., Petzcker, A., Gaebel, W., Linden, M., et al (1998). Predictors of Relapse and Rehospitalisation in Schizophrenia and Schizoaffective Disorder, *Schizophrenia Bulletin*, 24 (1), 87-98.

Doody, G. A., Gotz, M., Johnstone, E. C., Frith, C. D. & Cunningham Owens, D. G. (1998). Theory of Mind and Psychoses. *Psychological Medicine*, 28, 397-405.

Dragoi, V., Staddon, J. E. R., Palmer, R. G., & Buhusi, C. V. (2003). Interval Timing as an Emergent Learning Property. *Psychological Review*, 110, 126–144.

Droit-Volet, S., Clément, A., & Wearden, J.H. (2001). Temporal Generalization in 3- to 8-Year-Old Children. *Journal of Experimental Child Psychology*, 80, 271-288.

Droit-Volet, S. & Meck, W, H. (2007). How Emotions Colour Our Perception of Time, *Trends in Cognitive Sciences*, 11 (12), 504-513.

Droit-Volet, S., & Wearden, J. (2002). Speeding up an Internal Clock in Children? Effects of Visual Flicker on Subjective Duration. *Quarterly Journal of Experimental Psychology*, 55B, 193-211.

Dudley, R. E. J., John, C. H., Young, A. W. & Over, D. E. (1997). Normal and abnormal reasoning in people with delusions. *British Journal of Clinical Psychology*, 36, 243-258.

Eckblad, M. & Chapman, L. J. (1983). Magical Ideation as an Indicator of Schizotypy, *Journal of Consulting and Clinical Psychology*. Vol 51 (2), 215-225.

Eckblad, M., Chapman, L. J., Chapman, J.P. & Mishlove, M. (1982). "The Revised Social Anhedonia Scale." Unpublished test (copies available from authors), University of Wisconsin, Madison, WI.

Ellason, J. W. & Ross, C. A. (1995). Positive and Negative Symptoms in Dissociative Disorder and Schizophrenia, *Journal of Nervous and Mental Disease*, 183, 263-241.

Ellis, H. D. & Young, A. W. Accounting for Delusional Misidentifications, *British Journal of Psychiatry,* 157, 239-248.

Ellis, H. D., Lewis, M. B., Moselhy, H. F. & Young, A. W. (2000). Automatic Without Autonomic Responses to Familiar Faces: Differential Components of Covert Face Recognition in a Case of Capgras Delusion, *Cognitive Neuropsychiatry*, 5, 255-269.

Elvevag, B., McCormack, T., Gilbert, A., Brown, G., Weinberger, D. & Goldberg, T. (2003). Duration Judgements in Patients with Schizophrenia, *Psychological Medicine*, 33, 1249-1261.

Erlenmeyer-Kimmling, L., Cornblatt, B. A., Rock, D., Roberts, S., Bell, M. & West, A. (1993). The New York High-Risk Project: Anhedonia, Attentional Deviance and Psychopathology, *Schizophrenia Bulletin*, 19 (1), 141 – 153.

Erlenmeyer-Kimling, L., Adamo, U. H.,Rock, D., Roberts, S. A., Bassett, A. S., Squires-Wheeler, E., Cornblatt, B. A., Endicott, J., Pape, S. & Gottesman, I. I. (1997). The New-York High-Risk Project: Prevalence and Co-Morbidity of Axis I Disorder in Offspring of Schizophrenic Parents and 25 Year Follow-Up, *Archives of General Psychiatry*, 54 (12), 1096-1102.

Escher, S., Romme, M., Buiks, A., Delespaul, P., & van Os, J. (2002). Formation of delusional ideation in adolescents hearing voices: a prospective study. *American Journal Of Medical Genetics (Neuropsychiatric Genetics)*, 114, 913 – 920.

Fagen, R.M., & Young, D.Y. (1978). Temporal Patterns of Behaviors: Durations, Intervals, Latencies, and Sequences. In P. W. Colgan (Ed.), *Quantitative Ethology* (pp. 79-114). New York: Wiley.

Faraone, S. V., Green, A. I., Seidman, L. J., & Tsuang, M. T. (2001). "Schizotaxia": Clinical Implications and New Directions in Research, *Schizophrenia Bulletin*, 27 (1), 1 – 18.

Fear, C. F. & Healey, D. (1997). Probabilistic Reasoning in Obsessive-Compulsive and Delusional Disorders, *Psychological Medicine*, 27 (1), 199-208.

Ferrara, A., Lejeune, H. & Wearden, J. H. (1997). Changing Sensitivity to Duration in Human Scalar Timing: An Experiment, a Review, and some Possible Explanations, *The Quarterly Journal of Experimental Psychology*, 50B (3), 217 – 237.

Ferster, C. B. & Skinner, B. F. (1957). *Schedules of Reinforcement.* New York: Appleton-Century-Crofts.

Fish, B., Marcus, J., Hans, S.L., Auerbach, J.G., & Perdue, S. (1992) Infants at Risk for Schizophrenia: Sequelae of a Genetic Neurointegrative Defect. A Review and Replication Analysis of Pandysmaturation in the Jerusalem Infant Development Study. *Archives of General Psychiatry,* 49:221-235, 1992.

Fisher, J. E., Mohanty, A., Herrington, J. D., Koven, N. S., Miller, G. A. & Heller, W. (2004). Neuropsychological Evidence for Dimensional Schizotypy:

Implications for Creativity and Psychopathology, *Journal of Research in Personality*, 38 (1), 24-31.

Folley, B. S. & Park, S. (2005). Verbal Creativity and Schizotypal Personality in Relation to Prefrontal Hemispheric Laterality: A Behavioral and Near-Infrared Optical Imaging Study. *Schizophrenia Research*, 80, 271-282.

Foucault, M. (1965). *Madness and Civilisation: A History of Insanity in the Age of Reason.* New York: Random House.

Freedman, B. J. (1974). The Subjective Experience of Perceptual and Cognitive Disturbances in Schizophrenia: A Review of Autobiographical Accounts, *Archives of General Psychiatry*, 30 (3), 333-340.

Freeman, T. (1981). On the Psychopathology of Persecutory Delusions, *British Journal of Psychiatry*, 139, 529-532.

Freeman, T. (1990). Psychoanalytic Aspects of Morbid Jealousy in Women, *British Journal of Psychiatry*, 156, 68-72.

Freeman, D., & Garety, P.A. (2003). Connecting Neurosis and Psychosis: the direct influence of emotion on delusions and hallucinations, *Behavior Research and Therapy,* 41, 923-947.

Freeman, D., Garety, P. A., Kuipers, E., Fowler, D. & Bebbington, P. E. (2002). A Cognitive Model of Persecutory Delusions, *British Journal of Clinical Psychology*, 41 (4), 331-347.

Frith, C. D. (1979). Consciousness, Information Processing and Schizophrenia, *British Journal of Psychiatry*, 134, 225-235.

Frith, C. D. (1987). The Positive and Negative Symptoms of Schizophrenia Reflect Impairments in the Perception and Initiation of Action. *Psychological Medicine*, 17, 631-648.

Frith, C. D. (1992). The cognitive neuropsychology of schizophrenia. Hove: Lawrence Erlbaum.

Frith, C. D. & Corcoran, R. (1996). Exploring ` Theory of Mind ' in People with Schizophrenia. *Psychological Medicine*, 26, 521-530.

Frith, C.D. and Done, D.J., (1989). Experiences of Alien Control in Schizophrenia Reflect a Disorder in the Central Monitoring of Action. *Psychological Medicine,* 19, 359–363.

Fry, W., Kelleher, R. T., & Cook, L. (1960). A Mathematical Index of Performance on Fixed-Interval Schedules of Reinforcement, *Journal of the Experimental Analysis of Behaviour*, 3, 193 – 199.

Gallagher, A. D., Dinin, T. G. & Baker, L. G. V. (1994). The Effects of Varying Auditory Input on Schizophrenic Hallucinations: A Replication, *British Journal of Medical Psychology*, 67, 67-76.

Garety, P. A. (1991). Reasoning and Delusions. *British Journal of Psychiatry*, 159 (Suppl. 14), 14-18.

Garety, P. A. & Freeman, D. (1999). Cognitive Approaches to Delusions: A Critical Review of Theories and Evidence. *British Journal of Clinical Psychology,* 38, 113-154.

Garety, P. A. & Hemsley, D. R. (1994). *Delusions: Investigations into the Psychology of Delusional Reasoning.* Oxford University Press : Oxford.

Garety, P. A. & Hemsley, D. R. & Wesseley, S. (1991). Reasoning in Deluded Schizophrenic and Paranoid Patients: Biases in Performance in Performance on a Probabilistic Inference Task, *Journal of Nervous and Mental Disease*, 179 (4), 194-201.

Gibbon, J. (1977). Scalar Expectancy Theory and Weber's Law in Animal Timing, *Psychological Review*, 84 (3), 279-325.

Gibbon, J. (1991). Origins of Scalar Timing. Learning and Motivation, 22, 3–38.

Gold, K. & Rabins, P. V. (1989). Isolated Visual Hallucinations and the Charles Bonnet Syndrome: A Review of the Literature and Six Cases, *Comprehensive Psychiatry*, 30 (1), 90-98.

Golden, R. R. & Meehl, P. E. (1979). Detection of the Schizoid Taxon with MMPI Indicators, Journal of Abnormal Psychology. 88 (3), 217-233.

Gooding, D. C., Tallent, K. A., & Matts, C. W. (2005). Clinical Status of At-Risk Individuals 5 Years Later: Further Validation of the Psychometric High-Risk Strategy, *Journal of Abnormal Psychology*, 114 (1), 170 – 175.

Gould, L. N. (1948). Verbal Hallucinations and Activation of Vocal Musculature, *American Journal of Psychiatry*, 105, 367-372.

Gould, L. N. (1949). Auditory Hallucinations and Subvocal Speech, *Journal of Nervous and Mental Disease*, 109, 418-427.

Gould, L. N. (1950). Verbal Hallucinations as Automatic Speech, *American Journal of Psychiatry*, 107, 110-119.

Gray, N.S., Fernandez, M., Williams, J., Ruddle, R.A., & Snowden, R.J. (2002). Which Schizotypal Dimensions Abolish Latent Inhibition? *British Journal of Clinical Psychology*, 41, 271 – 284.

Green, P., Hallett, S. & Hunter, M. (1983). Abnormal Interhemispheric Specialisation in Schizophrenics and High-Risk Children. In Flor-Henry, P. & Gruzelier, J (Eds.). *Laterality and Psychopathology* (pp. 448-470). Amsterdam: Elsevier.

Green, P. & Preston, M. (1981). Reinforcement of Vocal Correlates of Auditory Hallucinations by Auditory Feedback: A Case Study, *British Journal of Psychiatry*, 139, 204-208.

Green, M. J. & Williams, L. M. (1999). Schizotypy and Creativity as Effects of Reduced Cognitive Inhibition, *Personality and Individual Differences*, 27 (2), 263-276.

Grimby, A. (1993). Bereavement Among Elderly People: Grief Reactions, Post-Bereavement Hallucinations and Quality of Life. *Acta Psychiatrica Scandinavica*, 87, 72–80.

Grimby, A. (1998). Hallucinations Following the Loss of a Spouse: Common and Normal Events Among the Elderly. *Journal of Clinical Gerontology*, 4, 65–74.

Grossberg, S. (2000). How Hallucinations May Arise from Brain Mechanisms of Learning, Attention and Volition, *Journal of the International Neuropsychological Society*, 6 (5), 583-592.

Haddock, G., Slade, P.D., & Bentall, R.P. (1995). Auditory hallucinations and the verbal transformation effect: the role of suggestions. *Personality and Individual Differences*, 19, 301 – 306.

Haddock, G., Tarrier, N., Spaulding, W., Yusupoff, L., Kinney, C. & McCarthy, E. (1998). Individual Cognitive-Behaviour Therapy in Hallucinations and Delusions: A Review, *Clinical Psychology Review*, 18 (7), 821-838.

Hamilton, M. (1984). *Fish's schizophrenia*. London: Wright.

Hans, S.L., Marcus, J., Henson, L., Auerbach, J.G., & Mirsky, A. F. (1992) Interpersonal Behavior of Children At Risk for Schizophrenia. *Psychiatry*, 55:314-335.

Harrision, G., Hopper, K., Craig, T., Laska, E., Siegel, C., Wanderling, J., et al (2001). Recovery From Psychotic Illness, *British Journal of Psychiatry*, 178, 506-517.

Hayes, S. C., Brownstein, A. J., Haas, J. R., & Greenway, D. E. (1986). Instructions, multiple schedules, and extinction: Distinguishing rule-governed from schedule - controlled behavior. *Journal of the Experimental Analysis of Behavior*, 46, 137-147.

Heilbrun, A. B. (1980). Impaired Recognition of Self-Expressed Thought in Patients with Auditory Hallucinations, *Journal of Abnormal Psychology*, 89, 728-736.

Heilbrun, A. B., Blum, N. A. & Haas, M. (1983). Cognitive Vulnerability to Hallucination: Preferred Imagery Mode and Spatial Location of Sounds, *British Journal of Psychiatry*, 143, 294-299.

Heins, T., Gray, A. & Tennant, M. (1990). Persisting Hallucinations Following Childhood Sexual Abuse. *Australian and New Zealand Journal of Psychiatry*, 24 (4), 561-565.

Hemsley, D. R. (1987). An Experimental Psychological Model for Schizophrenia. In Hafner, H., Gattaz, W. F., & Janzarik, W. (Eds.). *In Search for the Causes of Schizophrenia*, (pp. 179-188). Heidelberg: Springer.

Hemsley, D. R. (1993). A Simple (or Simplistic?) Cognitive Model for Schizophrenia, *Behaviour Research and Therapy*, 31, 633–646.

Hemsley, D. R., & Garety, P. A., (1986). The Formation and Maintenance: A Bayesian Analysis, *British Journal of Psychiatry*, 149: 51-6. In Bentall, R. P. (2003). Abnormal Attitudes. *Madness Explained, Psychosis and Human Nature*. PP. 315 – 322. London: Penguin Books Ltd.

Herron, W. G., Schultz, C. L. & Welt, A. G. (1992). A Comparison of 16 Systems to Diagnose Schizophrenia, *Journal of Clinical Psychology*, 48, 711-721.

Higa, J. J., Wynne, C. D. L., & Staddon, J. E. R. (1991). Dynamics of Time Discrimination. *Journal of Experimental Psychology: Animal Behavior Processes*, 17, 281 - 291.

Hoffman, R. E. (1986). Verbal Hallucinations and Language Production Processes in Schizophrenia. *Behavioural and Brain Sciences* 9, 503-548.

Hoffman, R. E. & Rapaport, J. (1994). A Psycholinguistic Study of Auditory/Verbal Hallucinations: Preliminary Findings. In David, A. S. & Cutting, J. C. (Eds.) *The Neuropsychology of Schizophrenia* (pp. 255-267). Erlbaum: London.

Hofland, K., & Johansson, S. (1982). *Word frequencies in British and American English*. Bergen: Norwegian Computing Centre for the Humanities.

Horan, W. P., Reise, S. P., Subotnik, K. L., Ventura, J., & Nuechterlein, K. H. (2008). The Validity of Psychosis Proneness Scales as Vulnerability Indicators of Recent-Onset Schizophrenia Patients, *Schizophrenia Research*, 100, 224-236.

Honig, A., Romme, M., Ensink, B. J., Escher, S., Pennings, M. & Devries, M. W. (1998). Auditory Hallucinations: A Comparison Between Patients and Nonpatients, *Journal of Nervous and Mental Disease*, 10, 646-651.

Huq, S. F., Garety, P. A., & Hemsley, D. R., (1988). Probabilistic Judgements In Deluded and Nondeluded Subjects. *Quarterly Journal of Experimental Psychology*, 40A, 801-12.

Irwin, J. R., & McClelland, G. H. (2003). Negative Consequences of Dichotomizing Continuous Predictor Variables. *Journal of Marketing Research*, 40, 366–371.

Jablensky, A. (2002). Prevalence and Incidence of Schizophrenia Spectrum Disorders: Implications for Prevention, *Australian and New Zealand Journal of Psychiatry*, 34, 26-34.

Jakes, S. & Hemsley, D. R. (1986). Individual Differences in reaction to Brief Exposure to Unpatterned Stimulation, *Personality and Individual Differences*, 7, 121-123.

Jaynes, J. (1979). *The Origins of Consciousness in the Breakdown of Bicameral Mind.* London: Penguin.

John, C. H. & Dodgson, G. (1994). Inductive Reasoning in Delusional Thinking. *Journal of Mental Health*, 3, 31-49.

Johns, L. C., & McGuire, P. K. (1999). Verbal Self-Monitoring and Auditory Hallucinations in Schizophrenia, *The Lancet*, 353, 9151, pp 469-470.

Johns, L. C. & Van-Os, J. (2001). The Continuity of Psychotic Experiences in the General Population, *Clinical Psychology Review*, 21 (8), 1125-1141.

Jones, P.B., Rodgers, B., Murray, R. M. & Marmot, M. (1994). Child Developmental Risk Factors for Schizophrenia, *Lancet* 344, 1398–1402.

Kane, J. M. (2006). Tardive Dyskinesia Circa 2006, *American Journal of Psychiatry*, 163, 1316-1318.

Kapur, S. & Remington, G. (1996). Serotonin-Dopamine Interaction and its Relevance to Schizophrenia, *American Journal of Psychiatry*, 153, 466-476.

Keefe, J. A. & Magaro, P. A. (1980). Creativity and Schizophrenia: An Equivalence of Cognitive Processing, *Journal of Abnormal Psychology*, 89 (3), 390-398.

Kemp, R., Chua, S., McKenna, P. & David, A. (1997). Reasoning and Delusions. *British Journal of Psychiatry*, 170, 398-405.

Kendler, K. S., Thacker, L. & Walsh, D. (1996). Self-Report Measures of Schizotypy as Indices of Familial Vulnerability to Schizophrenia, *Schizophrenia Bulletin*, 22 (3), 511 – 520.

Kent, G. & Wahass, S. (1996). The Content and Characteristics of Auditory Hallucinations in Saudi Arabia and the UK: A Cross-Cultural Comparison, *Acta Psychiatrica Scandinavica*, 94 (6), 433-437.

Kety, S. S., Rosenthal, D., Wender, P.H., Schulsinger, F. & Jacobsen, B. (1975). Mental Illness of the Biological and Adoptive Families of Adoptive Individuals Who Have Become Schizophrenic: A Preliminary Report Based on Psychiatric Interviews. In: Fieve, R. R., Rosenthal, D. & Brill, H. (Eds.) *Genetic Research in Psychiatry*, Baltimore: Johns Hopkins University Press, pp 147-165.

Kiang, M. (2009). Schizotypy and Language: A Review, *Journal of Neurolinguistics*, (In Press).

Killeen, P. R., & Feterman, J. G., (1988). A Behavioural Theory of Timing, *Psychological Review,* 95, 274 – 295.

Killeen, P., & Fetterman, J. G. (1993). The Behavioural Theory of Timing: Transition Analyses. *Journal of the Experimental Analysis of Behavior*, 59, 411–422.

Kinderman, P. & Bentall, R. P. (1996). Self-discrepancies and persecutory delusions: Evidence for a model of paranoid ideation. Journal of Abnormal Psychology, 105, 106-113.

Koffel, E. & Watson, D. (2009). Unusual Sleep Experiences, Dissociation and Schizotypy: Evidence for a Common Domain, *Clinical Psychology Review*, 29 (6), 548-559.

Krabbendam, L., Arts, B., van Os, J. & Aleman, A. (2004). Cognitive Functioning in Patients with Schizophrenia and Bipolar Disorder: A Quantitative Review, *Schizophrenia Research,* 80, 137-149.

Kraepelin, E. ([1913] 1919). Dementia Praecox. In Kraepelin, E, *Psychiatrica*, 8th edn (translated by Barclay, R). Melbourne, FL: Krieger.

Kring, A. M., Kerr, S. L., Smith, D. A. & Neale, J. M. (1993). Flat Affect in Schizophrenia Does Not Reflect Diminshed Subjective Experience in Emotion, *Journal of Abnormal Psychology*, 102 (4), 507 – 517.

Kugelmass, S., Faber, N., Ingraham, L. J., Frenkel, E., Nathan, M., Mirsky, A. F. & Shakar, G. B. (1995). Reanalysis of SCOR and Anxiety Measures in the Israeli High-Risk Study, *Schizophrenia Bulletin*, 21 (2), 205-217.

Kunugi, H., Tanaka, M., Hori, H., Hashimoto, R., Saitoh, O. & Hironaka, N. (2007). Prepulse Inhibition of Acoustic Startle in Japanese Patients with Chronic Schizophrenia, *Neuroscience Research,* 59 (1), 23–28.

Kwapil, T. R. (1998). Social Anhedonia as a Predictor of the Development of Schizophrenia Spectrum Disorders, *Journal of Abnormal Psychology*, 107 (4), 558 – 565.

Langdon, R. & Coltheart, M. (2004). Recognition of Metaphor and Irony in Young Adults: the Impact of Schizotypal Personality Traits. *Psychiatry Research*, 125 (1), 9-20.

Langdon, R., Michie, P. T., Ward, P. B., McConaghy, N., Catts, S. V. & Coltheart, M. (1997). Defective Self and/or Other Mentalising in Schizophrenia: A Cognitive Neuropsychological Approach. *Cognitive Neuropsychiatry*, 2, 167-193.

Laruelle, M., Kegeles, L. S. & Abi-Dargham, A. (2003). Glutamate, Dopamine and Schizophrenia, *Annals of the New York Academy of Science*, 1003, 138-158.

Lattal, K. A., & Neef, N. A. (1996). Recent Reinforcement-Schedule Research and Applied Behavior Analysis. *Journal of Applied Behavior Analysis*, 29, 213-230.

Launay, G., & Slade, P. (1981). The measurement of hallucinatory predisposition in male and female prisoners. *Personality and Individual Differences*, 2, 221–234.

Lee, K-H., Dixon, J. K., Spence, S. A. & Woodruff, P. W. R. (2006). Time Perception Dysfunction in Psychometric Schizotypy, *Personality and Individual Differences*, 40 (7), 1363-1373.

Lejeune, H., Richelle, M. & Wearden, J. H. (2006). About and Skinner and Time: Behaviour-Analytic Contributions to Animal Timing, *Journal of the Experimental Analysis of Behaviour*, 85, 125-142.

Lenzenweger, M. F. & Gold, J. M. (2000). Auditory Working Memory and Verbal Recall Memory in Schizotypy, *Schizophrenia Research*, 42 (2), 101-110.

Leslie, J.C. (1996). Intermittent Reinforcement. *Principles of Behavioral Analysis* (pp 83 – 109). Netherlands: Harwood Academic Publishers.

Lewandowski, K. E., Barrantes-Vidal, N., Nelson-Gray, R. O., Clancy, C., Kepley, H, O. & Kwapil-T. R. (2006). Anxiety and depression symptoms in psychometrically identified schizotypy, *Schizophrenia Research*, 83, 225-235.

Lewis G, David A, Andreasson S, Allebeck P (1992). Schizophrenia and City Life. *Lancet,* 340, 137-40.

Lhamon, W. T. & Goldstone, S. (1956). Estimation of One Second Durations by Schizophrenic Patients, *Archives of Neurology & Psychiatry*, 76 (6), 625-629.

Light, G. A., & Braff, D. L. (2000). Do Self-Reports of Perceptual Abnormalities Reflect Gating Deficits in Schizophrenia Patients, *Biological Psychiatry*, 47, 463 – 467.

Lippman, L. G. & Meyer, M. E. (1967). Fixed Interval Performance as Related to Instructions and to Subjects' Verbalizations of the Contingency, *Psychonomic Science*, 8, 135 – 136.

Lowe, D. G. (1979). Strategies, Context and the Mechanisms of Response Inhibition. *Memory and Cognition,* 7, 382-389.

Lowe, C. F., Beasty, A. & Bentall, R. P. (1983). The Role of Verbal Behaviour in Human Learning: Infant Performance on Fixed-Interval Schedules. *Journal of the Experimental Analysis of Behaviour,* 39, 157–164.

Lubow, R. E. (2005). Construct Validity of the Animal Latent Inhibition Model of Selective Attention Deficits in Schizophrenia, *Schizophrenia Bulletin*, 31 (1), 139-153.

Machado, A. (1997). Learning the Temporal Dynamics of Behaviour. *Psychological Review,* 104, 241–265.

Machado, A. & Keen, R. (1999). Learning to Time (LET) or Scalar Expectancy Theory (SET)? A Critical Test of Two Models, *Psychological Science*, 10 (3), 285-290.

Maher, B. A. (1974). Delusional thinking and perceptual disorder. *Journal of Individual Psychology*, 30, 98-113.

Malmberg, A., Lewis, G., David, A. & Alleback, P. (1998). Pre-morbid Adjustment and Personality in People with Schizophrenia, *British Journal of Psychiatry*, 172, 308-313.

Marcelis, M., Navarro-Mateu, F., Murray, R., Selten, J. -P. & van Os, J. (1998). Urbanization and Psychosis: A Study of 1942-1978 Birth Cohorts in the Netherlands, *Psychological Medicine*, 28, 871-879.

Margo, A., Hemsley, D. R. & Slade, P. D. (1981). The Effects of Varying Auditory Input on Schizophrenic Hallucinations, *British Journal of Psychiatry*, 139, 122-127.

Mason, O. & Claridge, G (2006). The Oxford-Liverpool Inventory of Feelings and Experiences (O-Life): Further Description and Extended Norms, *Schizophrenia Research*, 82, 203-211.

Mason, O., Claridge, G. & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences,* 53, 727-730.

Mason, O., Linney, Y. & Claridge, G. (2005). Short scales for measuring schizotypy. *Schizophrenia Research*, 78, 293 – 296.

Matussek, P. (1952). Studies in Delusional Perception. In Cutting, J. & Shepherd, M. (Eds.). *The Clinical Roots of the Schizophrenia Concept*, (pp. 89-103). Cambridge: University Press.

Maxwell, S.E. & Delaney, H.D. (1993). Bivariate Median Splits and Spurious Statistical Significance. *Psychological Bulletin,* 113 (1), 181–190.

McDonald, A. W., & Schulz, S. C. (2009). What we Know: Findings that Every Theory of Schizophrenia Should Explain, *Schizophrenia Bulletin*, 35 (3), 493 – 508.

McGrath, J. & McGlashan, T. H. (1999). Improving Outcomes for Recent-Onset Psychosis: Disentangling Hope, Speculation and Evidence, *Acta Psychiatrica Scandanavica*, 100 (2), 83-84. In Murray, R. M., Jones, P. B., Susser, E., van Os, J. & Cannon, M. (Eds.). The Epidemiology of Schizophrenia. Cambridge: University Press.

McCreery, C. & Claridge, G. (1996a). A Study of Hallucination in Normal Subjects – I. Self Report Data. *Personality and Individual Differences*, 21 (5), 739-747.

McCreery, C. & Claridge, G. (1996b). A Study of Hallucination in Normal Subjects – II. Self Electrophysiological Data, *Personality and Individual Differences*, 21 (5), 749-758.

McGlashan, T. (1988). A Selective Review of Recent North-American Long-Term Follow-Up Studies of Schizophrenia. *Schizophrenia Bulletin*, 14, 515-542.

McGuigan, F. J. (1966). Covert Oral Behaviour and Auditory Hallucinations, *Psychophysiology*, 3, 73-80.

Meck, W. H. (1983). Selective Adjustment of the Speed of Internal Clock and Memory Processes, *Journal of Experimental Psychology*, 9 (2), 171 – 201.

Meehl, P. (1962). Schizotaxia, schizotypia, schizophrenia. *American Psychologist*, 17: 827 – 838.

Meehl, P. (1989). Schizotaxia revisited. *Archives of General Psychiatry*, 46: 935 – 944.

Mellsopp, G., Varghese, F., Joshua, S. & Hicks, A. (1982). The Reliability of Axis-II of DSM-III, *American Journal of Psychiatry*, 139 (10), 1360-1361.

Meltzer, H. Y., & Stahl, S. M. (1976). The Dopamine Hypothesis of Schizophrenia: A Review, *Schizophrenia Bulletin*. 2, 19–76.

Menon, G. J., Rahman, I., Menon, S. J. & Dutton, G. N. (2003). Complex Visual Hallucinations in the Visually Impaired: The Charles Bonnet Syndrome, *Survey of Ophthalmology*, 48 (1), 58-72.

Merckelbach, H. & Van Der Ven, V. (2001). Another White Christmas: Fantasy Proneness and Reports of "Hallucinatory" Experiences' in Undergraduate Students, *Journal of Behaviour Therapy and Experimental Psychiatry*, 32 (3), 137-144.

Miers, T.C., and Raulin, M.L. (1984). The Development of a Scale to Measure Cognitive Slippage." Presented at the Eastern Psychological Association Convention, Boston, MA. Miller, D. T. & Ross, M. (1975). Self-Serving Biases in the Attribution of Causality: Fact or Fiction? *Psychological Bulletin*, 82 (2), 213-225.

Miller, P., Byrne, M., Hodges, A., Lawrie, S. M., Owens, D. G. C. & Johnstone, E. C. (2002). Schizotypal Components in People at High Risk of Developing Schizophrenia: Early Findings from the Edinburgh High-Risk Study, *British Journal of Psychiatry*, 180, 179-184.

Miller, P., Lawrie, S. M., Byrne, M., Cosway, R., & Johnstone, E. C. (2002). Self-Rated Schizotypal Cognitions, Psychotic Symptoms and the Onset of Schizophrenia in Young People at High-Risk for Schizophrenia, *Acta, Psychiatr Scand*, 105, 341 – 345.

Miller, P., Lawrie, S. M., Hodges, A., Clafferty, R., Cosway, R. & Johnstone, E. C. (2001). Genetic Liability, Illicit Drug Use, and Psychotic Symptoms: Preliminary Findings from the Edinburgh Study of People at High Risk for Schizophrenia, *Social Psychiatry and Psychiatric Epidemiology*, 36, 338 – 342.

Mintz, S., & Alpert, M. (1972). Imagery vividness, reality testing and schizophrenic hallucinations, *Journal of Abnormal and Social Psychology,* 19, 310 – 316.

Mitchley, N. J., Barber, J., Gray, J. M., Brooks, D. N. & Livingstone, M. G. (1998). Comprehension of Irony in Schizophrenia. *Cognitive Neuropsychiatry*, 3 (2), 127-138.

Mitropoulou, V., Harvey, P. D., Zegarelli, G., New, A. S., Silverman, J. M. & Siever, L. J. (2005). Neuropsychological Performance in Schizotypal Personality Disorder: Importance of Working Memory, *American Journal of Psychiatry*, 162, 1896-1903.

Moritz, S. & Woodward, T. S. (2006). Metacognitive Control Over False Memories: A Key Determinant of Delusional Thinking, *Current Psychiatry Reports*, 9 (3), 184-190.

Moriwaki, M., Kishi, T., Takahashi, H., Hashimoto, R., Kawashima, K., Okochi, T., et al (2009). Prepulse Inhibition of the Startle Response with Chronic Schizophrenia: A Replication Study, *Neuroscience Research*, 65 (3), 259-262.

Morrison, A. P., Frame, L. & Larkin, W. (2003). Relationships Between Trauma and Psychosis: A Review and Integration, *British Journal of Clinical Psychology*, 42 (4), 331-353.

Morrison, A. P. & Haddock, G. (1997). Self-Focused Attention in Schizophrenic Patients With and Without Auditory Hallucinations and Normal Subjects: A Comparative Study, *Personality and Individual Differences*, 23 (6), 937-941.

Mortenson, P. B., Pederson, C. B. & Westergaard, T., Wohlfahrt, J., Ewald, H., Mors, O., et al (1999). Effects of Family History and Season of Birth on the Risk of Schizophrenia, *The New England Journal of Medicine*, 340, 603-608.

Motulsky, H. J. & Ransnas, L. A. (1987). Fitting Curves to Data Using Non-Linear Regression: A Practical and Nonmathematical Review, *The Journal of the Federation of American Societies for Experimental Biology*, 1, 365 – 374.

Mueser, K. T., Yarnold, P. R., Levinson, D. F., Singh, H., Bellack, A. S., Kee, K., et al, (1990). Prevalence of Substance Abuse in Schizophrenia: Demographic and Clinical Correlates. *Schizophrenia Bulletin*, 16 (1), 31-56.

Neale, J. M. (1988). Defensive Functions of Manic Episodes. In Oltmanns, T. F. & Maher, B. A. (Eds.). *Delusional Beliefs*, (pp. 138-156). New York: Wiley.

Nelki, J. (1988). Making Sense of a Delusion of Smell: A Psychotherapeutic Approach. *British Journal of Medical Psychology*, 61, 267-275.

Nettle, D. (2006). Schizotypy and Mental Health Amongst Poets, Visual Artists and Mathematicians, *Journal of Research in Personality*, 40 (6), 876-890.

Nevin J. A. Grace R. C. Holland S. McLean A. P. (2001) Variable-Ratio Versus Variable Interval Schedules: Response Rate, Resistance to Change, and Preference. *Journal of the Experimental Analysis of Behavior.* 76, 43–74.

Nielsen, T. C. & Petersen, K. (1976). Electrodermal Correlates of Extraversion, Trait Anxiety and Schizophrenism, *Scandanavian Journal of Psychology*, 17 (1), 73-80.

Normington, C. J. (1967). Time Estimation in Process Reactive Schizophrenia, *Journal of Consulting Psychology*, 31 (2), 222.

O'Kearney, R. & Nicholson, C. (2008). Can a Theory of Mind Disruption Help Explain OCD Related Metacognitive Disturbances, *Behaviour Change*, 25 (2), 55-70.

Olin, S.C., and Mednick, S.A. (1996) Risk Factors of Psychosis: Identifying Vulnerable Populations Premorbidly. *Schizophrenia Bulletin,* 22(2):223-240.

Oruc, L. & Bell, P. (1995). Multiple Rape Trauma Followed by Delusional Parasitosis: A Case Report from the Bosnian War, *Schizophrenia Research,* 16, 173-174.

Osborne, L.A., McHugh, L., Saunders, J., & Reed, P. (2008). Parenting Stress Reduces the Effectiveness of Early Teaching Interventions for Autistic Spectrum Disorders. *Journal of Autism & Developmental Disorders,* 38, 1092 – 1103.

Osborne, L. A., & Reed, P. (2008). Parents' Perceptions of Communication with Professionals During the Diagnosis of Autism, *Autism*, 12, 309 – 324.

Overton, D. A. (1964). State-dependent or "dissociated" learning produced with pentobarbital. *Journal of Comparative and Physiological Psychology*, 57, 3 – 12.

Paivio, A. (1963). Learning of Adjective-Noun Paired-Associates as a Function of Adjective-Noun Word Order and Noun Abstractness. *Canadian Journal of Psychology*, 17, 370-379.

Paivio, A. (1965). Abstractness, Imagery, and Meaningfulness, in Paired-Associate Learning. *Journal of Verbal Learning, Verbal Behavior*, 4, 32-38.

Paivio, A. (1971). *Imagery and verbal processes.* New York: Holt, Rhinehart and Winston.

Paivio, A. (1978). Mental comparisons involving abstract attitudes. *Memory and Cognition*, 6, 199 – 208.

Paivio, A., Yuille, J.C., & Madigan, S.A., (1968). Concreteness, Imagery and Meaningfulness, *Journal of Experimental Psychology: Monograph Supplement*, Vol. 76(1), 1- 25.

Peele, D. B., Casey, J., & Silberberg, A. (1984). Primacy of inter response-time reinforcement in accounting for rate differences under variable-ratio and variable interval schedules. *Journal of Experimental Psychology: Animal Behaviour Processes, 10,* 149–167.

Penney, T. B., Meck, W. H., Roberts, S. A., Gibbon, J., Erlenmeyer-Kimling, L. (2005). Interval Timing Deficits in Individuals at High Risk for Schizophrenia, *Brain and Cognition*, 58, 109 – 118.

Penton-Voak, I.S., Edwards, H., Percival, A., & Wearden, J.H. (1996). Speeding up an Internal Clock in Humans? Effects of click trains on subjective duration. *Journal of Experimental Psychology: Animal Behavior Processes*, 22, 307-320.

Peralta, P. & Cuesta, V. J. (2007). A Dimensional and Categorical Architecture for the Classification of Psychotic Disorders, *World Psychiatry*, 6 (2), 100-101.

Peters, E., Day, S. & Garety, P. (1997). From Preconscious to Conscious Processing - Where Does the Abnormality Lie in Delusions? *Schizophrenia Research*, 24 (1), 120-120(1).

Peters, E., Joseph, S., Day, S., Garety, P., (2004) Measuring delusional ideation: the 21-item Peters et al. Delusions Inventory (PDI). *Schizophrenia Bulletin,* 30(4), 1005-22.

Pilling, S., Bebbington, P., Kuipers, E., Garety, P., Geddes, J., Orbach, G., & Morgan, C. (2002). Psychological Treatments in Schizophrenia: I. Meta-Analysis of Family Intervention and Cognitive Behaviour Therapy, *Psychological Medicine*, 32, 763 – 782.

Pinel, P. (1801). *Traite Medic-Philosphique sur L'Alientation Mentale*. Paris. In Read, J. (2004). *A History of Madness*, In Read, J., Mosher, L. R. & Bentall,

R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 9-20). Hove: Brunner-Routledge.

Platt, J. R. (1979). Temporal Differentiation and the Psychophysics of Time. In Zeiler, M. D. & Harzem, P. (Eds.), *Advances in the Analysis of Behaviour, Vol. 1: Reinforcement and the Organization of Behaviour* (pp. 1–29). Chichester, England: Wiley.

Posey, T.B. & Losch, M.E. (1983). Auditory hallucinations of hearing voices in 375 normal subjects. *Imagination, Cognition and Personality*, 2, 99–113.

Poulton, R., Caspi, A., Moffitt, T. E., Cannon, M., Murray, R. & Harrington, H. (2000). Children's Self-Reported Psychotic Symptoms and Adult Schizophreniform Disorder, *Archives of General Psychiatry*, 57 (11), 1053-1058.

Rabin, A. L. (1957). Time Estimation of Schizophrenics and Non-Psychotics, *Journal of Clinical Psychology*, 13, 88-90.

Rado, S. (1953). Dynamics and Classification of Disordered Behaviour, *American Journal of Psychiatry*, 110, 406-416.

Raia, C.P., Shillingford, S.A., Miller, H.L., & Baier, P.S. (2000). Interaction in Procedural Factors in Human Performance on Yoked Schedules. *Journal of the experimental analysis of human behavior*, 74 (3), 265-281.

Raine, A. (1991). The SPQ: A scale for the assessment of schizotypal personality based on DSM-1II-R criteria. Schizophrenia Bulletin, 17, 555-564.

Raine, A. & Benishay, D. (1995). The SPQ-B: A Brief Screening Instrument for Schizotypal Personality Disorder, *Journal of Personality Disorders*, 9 (4), 346-355.

Raine, A. & Lencz, T. (1995). Theoretical and Conceptual Issues in Schizotypal Personality Research. In Raine, A, Lencz, T. & Mednick, S. A. (Eds.) *Schizotypal Personality*, (pp. 3-18) Cambridge: University Press.

Rakitin, B. C., Gibbon, J., Penney, T. B., Malapani, C., Hinton, S. C. & Meck, W. H. (1998). Scalar Expectancy Theory and Peak-Interval Timing in Humans. *Journal of Experimental Psychology*, 24, 15–33.

Rankin, P. M. & O'Carroll, P. J. (1995). Reality Discrimination, Reality Monitoring and Disposition towards Hallucinations. *British Journal of Clinical Psychology,* 34, 517–528.

Rao, V. & Lyketsos, C. G. (1998). Delusion in Alzheimer's Disease: A Review, *Journal of Neuropsychiatry and Clinical Neurosciences*, 10, 373-382.

Raulin, M.L. (1984). Development of a Scale to Measure Intense Ambivalence, *Journal of Consulting and Clinical Psychology,* 52, 63-72.

Raulin, M.L., and Wee, J.L. (1984). The Development and Initial Validation of a Scale to Measure Social Fear, *Journal of Clinical Psychology,* 40, 780-785, 1984.

Read, J. (2004a). Biological Psychiatry's Lost Cause. In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 57-65). Hove: Brunner-Routledge.

Read, J. (2004b). The Invention of "Schizophrenia". In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 21-34). Hove: Brunner-Routledge.

Read, J. (2004c). Does "Schizophrenia" Exist? Reliability and Validity. In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 43-56). Hove: Brunner-Routledge.

Read, J. (2004d). A History of Madness, In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 9-20). Hove: Brunner-Routledge.

Read, J., Agar, K., Argyle, N., & Aderhold, V. (2003). Sexual and Physical Abuse during Childhood and Adulthood as Predictors of Hallucinations, Delusions and Thought Disorder. *Psychology and Psychotherapy: Theory, Research and Practice*, 76 (1), 1-22.

Read, J. & Argyle, N. (1999). Hallucinations, Delusions and Thought Disorder among Adult Psychiatric Inpatients with a History of Child Abuse, *Psychiatric Services*, 50, 1467-1472.

Read, J. & Mason, J. (2004). Genetics, Eugenics and Mass Murder. In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 35-42). Hove: Brunner-Routledge.

Read, J., Mosher, L. R. & Bentall, R. P. (2004) "Schizophrenia is not an Illness. In Read, J., Mosher, L. R. & Bentall, R. P. (Eds.) *Models of Madness: Psychological, Social and Biological Approaches to Schizophrenia* (pp. 3-7). Hove: Brunner-Routledge.

Reed, P. (in press). An Experimental Analysis of Steady-State Response Rate Components on Variable Ratio and Variable Interval Schedules of

Reinforcement. *Journal of Experimental Psychology: Animal Behavior Processes.*

Reed, P. (1989). Influence of Interresponse Time Reinforcement on the Signalled Reward Effect. *Journal of Experimental Psychology: Animal Behaviour Processes*, 15, 224–231.

Reed, P. (1999). Effect of Perceived Cost on Judgments Regarding the Efficacy of Investment. *Journal of Economic Psychology,* 20, 657–676.

Reed, P. (2001). Schedules of Reinforcement as Determinants of Human Causality Judgements and Response Rates. *Journal of Experimental Psychology: Animal Behavior Processes*, 27 (3), 187-195.

Reed, P. (2003). The Effect of Signalled Reinforcement on Rats' Fixed-Interval Responding, *Journal of the Experimental Analysis of Behaviour*, 79 (3), 367-382.

Reed, P. (2007). Human Sensitivity to Reinforcement Feedback Functions. *Psychonomic Bulletin & Review*, 14 (4), 653 – 657.

Reed, P., & Morgan, T. A. (2008). Effect on Subsequent Fixed-Interval Schedule Performance of Prior Exposure to Ratio and Interval Schedules of Reinforcement, *Learning & Behaviour*, 36, 82 – 91.

Reed, P., Schachtman, T. R., & Hall, G. (1988). Potentiation of Responding on a VR Schedule by a Stimulus Correlated with Reinforcement: Effects of Diffuse and Localized Signals. *Animal Learning & Behavior,* 16, 75–82.

Reed, P. Wakefield, D., Harris, J., Parry, J., Cella, M., & Tsakanikos, E. (2008). Seeing Non-existent events: effects of environmental conditions, schizotypal symptoms, and sub-clinical characteristics. *Journal of Behaviour Therapy and Experimental Psychiatry*, 39(3), 276 - 291.

Reed, P. & Wright, J. E. (1988). Effects of Magnitude of Food Reinforcement on Free-Operant Response Rates, *Journal of the Experimental Analysis of Behaviour*, 49 (1), 75-85.

Reese, W. D. (1971). The Hallucinations of Widowhood, *British Medical Journal*, 210, 37-41.

Richards, J. B., & Seiden, L. S. (1991). A Quantitative Interresponse-Time Analysis of DRL Performance Differentiates Similar Effects of the Antidepressant Desipramine and the Novel Anxiolytic Gepirone. *Journal of the Experimental Analysis of Behavior*, 56, 173-192.

Roberts, R.E., Tarpy, R.M., & Lea. S.E.G. (1984). Stimulus Response Overshadowing: Effect of Signalled Reward on Instrumental Responding as Measured by Response Rate and Resistance to Change. *Journal of Experimental Psychology: Animal Behavior Processes,* 10, 244-255.

Romme, M. & Escher, S. (Eds.) (1993). *Accepting Voices*. London: MIND Publications.

Roper, K. L., & Zentall, T.R. (1999). Observing behavior in Pigeons: The Effect of Reinforcement Probability and Response Cost Using a Symmetrical Choice Procedure, *Learning and Motivation*, 30, 201 – 220.

Rosenfarb, I. S., Newland, M. C., Brannon, S. E., & Howey, D. S. (1992). Effects of self-generated rules on the development of schedule controlled behaviour. *Journal of the Experimental Analysis of Behaviour*, 58, 107-121.

Ross, C. & Pam, M. (1995). *Pseudoscience in Biological Psychiatry: Blaming the Body*. New York: Wiley.

Rossi, A. & Daneluzzo, E. (2002). Schizotypal Dimensions and Normals and Schizophrenic Patients: A Comparison With Other Clinical Samples, *Schizophrenia Research*, 54, 67-75.

Saha, S., Chant, D., Welham, J. & McGrath, J. (2005). A Systematic Review of the Prevalence of Schizophrenia. PLoS Medicine 2 (5): e141. doi:10.1371/journal.pmed.0020141.

Salzinger, K. (1984). The Immediacy Hypothesis in a Theory of Schizophrenia. In Spaulding, W. D., & Cole, J. K. (Eds.). *Theories of Schizophrenia and Psychosis*, (pp. 231-282). Lincoln: University of Nebraska Press.

Sansonnet-Hayden, H., Haley, G., Marriage, K. & Fine, S. (1987). Sexual Abuse and Psychopathology in Hospitalized Adolescents, *Journal of the American Academy of Child and Adolescent Psychiatry*, 26 (5), 753-757.

Sarfati, Y., Hardy-Bayle, M. C., Besche, C. & Widlocher, D. (1997). Attribution of Intentions to Others in People with Schizophrenia: A Non-Verbal Exploration with Comic Strips. *Schizophrenia Research*, 25, 199-209.

Schneider, K. (1959). *Clinical Psychopathology*. New York: Grune & Stratton.

Schwartz, B. (1982). Interval and Ratio Reinforcement of a Complex Sequential Operant in Pigeons, *Journal of the Experimental Analysis of Behaviour*, 37 (3), 349-357.

Sharma, R.P., Dowd, S.M., & Janicek, P.G. (1999). Hallucinations in the acute schizophrenic-type psychosis: effects of gender and age of illness onset. *Schizophrenia Research*, 37, 91-95.

Shergill, S. S., Murray, R. M. & McGuire, P. K. (1998). Auditory Hallucinations: A Review of Psychological Treatments, *Schizophrenia Research*, 32 (3), 137-150.

Shimoff, E., Catania, A. C., & Matthews, B. A. (1986). Human Operant Performance: Sensitivity and Pseudosensitivity to Contingencies, *Journal of the Experimental Analysis of Behaviour*, 46, 149-157.

Shrira, A., & Tsakanikos, E. (2009). Latent inhibition as a function of positive and negative schizotypal symptoms: Evidence for a bi-directional model, *Personality and Individual Differences*, 47, 434-438.

Siegel, R. K. (1984). Hostage Hallucinations: Visual Imagery Induced by Isolation and Life-Threatening Stress, *Proceedings for the Society of Psychical Research*, 26, 259-394.

Skinner, B. F. (1936). The verbal summator and a method for the study of latent speech., *The Journal of Psychology*, 2, 71-107.

Skinner, B. F. (1938). The Behaviour of Organisms: An Experimental Analysis. New York: Appleton-Century-Crofts.

Skirrow, P., Jones, C., Griffiths, R. D., & Kaney, S. (2002). The Impact of Current Media Events on Hallucinatory Content: The Experience of the Intensive Care Unit (ICU) Patient. *British Journal of Clinical Psychology*, 41 (1), 87–91.

Slade, P. D. (1972). The Effects of Systematic Desensitization on Auditory Hallucinations, *Behaviour Research and Therapy*, 10, 85-91.

Slade, P. D. (1973). The Psychological Investigation and Treatment of Auditory Hallucinations: A Second Case Report, *British Journal of Medical Psychology*, 46, 293-296.

Slade, P. D. (1976). An Investigation of Psychological Factors in the Predisposition to Auditory Hallucinations, *Psychological Medicine*, 6, 123-132.

Slade, P. D., & Bentall, R. P. (1988). *Sensory deception: a scientific analysis of hallucination.* London: Croom Helm.

Snyder, S. H. (1974). *Madness and Brain,* New York: McGraw-Hill.

Soriano, M. F., Jiminez, J. F., Roman, P. & Bajo, M.T. (2009). Intentional Inhibition in Memory and Hallucinations: Directed Forgetting and Updating, *Neuropsychology*, 23 (1), 61-70.

Spielberger, C.D. (1983). *State-Trait Anxiety Inventory STAI (Form Y).* Palo Alto, CA: Consulting Psychologists Press, Inc.

Spielberger, C.D., Gorsuch, R.L., & Lushene, R., (1970). Manual for the State-Trait.

Spivak, B., Trottern, S. F., Mark, M., Bleich, A. and Weizman, A. (1992). Acute Transient Stress-Induced Hallucinations in Soldiers, *British Journal of Psychiatry* 160, 412-414.

Staddon, J. E. R., Chelaru, I. M. & Higa, J. J. (2002). A Tuned-Trace Theory of Interval Timing Dynamics, *Journal of the Experimental Analysis of Behaviour*, 77, 105-124.

Staddon, J. E. R., & Higa, J. J. (1999). Timing and Memory: Towards a Pacemaker-Free Theory of Interval Timing, *Journal of the Experimental Analysis of Behaviour*, 75, 215-251.

Stephane, M., Thuras, P., Nassrallah, H. and Georgopoulos, A. P. (2003). The Internal Structure of the Phenomenology of Auditory Verbal Hallucinations, *Schizophrenia Research,* 61, 185–193.

Stirling, J., Barkus, E., Lewis, S. (2007). Hallucination Proneness, Schizotypy and Meta-Cognition. *Behaviour Research and Therapy*, 45, 1401–1408.

Stubbs, A. (1979). Temporal Discrimination and Psychophysics. In Zeiler, M. D. & Harzem, P. (Eds.), *Advances in the Analysis of Behaviour, Vol. 1:*

Reinforcement and the Organization of Behaviour (pp. 341–369). Chichester, England: Wiley.

Taiminen, T., Jääskeläinen, S., Ilonen, T., Meyer, H., Karlsson, H., Lauerma, H., Leinonen, K. M., Wallenius, E., Kaljonen, A. & Salokangas, R. K. (2000). Habituation of the Blink Reflex in First-Episode Schizophrenia, Psychotic Depression and Non-Psychotic Depression. *Schizophrenia Research,* 44, 69–79.

Takahashi H, Iwase M, Ishii R, Ohi K, Fukumoto M, Azechi M, et al. (2008) Impaired Prepulse Inhibition and Habituation of Acoustic Startle Response in Japanese Patients with Schizophrenia. *Neuroscience Research*, 62,187–94.

Takei, N., Sham, P. C., O'Callaghan, E., Glover, G. & Murray, R. M. (1995). Schizophrenia: Increased Risk Associated with Winter and City Birth – A Case-Control Study in 12 Regions Within England and Wales, *Journal of Epidemiology and Community Health*, 49 (1), 106-107.

Tallent, K.A. and Gooding, D.C. (1999). Working Memory and Wisconsin Card Sorting Test Performance in Schizotypic Individuals: a Replication and Extension. *Psychiatry Research,* 89, 161–170.

Tarrier, N. (1987). An Investigation of Residual Psychotic Symptoms in Discharged Schizophrenic Patients, *British Journal of Clinical Psychology*, 26, 141-143.

Tien, A. Y. (1991). Distribution of Hallucinations in the Population, *Social Psychiatry and Psychiatric Epidemiology*, 26 (6), 287-292.

Tienari, P., Sorri, A., Lahti, I., Naarala, M., Wahlberg, K-E., Moring, J., et al, (1987). Genetic and Psychosocial Factors in Schizophrenia: The Finnish Adoptive Family Study. *Schizophrenia Bulletin*, 13 (3), 477-484.

Tonneau, F. (2004). Consciousness Outside the Head. *Behavior and Philosophy*, 32, 97 -123.

Toone, B. K., Cooke, E. & Lader, M. H. (1981). Electrodermal Activity in the Affective Disorders and Schizophrenia, *Psychological Medicine*, 11, 497-508.

Torgalsboen, A. K. (1999a). Co-morbidity in Schizophrenia. *Scandanavian Journal of Psychology*, 40, 147-152.

Torgalsboen, A. K. (1999b). Full Recover from Schizophrenia, *Psychiatry Research*, 88, 143-152.

Torrey, E. F. (1987). Prevalence Studies in Schizophrenia, *British Journal of Psychiatry*, 150, 598-608.

Treisman M, Faulkner A, Naish PLN, Brogan D (1990) The Internal Clock: Evidence for a Temporal Oscillator Underlying Time Perception with some Estimates of its Characteristic Frequency. *Perception*, 19: 705-748.

Tsakanaikos, E. (2004). Logical Reasoning in Schizotypal Personality. *Personality and Individual Differences*, 37, 1717 – 1726.

Tsakanikos, E. (2006). Perceptual Biases and Positive Schizotypy: The Role of Perceptual Load, *Personality and Individual Differences*, 41 (5), 951-958.

Tsakanikos, E. & Claridge, G. (2005). More Words, Less Words: Verbal Fluency as a Function of "Positive" and "Negative" Schizotypy, *Personality and Individual Differences*, 39 (4), 705-713.

Tsakanikos, E., & Reed, P. (2005a). Seeing words that are not there: detection biases in psychometric schizotypy. *British Journal of Clinical Psychology*, 44, 295-299.

Tsakanikos, E., & Reed, P. (2005b). Do Positive Schizotypal Symptoms Predict False Perceptual Experiences in Nonclinical Populations? *Journal of Nervous and Mental Disease*, 193 (12), 809-812.

Tsakanikos, E., Sverdrup-Thygenson, L. & Reed, P. (2003). Latent Inhibition and Psychosis Proneness: Visual Search as a Function of Pre-Exposure to the Target and Schizotypy Level, *Personality and Individual Differences*, 34 (4), 575 – 589.

Tsuang, M. T., Stone, W. S. & Faraone, S. V. (2000). Toward Reformulating the Diagnosis of Schizophrenia, *American Journal of Psychiatry*, 157, 1041-1050.

Tuke, S. (1813). *Description of the Retreat*. York: Society of Friends.

Tysk, L. (1983). Time Estimation by Healthy Subjects and Schizophrenic Patients: A Methodological Study, *Perceptual and Motor Skills*, 56 (3), 983 – 988.

Van De Ven, V. & Merckelbach, H. (2003). The Role of Schizotypy, Mental Imagery and Fantasy Proneness in Hallucinatory Reports of Undergraduate Students, *Personality and Individual Differences*, 35 (4), 889-896.

Van Os, J., Hanssen, M., Bijl, R. V. & Ravelli, A. (2000). Strauss (1969) Revisited: A Psychosis Continuum in the General Population? *Schizophrenia Research*, 45, 11-20.

Van Os, J. & Verdoux, H. (2003). Diagnosis and Classification of Schizophrenia: Categories Versus Dimensions, Distributions Versus Disease, In Murray, R. M., Jones, P. B., Susser, E., van Os, J. & Cannon, M. (Eds.). The Epidemiology of Schizophrenia. (pp. 364-410). Cambridge: University Press.

Van Strien, J. W. & Van Kampen, D. (2008). Positive Schizotypy Scores Correlate with Left Visual Field Interference for Negatively Valenced Emotional

Words: A Lateralized Emotional Stroop Study, *Psychiatry Research*, 169 (3), 229-234.

Vaughn, S., Schumm, J.S. & Sinagub, J. (1996). *Focus Group Interviews in Education and Psychology*. Thousand Oaks, CA: Sage.

Venables, P.H., Wilkins, S., Mitchell, D.A., Raine, A. & Bailes, K. A (1990). Scale for the Measurement of Schizotypy. *Personality and Individual Differences*, 11, 481-495.

Verdoux, H. & van Os, J. (2001). Psychotic Symptoms on Non-Clinical Populations and the Continuum of Psychosis, *Schizophrenia Research*, 54, 59 – 65.

Verdoux, H., van-Os, J., Maurice, S., Gay, B., Salamon, R. & Bourgeois, M. (1998). Is Early Adulthood a Critical Development Stage for Psychosis Proneness? A Survey of Delusion Ideation in Normal Subjects, *Schizophrenia Research*, 29 (3), 247-254.

Vollema, M. G. & Hoijtink, H. (2000). The Multi-Dimensionality of Self-Report Schizotypy in a Psychiatric Population: An Analysis Using Multidimensional Rasch Models, *Schizophrenia Bulletin*, 26 (3), 565 – 575.

Wahl, O. F., & Sieg, D. (1980). Time Estimation Among Schizophrenics. *Perceptual and Motor Skills*, 50 (2), 535 – 541.

Walker, E., and Lewine, R.J. (1990) Prediction of Adult-Onset Schizophrenia from Childhood Home movies of the Parents. *American Journal of Psychiatry*, 147(8): 1052-1056.

Walter, H., Kammerer, H., Frasch, K., Spitzer, M. & Abler, B. (2009). Altered Reward Functions in Patients on Atypical Antipsychotic Medication in line with the Revised Dopamine Hypothesis of Schizophrenia, *Psychopharmacology*, 206 (1), 121-132.

Wan, L., Friedman, B. H., Boutros, N. N. & Crawford, H. J. (2008). Smoking Status Affects Men and Women Differently on Schizotypal Traits and Cognitive Failures, *Personality and Individual Differences*, 44 (2), 425-435.

Wang, Y., Chan, R. C. K., Yu, X., Shi, C., Cui, J., Deng, Y. (2008). Prospective Memory Deficits in Subjects with Schizophrenia Spectrum Disorders: A Comparison Study with Schizophrenic Subjects, Psychometrically Defined Schizotypal Subjects and Healthy Controls, *Schizophrenia Research*, 106 (1), 70-80.

Warner, R. (1985). *Recovery from Schizophrenia.* New York, NY: Routledge and Kegan Paul.

Waters, F. & Jablensky, A. (2009). Time Discrimination Deficits in Schizophrenia Patients with First-Rank (Passivity) Symptoms, *Psychiatry Research*, 167, 12-20.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, 54 (6), 1063 – 1070.

Wearden, J. H. (1988). Some Neglected Problems in the Analysis of Human operant Behaviour. In Davey, G. & Cullen, C. (Eds.) *Human Operant Conditioning and Behaviour Modification* (pp. 197 – 224). New York: Wiley.

Wearden, J. H. (1991a). Do Humans Possess an Internal Clock with Scalar Timing Properties? Learning and Motivation, 22, 59-83.

Wearden, J. H. (1991b). Human Performance on an Analogue of an Interval Bisection Task, *The Quarterly Journal of Experimental Psychology Section B*, 43 (1), 59-81.

Wearden, J. H. (1992) Temporal Generalization in Humans. *Journal or Experimental Psychology: Animal Behaviour Processes,* 18, 134-144.

Wearden, J. (2001). More clock within us. In McCreedy, S. (Ed.), *The Discovery of Time* (pp. 204 – 225). London: MQ Publications.

Wearden, J. H. (2003). Applying the Scalar Timing Model to Human Time Psychology: Progress and Challenges. In Helfrich, H. (Ed.), *Time and Mind II: Information-Processing Perspectives* (pp.21-39). Gottingen: Hogrefe & Huber.

Wearden, J. H. (2004). Decision processes in models of timing. *Acta Neurobiologiae Experimentalis, 64,* 303–317.

Wearden, J.H., & Bray, S. (2001). Scalar Timing Without Reference Memory: Episodic Temporal Generalization and Bisection in Humans. *Quarterly Journal of Experimental Psychology*, 54B, 289-310.

Wearden, J.H., Denovan, L., Fakhri, M., & Haworth, R. (1997). Scalar Timing in Temporal Generalization in Humans with Longer Stimulus Durations. *Journal of Experimental Psychology: Animal Behavior Processes*, *23*, 502-511.

Wearden, J. H., Edwards, H., Fakhri, M. & Perceival, A. (1998). Why "Sounds are Judged Longer than Lights": Application of a Model of the Internal Clock in Humans, *Quarterly Journal of Experimental Psychology*, 51B, 97 – 120.

Wearden, J. H. & Ferrara, A. (1995). Stimulus Spacing Effects in Temporal Bisection by Humans. *Quarterly Journal of Experimental Psychology,* 48B, 289–310.

Wearden, J. H., & Ferrara, A. (1996). Stimulus Range Effects in Temporal Bisection by Humans. *Quarterly Journal of Experimental Psychology*, 49B, 24-44.

Wearden J. H, Penton-Voak I. S. (1995) Feeling the Heat: Body Temperature and the Rate of Subjective Time, Revisited. *Quarterly Journal of Experimental Psychology*, 48B, 129-141.

Wearden, J. H., Philpot, K., & Win, T. (1999). Speeding up and (. . . relatively. . .) slowing down an internal clock in humans. *Behavioural Processes, 46,* 63–73.

Wearden, J. H., Rogers, P. & Thomas, R. (1997). Temporal Bisection in Humans with Longer Stimulus Durations, *Quarterly Journal of Experimental Psychology*, 50B, 79–94.

Wearden, J. H., Wearden, A. J., & Rabbitt, P. (1997). Age and IQ effects on stimulus and response timing. *Journal of Experimental Psychology: Human Perception and Performance*, 23, 962-979.

Webb, E., Ashton, C. H., Kelly, P. & Kamali, F. (1996). Alcohol and Drug Use in UK University Students, *The Lancet*, 922 – 925.

Weiner, H. (1969). Controlling Human Fixed-Interval Performance. *Journal of Experimental Analysis of Behaviour*, 12, 349 – 373.

Weinstein, A. D., Goldstone, S. & Boardman, J. K. (1958). The Effect of Recent and Remote Frames of Reference on Temporal Judgement of Schizophrenic Patients, *Journal of Abnormal Social Psychology*, 57, 241-244.

Weiss, A. P. & Hecker, S. (1999). Neuroimaging of Hallucinations: A Review of the Literature, *Psychiatry Research: Neuroimaging*, 92, 61-774.

Wender, P. H., Rosenthal, D., Kety, S. S., Schulsinger, F. & Weiner, J. (1974). Crossfostering: A Research Strategy for Clarifying the Role of Genetic and Experiential Factors in the Etiology of Schizophrenia, *Archives of General Psychiatry*, 30, 121-128.

West, L. J. (1962). A General Theory of Hallucinations and Dreams. In West, L. J. (Ed.), *Hallucinations*, (pp. 275-291). New York: Grune & Stratton.

West, L. J. (1975). A Clinical and Theoretical Overview of Hallucinatory Phenomena. In Siegel, R. K. & West, L. J. (Eds.), *Hallucinations: Behaviour, Experience, Theory* (pp. 287-311). New York: Wiley.

Whaley, A. L. (2001). Cultural Mistrust and the Clinical Diagnosis of Paranoid Schizophrenia in African American Patients. *Journal of Psychopathology and Behavioural Assessment*, 23, 93-100.

Williams, M. B. (1993). The psychometric assessment of schizotypal personality. PhD thesis. Institute of Psychiatry, University of London, unpublished.

Williams, L. & Parker, H. (2001). Alcohol, Cannibis, Ecstasy and Cocaine: Drugs of Reasoned Choice Among Young Adult Recreational Drug Users in England, *International Journal of Drug Policy*, 12, 397 – 413.

Wykoff, R. F. (1987). Delusions of Parasitosis: A Review, *Reviews of Infectious Diseases*, 9 (3), 433-437.

Young, H. F. & Bentall, R. P. (1995). Hypothesis testing in patients with persecutory delusions: Comparison with Depressed and Normal Subjects. *British Journal of Clinical Psychology*, 34, 353-369.

Young, H.F., Bentall, R.P., Slade, P.D., & Dewey, M.E. (1987). The role of brief instructions and suggestibility in the elicitation of hallucinations in normal and psychiatric subjects. *Journal of Nervous and Mental Disease*, 175, 41 – 48.

Yung, A. R. & McGorry, P. D. (1996a). The Initial Prodrome in Psychosis: Descriptive and Qualitative Aspects. *Australian and New Zealand Journal of Psychiatry,* 30, 587–599.

Yung, A. R. & McGorry, P. D. (1996b). The prodromal phase of first-episode psychosis: past and current conceptualizations. *Schizophrenia Bulletin.* 22, 353–370.

Zubin, J. & Spring, B. (1977). Vulnerability: a new view of schizophrenia, *Journal of Abnormal Psychology,* 86, 260–266.