LATENT INHIBITION AND PSYCHOMETRICALLY DEFINED SCHIZOTYPY: AN EXPERIMENTAL INVESTIGATION

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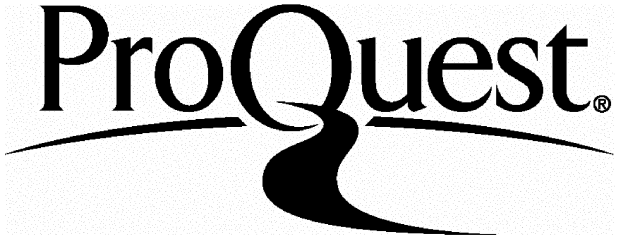

Abstract

The thesis adopted a personality-based approach to experimental psychopathology testing alternative interpretations of latent inhibition deficits as a function of psychotic-like features in non-clinical participants. Chapter 1 reviews the evidence on the continuity of psychotic-like experiences, describes the historical origins of dimensional views of psychosis, and discusses methodological advantages and pitfalls in schizotypy research. Chapter 2 reviews different sources of evidence on a link between disruption of latent inhibition and the schizophrenia continuum, as well different theories of latent inhibition, and discusses methodological issues in terms of the existing latent inhibition paradigms. The review suggests that the interpretation of the disruption of latent inhibition within the schizophrenia continuum remains elusive due to a number of methodological and theoretical problems. In Chapter 3, a preliminary evaluation of self-report psychotic-like experiences was examined in terms of the capacity of different psychometric scales to predict perceptual and decision biases, akin to those observed in schizophrenia, when searching for fast moving words. Additionally, this chapter examined whether various schizotypy traits were associated with the ability to identify fast moving words, prior to the development of this paradigm as a latent inhibition procedure (Experiments 1 & 2). In Chapter 4, a novel latent inhibition paradigm was introduced. Visual search of fast moving words was examined as a function of target preexposure, amount of pre-exposure, and schizotypy (STA), without the target/ distractor reversal employed in most past investigations of latent inhibition in humans, and without including a masking task (Experiment 3 & 4). Latent inhibition was found to be relatively disrupted in high-schizotypy scores, but intact in their low-schizotypy

counterparts. In Chapter 5, latent inhibition was examined in relation to schizotypy after procedural changes were introduced to address possible confounds in the previous experiments. In addition, in effort to evaluate attentional accounts, performance after stimulus preexposure was examined under individual testing (Experiment 5) and group testing (Experiment 6) conditions. In Chapter 6, in order to evaluate context effects on latent inhibition, and test predictions derived from opposing accounts, latent inhibition was assessed in high- and low-schizotypy scorers within a stable context (Experiment 7), and after a context change (Experiment 8). In Chapter 7, in order to evaluate whether the latent inhibition deficits are due to enhanced stimulus salience (related to a putative heightened perceptual awareness in high-schizotypy scorers), participants were conjointly tested in terms of latent inhibition and their ability to discriminate between different levels of stimulus salience, as assessed by a visual pop-out task (Experiments 9 & 10). In Chapter 8, a compound-stimulus discrimination paradigm was developed (Experiment 11), in order to test target/distractor shift-learning in different schizotypy dimensions (Experiment 12). In Chapter 9, a theoretical integration of the findings is proposed. The data obtained are discussed in terms of a two-component (attentional + associative) model of latent inhibition deficits.

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Chapter 3

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Chapter 4

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Chapter 8

Tsakanikos, E., & Reed, P. (submitted). Compound-stimulus discrimination as a function of reversal shift and different dimensions of schizotypy.

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CHAPTER 1

Schizotypy: a review of basic concepts and evidence

1.1 The continuity of psychotic experiences

Experiences that bear a close resemblance to psychotic symptoms are not limited to clinical populations. For example, hallucinations (perceptions of objects that are absent at the moment of the perceptual experience) have been viewed traditionally as a hallmark for schizophrenia, as their estimated incidence in schizophrenia approximates 50% (Bentall, 1990). Yet, hallucinatory experiences can be induced in non-clinical participants as a result of certain circumstances, such as changes in the neuro-chemical balance (Mahowald, Woods & Schenck, 1998; Schulz, Wilde, Volk & Geisler, 1992; Tacke & Ebert, 1991), sleep deprivation (Mahowald *et al.*, 1998; Schulz *et al.*, 1992), and hypnotic suggestion (Bentall, 2000). Additionally, a substantial proportion of non-clinical participants tend to report hallucinatory experiences under no specific circumstances (e.g., Barrett & Etheridge, 1992; Posey & Losch, 1983; Tien, 1991; Ohayon, 2000; McGee, Williams & Poulton, 2000).

Posey and Losch (1983) questioned a sample of 375 undergraduate students as to whether they had ever experienced any type of auditory hallucination. A 36% of the sample reported hearing a voice calling someone's name when alone, and a 39% reported hearing one's thoughts as if spoken aloud. Clinical interviews and data obtained with the Minnesota Multiphasic Personality Inventory (MMPI) suggested that these experiences

were not clinically significant, nor were they related to a prior pathology or substance use (Posey & Losch, 1983). In a later study on a sample of 586 students, it was found that a proportion between 30% and 40% of the sample reported that they had experienced hearing voices, and about 15% reported that frequency of such an experience was once a month (Barrett & Etheridge, 1992). The reported hallucinatory experiences were not due to a tendency to respond in a socially desirable way, as assessed by measures of social desirability, nor due to manifest psychopathology (Barrett & Etheridge, 1992).

In the general population, the lifetime prevalence of hallucination (not related to medical problems or substance use) has been found to be 10% for men and 15% for the women (Tien, 1991). More recently, in a large epidemiological study (N = 13.057), 38.7% reported hallucinatory experiences occurring at sleep onset and during daytime (Ohayon, 2000). The reported frequency of those experiences was: 19.6% less than once a month, 6.4% monthly, 2.7% once a week, and 2.4% more than once a week (Ohayon, 2000). The above percentages, however, should be taken only as approximate estimates of the distribution of hallucinatory experiences in the general population. This caveat might be important, as the above estimates were based on self-report measures of unusual experiences, which are likely to depend on the specific methodology employed in different studies.

Apart from hallucinations, there is a range of other unusual perceptual distortions often associated, albeit not exclusively, with schizophrenia. Such perceptual distortions include déjà vu (a false sense of familiarity for novel events), de-personalization (the self is perceived as alien or as a robot), de-realisation (a loss of the sense of reality), micropsia (if perceived objects look

smaller than normal), as well as other atypical perceptual distortions relating to an idiosyncratic experience of objects and events (Cutting, 1995). As with most psychotic symptoms, perceptual distortions are not exclusively found in schizophrenic patients, but have also been reported in patients with a wide range of localised neurological problems (e.g., Ceriani, Gentileschi, Muggia & Spinnler, 1998; Sierra, Lopera, Lambert, Phillips & David, 2002; Spatt, 2002), and there is some evidence of distorted visual perception after benzodiazepine administration in healthy volunteers (Giersch, 2001). Like hallucinatory experiences, perceptual distortions are often reported by non-clinical participants under no specific conditions (e.g., Chapman, Chapman & Raulin, 1978; Claridge & Broks, 1984).

Delusions (irrational, idiosyncratic ideation formed in the absence of appropriate evidence, not being part of a certain culture), despite the lack of a generally accepted classification system (for a discussion see, Bentall, Corcoran, Howard, Blackwood & Kinderman, 2001), are also considered a typical symptom of schizophrenia. Diagnostic classification systems, such as the DSM-III (American Psychological Association, 1980) tend to place a special emphasis on the bizarre (e.g., thought broadcasting) versus the non-bizarre (e.g., jealously) content of delusions, as the former type often tends to be associated with schizophrenia. Ideas of a delusional nature can also be found in the general population. The prevalence rates of delusional ideas have been also investigated in a sample of participants (N= 810) that were first administered self-report measures, and then were interviewed by clinicians (Eaton, Romanoski, Anthony & Nestadt, 1991). Bizarre delusions had a 2% prevalence rate, while paranoid delusions and delusions of having a

special power had a prevalence rate between 4% and 8% (Eaton *et al.*, 1991). It is interesting to note that in the previous study there was a remarkable agreement between self-report measures and psychiatric interviews.

In addition, during the development of an inventory for the measurement of delusions in non-clinical populations (PDI - Peters et al. Delusional Inventory; Peters, Joseph & Garety, 1999) that included a control group of deluded patients, it was found that 10% of the non-clinical sample reported more delusional ideas than the mean for the deluded patients. However, the overall number of deluded ideas was significantly higher in the deluded patients than the non-clinical patients, establishing a criterion validity of the inventory (Peters *et al.*, 1999). The investigators interpreted these overlapping distributions as a manifestation of the continuity of the psychotic symptoms in line with dimensional hypotheses of schizophrenia (Claridge, & Broks, 1984; Eysenck & Eysenck, 1975).

Delusional ideas have been found to be more pronounced in members of 'new-age' religious movements, such as Hare Krishnas and Druids, as compared to non-religious, religious non-clinical participants, and deluded patients (Peters, Day, McKenna & Orbach, 1999). However, delusional ideas in members of these movements, unlike deluded patients, were not associated with distress (Peters *et al.*, 1999). These findings are not only congruent with the suggestion that people with intense spiritual beliefs can have experiences similar to the positive symptomatology in schizophrenia (Jackson, 1997), but also with the notion of benign/healthy schizotypy (Jackson, 1997; McCreery & Claridge, 2002).

Despite the report of psychotic-like experiences in the non-clinical population, the degree to which these experiences are related to the psychotic symptomatology in schizophrenia could be questioned. It could be argued, for example, that reporting experiences that are similar to psychotic symptomatology does not necessarily prove that schizophrenia-like features are distributed in the general distribution. Instead, it could be suggested that the report of such experiences might reflect certain latent factors, such as the influence of recreational substances (especially in cases were use of recreational substances may not have been disclosed), misinterpretations of the questions, or an attempt to present an unconventional, eccentric self-image. The above possibilities cannot be excluded given that self-reported (and clinically non-significant) psychotic symptoms tend to appear more frequently in participants of younger age and lower educational level (Johns & van Os, 2001). Despite this possible limitation, there are increasingly converging lines of evidence suggesting that reported psychotic-like features are a phenotypic indicator for a potential vulnerability to schizophrenia.

1.2 Genetic and longitudinal studies

In support of the link between schizophrenia and self-report psychotic-like traits, a higher incidence of such traits has been identified in biological relatives of schizophrenic patients than controls (Kendler, Thacker & Walsh, 1996; Kety, Wender & Jacobsen, 1994; Tsuang, Gilbertson & Faraone, 1991; Yaralian, Raine & Lencz, 2000). More recently, significantly higher levels of psychotic-like features were found in siblings and children of schizophrenic patients than in their parents (Vollema, Sitskoorn, Appels & Kahn, 2002). This

effect remained statistically significant after controlling for differences in IQ, age, and gender. The latter finding provides additional support to a putative link between psychosis-proneness and psychotic-like features, given that the lifetime risks of developing schizophrenia for first-degree relatives of schizophrenic patients is 6% for parents, 9% for siblings, and 13% for children (Gottesman & Shields, 1982).

However, data from studies that demonstrated a differential proportion of self-reported psychotic-like traits in different kind of relatives need to be interpreted cautiously. In some cases, such studies might reflect possible selection biases. For example, low incidence of psychotic features in parents might be due to the possibility that they were the healthier group, since they were able to get married and have children. Additionally, differential percentages of self-reported psychotic-like features across different kinds of relatives might reflect a differential degree of defensiveness in admitting psychotic-like symptoms across relatives of schizophrenia patients, with the parents being the most defensive group (see, Clementz, Grove, Katsanis & Iacono, 1991).

Despite the possible methodological limitations in investigating the distribution of psychotic-like traits across different degrees of kin, psychotic-like experiences, as assessed through self-reported measures, have shown predictive value. In a longitudinal study, for example, high incidence of self-report unusual perceptual experiences and delusional-like ideation in non-clinical participants predicted a higher frequency of psychosis over the next 10 years (Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994). Participants who reported a high number of psychotic-like symptoms (as assessed by the

Perceptual Aberration and Magical Ideation Scale) were 5 times more likely to be diagnosed with a psychotic syndrome in a follow-up period than controls. Similar results were obtained in a replication study (Kwapil, Miller, Zinser, Chapman & Chapman, 1997).

In addition to the above longitudinal studies, mounting evidence suggest that the occurrence of psychotic-like experiences is associated with deficits similar to those observed in schizophrenic patients in respect to certain domains of cognitive functioning. Such domains include spatial memory (e.g., Park, Holzman & Lenzenweger, 1995; Park & McTigue, 1997; but see Lenzenweger & Gold, 2000), selective attention, as assessed by negative priming (Beech, Baylis, Smithson & Claridge, 1989; Beech & Claridge, 1987; Claridge, Clark & Beech, 1992; Steel, Hemsley & Jones, 1996), the Stroop effect (Moritz, Andresen, Naber, Krausz & Probsthein, 1999; but see Beech *et al.*, 1989; Steel *et al.*, 1996), and sustained attention, as assessed by the Continuous Performance Test (Lenzenweger, Cornblatt & Putnick, 1991; Rawlings & Goldberg, 2001). Additionally, the presence of psychotic-like symptoms in non-clinical participants has been associated with increased attentional distractibility, as indexed by paradigms of latent inhibition, similar to that observed in schizophrenic patient (Baruch, Hemsley & Gray, 1988b; Braunstein-Bercovitz & Lubow, 1998; Lipp & Vaitl, 1992; Lubow, Ingberg-Sachs, Zalstein-Orda, & Gewirtz, 1992). Some of the above cognitive domains, such as spatial memory and sustained attention are often seen as cognitive phenotypes of schizophrenia. A review of longitudinal and genetic studies indicates that dysfunctions in these domains are present at the onset of illness, are relatively stable over time, and are present in non-psychotic

relatives (see Hoff & Kremen, 2002). Unfortunately, there is still an absence of longitudinal and genetic studies involving various measures of attentional selection, such as negative priming and latent inhibition. Some cognitive domains appear less popular in the longitudinal and genetic research, possibly due to the absence of psychometrically sensitive standardised procedures, coupled with theoretical uncertainties that may surround certain cognitive phenomena, as in the case of latent inhibition. Such uncertainties, however, have inspired a substantial amount of experimental research, which will be reviewed in the next chapter.

1.3 Historical origins of dimensional views of psychosis

As seen in the previous sections, various sources of evidence (epidemiological, genetic, experimental, longitudinal) in the last quarter of the 20th century suggested a dimensionality of the psychotic symptoms. However, dimensional views of psychosis appeared much earlier. These ideas can even be traced back in the early conceptualisations of schizophrenia.

Variations in personality have been conceptualised traditionally as differences in terms of degree rather than category. For example, it can be said that Mr X is more assertive than Mr Y, or that Mr Y is more open to new ideas than Mr Z. In such descriptions, there is an explicit acceptance that traits such as 'assertiveness' and 'openness to new ideas' exist as continua rather that as categories. Differential psychology pioneered a view of traits as graded continua, i.e. quantifiable dimensions the structure of which can be modelled with statistical tools such as factor analysis.

Although the continua describing varying 'normal' behavioural dispositions do not necessarily have abnormality as a reference point, an excessive manifestation of a certain disposition at the extreme point of the continuum can be dysfunctional. For instance, a tendency to worry about potential negative events can be classified as 'neurotic' only when it occurs at increased frequency and intensity, i.e. being disproportionate to the triggering occasion. Neurotic states, such as neurotic anxiety and mild depression, can be understood as departures from the norm, for which the average person has empathy. On the contrary, the psychotic phenomena evoke puzzlement, fear and a sense that these experiences are alien and beyond the reach of empathy (Claridge, 1995). Consequently, although continuity between neurosis and normality has been traditionally viewed as plausible, the notion of continuity between psychosis and normality has proved to be more difficult to accept.

Psychosis has often been conceptualised as a natural category, rather that a dimension, that exists 'out there'. Kreapelin's concept of 'dementia praecox' in 1896 included catatonic, hebephrenic and paranoid conditions, and described a cluster of disturbing behaviours that shared a common onset, course and outcome. However, Kreapelin was convinced that his task was *not to describe* a syndrome, but *to discover* a disease entity underlying the psychotic manifestations. Kreapelin believed that his nosological entity was an organic disease of neuro-generative nature (see Boyle, 1990; Cutting, 1985, for reviews). The notion of the insanity as a single entity can be traced back to the German physician William Griesinger in 1845. Despite the differences in the clinical picture between patients, Griesinger concluded that

insanity should not be subdivided into different types. Instead, he maintained that there is only one type of psychosis, a suggestion known as the '*Einheitspsychose*' (unitary psychosis) theory (see Berrios, 1995; Cutting 1985).

Eugene Bleuler, who coined the term 'schizophrenia' in 1908, was less convinced than Kreapelin about a purely organic aetiology of the disease. He believed that both organic and psychological components are necessary for the emergence of schizophrenia. The organic factor was the cerebral substrate and the psychological factor was a loosening of associations, manifest in blocking or in splitting of ideas, responsible for secondary symptoms such as hallucinations and delusions. Like Kreapelin, E. Bleuler held the view that a single morbid process was the starting point for the emergence of psychotic symptoms (Boyle, 1990). Contributing to a dimensional view of psychosis, E. Bleuler and his colleagues in the 1910s used the terms 'schizoid personality' and 'latent schizophrenia' to describe individuals who, despite being odd and eccentric, did not full the clinical criteria for a schizophrenia diagnosis (M. Bleuler, 1978). These views seem to be reflected in the later DSM-III descriptions of 'schizoid' and 'schizotypal personality disorder' (American Psychiatric Association, 1980). The notion, however, of attenuated symptoms of schizophrenia as personality traits entailed, at least at some extent, the implicit acceptance of these symptoms as graded continua, i.e. from the schizoid personality traits to the fully-fledged symptoms of schizophrenia. According to M. Bleuler (1978), the usage of the term 'schizoid' contributed to a gradual awareness of the fact that

schizophrenia is not an inaccessible condition, which is beyond the reach of empathy.

The first explicit dimensional theory of psychosis was put forward by Kretschmer in the early 1920s. Kretschmer considered schizoid characteristics as both sub-clinical manifestations and traits of the normal temperament. These traits were over-sensitivity, unsociability, reserve, humorlessness and eccentricity. He believed that schizoid personalities fluctuated between illness and health, reflecting the fundamental symptoms of schizophrenia. According to Kretschmer's model, normal personality differences can be described by traits associated with schizophrenia ('schizothymia') and manic-depressive psychosis ('cyclothymia'). The idea of 'schizothymia' and 'cyclothymia' as endpoints of a normal personality dimension influenced significantly subsequent personality-based continuum views of psychosis (see Claridge, 1995; Cutting, 1985, for reviews). The view of psychotic traits as graded continua was further developed by Eysenck (Eysenck & Eysenck, 1976), who suggested that 'Psychoticism' is a normal personality dimension that may or may not associated with maladjustment. The construct of 'Psychoticism', along with other views of psychotic-like personality traits will be discussed in more detail in the next section.

1.4 Psychoticism, schizotypy and shizotaxia

In Eysenck's theory, Psychoticism (P) constitutes the third personality dimension (Eysenck & Eysenck; 1975; Eysenck & Eysenck, 1976) which is orthogonal to extraversion and neuroticism. High P individual are characterised by antisocial/aggressive tendencies, impulsivity, hostility, and

appear odd, unemotional, lacking in sympathy, with paranoid ideas that other people are against them. At the other end of the continuum, low P individual are thought to be sociable, tender-minded, agreeable and altruistic. Prisoners, schizophrenic patients, alcohol and drug abusers, and children reporting increased antisocial behaviour have all been reported to show elevated P scores (reviewed in Eysenck & Eysenck, 1976). Evidence in support of the P construct has come from genetic studies, given that the risk of psychopathy, criminality, alcoholism, and various personality disorders appears increased in biological relatives of schizophrenic patients (e.g., Kety, Rosenthal, Wender, & Schulsinger, 1968; Mednick, Schulsinger, Higgins & Bell, 1974).

According to Eysenck's theory, high P scores are not necessarily incompatible with social achievement and success, as certain individual may use some of their P qualities (e.g., aggressiveness, lack of inhibition) to achieve social status and power. Eysenck also proposed an account to explain the association between Psychoticism and creativity (Eysenck, 1993): cognitive characteristics, such as overinclusive thinking (i.e. the tendency to generate an increased number of unusual items during a categorisation test) which is associated with high scores on Psychoticism, tend to facilitate originality, which, in optimum circumstances, can lead to creativity. However, the specificity of the P construct has often been criticised (Claridge, 1981), along with the relative weak predictive validity of the P scales (Chapman et al., 1994).

Claridge (1972) also believed that psychosis was an exaggeration of normally distributed cognitive and personality features. In addition, Claridge argued that the normal nervous system is organised in such ways, which can

be described as 'schizotypal' (Claridge, 1967; Claridge and Broks, 1984). This proposal, which was also supported by other researchers (Venables, 1960), was made on the basis of evidence that schizophrenic patients are unique from other psychiatric patients in that they show a highly unusual pattern of psychophysiological activity, mainly characterised by homeostatic instability, implicating arousal and selective attention (Claridge, 1967). Claridge has emphasized that one of the most striking features in schizophrenia is an extreme variability within the same individual, suggesting a dissociation of physiological systems that are normally yoked in a self-regulatory way. Non-clinical participants scoring highly on P have shown a profile of psychophysiological activity akin to that observed in schizophrenic patients, suggesting a similar organization of the nervous system (see Claridge and Broks, 1984, for a review). According to Claridge, a basic characteristic of the schizotypal nervous system may be a fundamental *instability* of physiological reactivity, i.e. not consistently 'over-active' or 'under-active' but consistently unstable.

The term 'schizotypy' was first used by Meehl (1962) to describe the phenotypic manifestation of a genetically defined disposition to schizophrenia, which he called 'schizotaxia', i.e. the putative genotype underlying schizophrenia. According to Meehl (1962), schizotypy is characterized by cognitive slippage, aversion to social contact, ambivalence, and anhedonia. Before Meehl, Rado (1953) used a similar term ('schizotype', as an abbreviation of the term 'schizophrenic phenotype') to describe a hereditary disposition to schizophrenia, mainly characterized by a chronic anhedonia. Additionally, the idea of a 'pre-psychotic' personality can be traced at least

back 40 years earlier (see Blueler and Kretschmer in the previous section), with the emphasis placed on social withdrawal, and aversion for any social contact.

It is interesting to note that in some of these early formulations (Meehl, 1962; Rado, 1953) the notion of 'pre-psychotic' characteristics was closely related to personality traits that could be described in contemporary terms as 'negative schizotypy', due to their resemblance to negative symptoms of schizophrenia (i.e. the relative absence of normal functioning). However, the term 'schizotypy' in the recent literature tends to be used in a broader sense to include various personality and cognitive features that resemble typical symptoms of schizophrenia (Claridge, 1997). This broadened definition of schizotypy, as the degree to which non-clinical participants report experiences and behavioural tendencies that resemble with typical psychotic symptoms, has been adopted in the present thesis.

A descriptive analysis[1] of the empirical reports published in peer-reviewed journals in the last 10 years (Figure 1.1) showed that the term 'schizotypy', in a broadened definition, has been increasingly employed in investigations that assessed the incidence of psychotic-like experiences in non-clinical participants. In the vast majority of these investigations, schizotypy has been examined in conjunction with behavioural, cognitive, or

[1] The above data represent combined results of successive searches in the PSYCINFO for each publication year. The term 'schizotypy' was entered in the abstract or in the title. This strategy was adopted because in most cases, although the reports were on schizotypy, 'schizotypal personality' was the major descriptor, instead of 'schizotypy'. This made the search problematic as the descriptor 'schizotypal personality' includes both 'schizotypy' and 'schizotypy personality disorder'. Records that merely included the term schizotypy without being the object of the main investigation were eliminated from the final analysis. Other search restrictions included 'publication type' (empirical study), 'document type' (journal article), 'population' (human), and 'special feature' (peer reviewed).

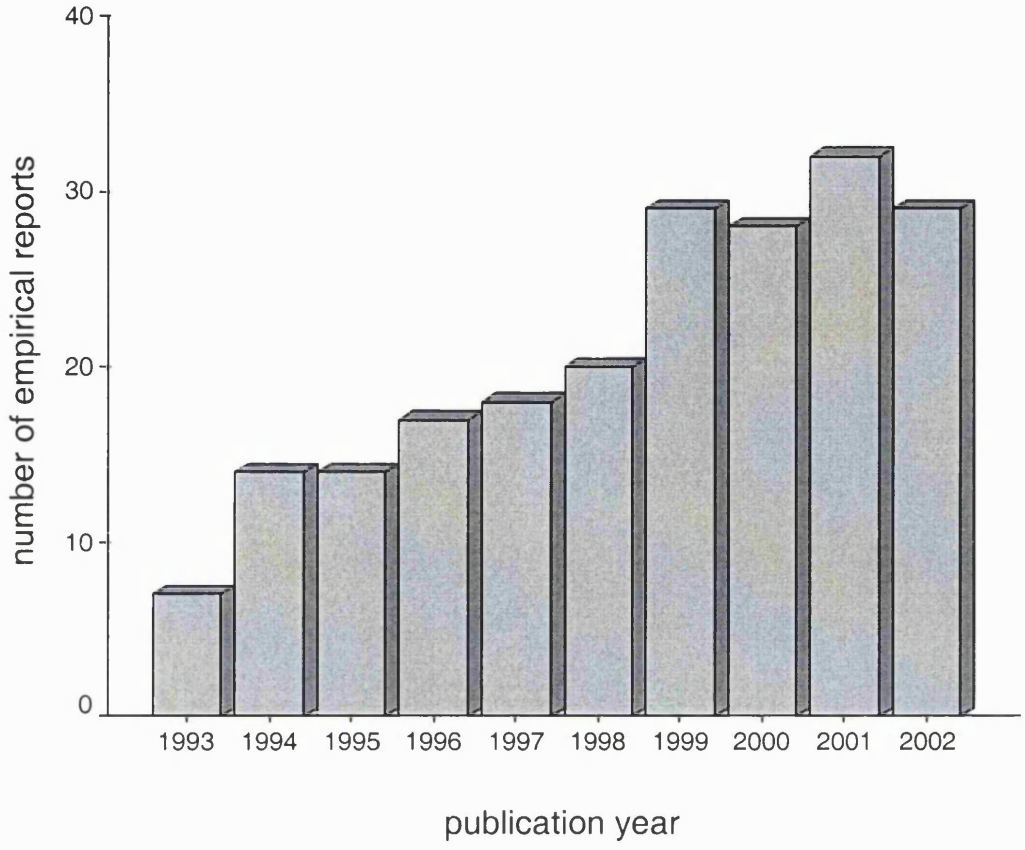


Figure 1.1

The usage of the term 'schizotypy' in empirical papers published in the last 10 years in peer-reviewed journals.

physiological measures. The results of this search suggested an increasing interest in investigating psychotic-like experiences in conjunction with putative underlying 'deficits', reflecting the current status of continuum hypotheses of schizophrenia in inspiring further research.

1.5 Fully dimensional versus taxonometric views of schizotypy

Despite a relative agreement on the notion that the presence of psychotic-like features the general population reflects some degree of dimensionality in schizophrenia, there is no consensus on the definition of such a

dimensionality. Claridge (1997) identified two models within which psychotic continuity has been being viewed: the quasi-dimensional and the fully dimensional model. The quasi-dimensional model tends to be more clinically oriented, as continuity is conceptualised in term of the variations in the underlying pathology of psychosis, such as personality disorders (schizophrenia spectrum disorders) and schizophrenia. On the contrary, the fully dimensional model, although it incorporates the quasi-dimensional view of schizophrenia, takes 'normality' as the starting point, with the personality disorders at the middle, and the fully-fledged schizophrenia at the other end of the continuum. An example of the fully dimensional view is the construct of 'psychoticism', (Eysenck & Eysenck, 1976) which is more personality-based including both healthy variations of psychotic-like traits and the proneness to psychosis (Claridge, 1997; Claridge & Beech, 1995).

Contrary to fully dimensional views of schizotypy, Meehl (1962; 1990) proposed that liability for schizophrenia-spectrum disorders, which can be indexed by the presence of psychotic-like features, is dichotomously distributed. According to Meehl, significant schizotypic signs bear close resemblance to schizotypal and schizoid personality disorder symptomatology as defined in the DSM-III (American Psychiatric Association, 1980). He proposed a theory of schizotypy as a subtle neurological disorder ('schizotaxia') of genetic origin accompanied by neurogenerative manifestations (Meehl, 1962; 1990). Meehl also posited the existence of 'genophenocopies' of schizotypes. Such individuals are thought to be false positives, because although they may resemble schizotypes, they lack the neurological signs and aberrant psychophysiology that characterises

individuals who possess the schizotaxic gene. In an effort to achieve quantified ways to diagnose the schizotypal taxon, Meehl embarked on developing new taxometric statistical methods and making latent taxon inferences from behavioural indicators (Meehl, 1990). Meehl's view of schizotypy is strongly clinically oriented, precluding the possibility that 'genuine' schizotypal traits may be a normal variation of personality.

The distinction between fully and quasi-dimensional models is not purely theoretical, as it can enhance understanding of some potentially important methodological differences between various approaches in schizotypy research and, therefore, to evaluate possible limitations. For example, when studying putative neuropsychological deficits, assessed by standardised tests, as a function of psychotic-like traits, assessed by psychometric measures of schizotypy, some investigators employ a single, relatively large sample of non-clinical participants (Dinn, Harris, Aycicegi, Greene & Andover, 2002; Rosa, van Os, Fananas, Barrantes, Caparros, Gutierrez & Obiols, 2000; Tsakanikos & Reed, 2003), a strategy which is in line with fully dimensional view of psychosis. In contrast, other investigators chose to employ samples of extreme schizotypy scores screened from a substantially larger sample of participants (Gooding, Tallant & Hegyi, 2001; Lenzenweger & Korfine, 1994; Spitznagel & Suhr, 2002), excluding a large part of the distribution of schizotypy features.

The latter approach, known also as the 'high-risk approach', is more compatible with the quasi-dimensional than with the fully dimensional approach of schizotypy. In the high-risk approach, extreme deviations of schizotypy in non-clinical participants reflect non-diagnosed or 'mild' cases of

personality disorders within the schizophrenia spectrum. Nevertheless, certain methodological advantages of testing non-clinical participants of different schizotypy status might be compromised by certain selection biases as a result of selecting only extreme schizotypy scorers. For example, the selection of extreme schizotypy scores screened from very large samples of non-clinical participant might increase the likelihood of including cases that, despite the absence of a clinical diagnosis, resemble clinical cases in respect to intensity, and, therefore, the disruptive effects, of some active psychotic symptoms, including in fact 'clinical' cases that remain undiagnosed for whatever reason.

In addition, extreme schizotypy scorers selected from a substantially larger sample of participants are likely to possess some other 'deviant' personality traits that are not specific to schizophrenia, such as impulsivity or obsessive-compulsive tendencies. Likewise, it is possible that extreme schizotypy scorers are likely to characterised by some 'deviant' style of information processing, such as dyslexia and synaesthesia. It is a plausible assumption that by selecting extreme scorers of one type (e.g. schizotypy) one may also select participants with another 'deviant' personality traits or information processing style. In this case, it remains uncertain whether a reported irregular pattern of performance on a specific task is due to the high level of schizotypy or to any other 'deviant' characteristic.

Despite the aforementioned problems, the use of non-clinical participants who score highly on measures of schizotypy can complement clinical research. A frequent methodological problem in schizophrenia research seems to relate to the possibility that various performance deficits observed in

schizophrenic patients might be due to medication, poor motivation, hospitalisation, disruptive (or compensatory) effects of active psychotic symptoms. In addition to this problem, there is also the possibility of a generalised performance deficit in schizophrenia, given that schizophrenic patients perform worse than controls in almost any known task, suggesting a general performance decrement (see, Miller, Chapman, Chapman & Collins, 1995; Knight & Silverstein, 2001; Strauss, 2001, for reviews). It has been shown (Chapman & Chapman, 1973; Miller *et al.*, 1995) that such a generalised performance deficit is a function of task difficulty, rather than a function of a specific cognitive ability that the task is supposed to assess (generalised versus specific deficits).

The use of healthy, psychometrically defined schizotypy scorers can complement schizophrenia research, as performance deficits on a certain task cannot be easily attributed to the presence of active symptomatology, medication, motivation, or a generalised performance deficit. Importantly, high-schizotypy scorers do not demonstrate all types of performance deficits observed in schizophrenia, making less likely the presence of a generalised deficit in schizotypy. For example, despite the often-reported intellectual decline in schizophrenia (e.g., Aylward, Walker & Bettes, 1984; Bilder, Lipschutz-Broch, Reiter & Geisler, 1992; Gold, Arndt, Nopoulos, O'Leary & Andreasen, 1999), non-clinical participants who score highly on various schizotypy measures do not demonstrate a performance deficit on measures of general intelligence (Gooding, Kwapil & Tallent, 1999; Tsakanikos & Reed, 2003).

Three possible etiological hypotheses on the relation between schizotypy and schizophrenia can be made. According to the first hypothesis, schizotypy is an attenuated/latent form of schizophrenia. If this is the case, then it is possible that both conditions share the same etiological factors. A second hypothesis would be that schizotypy and schizophrenia, despite some superficial similarities, are entirely different entities and, therefore, are linked to different etiological factors. A third hypothesis postulates that there is a partial overlap between the two entities. Although there is a substantial amount of non-shared variance, they seem share to some common etiological factors.

The review of the literature on the continuity of psychotic-like symptoms in the general population (presented earlier in this chapter), as well as on the experimental and predictive validation of such experiences, seems to argue against the second hypothesis. However, it might be premature to conclude against the first or the third hypothesis, as a solid corpus of evidence is needed elucidating both the continuities and the non-continuities between schizotypy and schizophrenia on the behavioural, cognitive and physiological level. A theoretical integration between the continuities and the non-continuities between schizotypy and schizophrenia would benefit from a clearer understanding of some salient deficits within the schizophrenia spectrum, following a detailed investigation the specific experimental conditions under which these deficits can be demonstrated.

1.6 The measurement of psychotic-like traits

Over the last quarter of the century, there has been an increased interest in the measurement of aspects of personality that seem related to schizophrenia. Various psychometric scales have been developed in an effort to assess psychotic-like features and behavioural manifestations of the underlying construct of schizotypy. Some of scales have been developed on the basis of pre-existing clinical/diagnostic inventories such as the Minnesota Multiphasic Personality Inventory (*Schizotypy* – Golden and Meehl, 1979). Other scales have been modelled on the DSM-III criteria for the diagnosis of 'schizotypal personality disorder' (*STA* – Claridge & Broks, 1984; *Schizotypal Personality Questionnaire* – Raine, 1991), and borderline personality disorder (*STB* – Claridge & Broks, 1984), while others have employed items that phenomenologically correspond to the content of the psychotic symptomatology (*Magical Ideation* – Eckblad & Chapman, 1983; *Social and Physical Anhedonia* – Chapman, Chapman & Raulin, 1976; *Perceptual Aberration* – Chapman, Chapman & Raulin, 1978).

Furthermore, a set of scales has employed items reflecting specific behavioural dispositions (*Launay and Slade Hallucination Scale* – Launay & Slade, 1981; Peters *et al.* Delusional Inventory – Peters, Joseph & Garety, 1999), or included items tapping schizophrenia-related attentional and thought characteristics (*Schizophrenism* – Nielsen & Petersen, 1976; *Schizoid Cognition* – Rust, 1987). In addition, certain scales included items assessing attentional/cognitive functions combined with items tapping specific psychotic-like symptoms (*Venables Schizotypy Scales* – Venables, Wilkins, Mitchell,

Raine & Bailes, 1990), or have focused on certain aspects of personality, such as aggressive and antisocial tendencies, hypothetically representing the one end of the psychotic continuum (*Psychoticism* – Eysenck & Eysenck, 1975). Relatively recently, a set of scales has been constructed on the basis of factor-analytic studies of items from some of the older scales mentioned above assessing different dimensions of schizotypy (Oxford-Liverpool Inventory of Feelings and Experiences – O-LIFE; Mason, Claridge & Jackson, 1995).

Despite their differences, the common objective of all schizotypy scales was to assess schizophrenic-like features underlying the trait of schizotypy in the normal population. Although the success of doing so has varied, each scale has independently contributed to the validity of this objective. For example, the schizotypal personality scale (STA – Claridge & Broks, 1984), which has been constructed to reflect the DSM III-R description of schizotypal personality, has been shown to have good predictive validity and test-retest reliability (Jackson & Claridge, 1991). In factor-analytic studies STA had high loading on the "positive" aspects of schizotypy, mainly psychotic-like cognitive and perceptual experiences (Bentall, Claridge & Slade, 1989; Vollema & van den Bosch, 1995). The construction of this scale lies within the tradition of the individual differences approach in measurement of psychotic-like traits, attempting to blend together both personality and clinical approaches.

The STA scale includes 37 items assessing hallucinatory experiences (e.g., "When in the dark, do you often see shapes and forms even though there is nothing there?" "Have you ever thought you heard people talking only to discover that it was in fact some non-descript noise?"), perceptual

distortions (e.g., "Do everyday things sometimes look smaller or larger than usual?", "Have you ever had the sensation that of your body or part of it changing shape?"), delusion-like ideation (e.g., "Do you sometimes feel that your accidents are caused by mysterious forces?", "Have you ever felt that you were communicating with another person telepathically?"), cognitive difficulties and social anxiety (e.g., "Do your thoughts ever stop suddenly causing you to interrupt what you were saying?", "When in a crowded room, do you often have difficulty in following a conversation?"). The full STA scale is included in Appendix 1.

In several investigations, non-clinical participants scoring highly on the STA have been shown to share similar behavioural, cognitive and neuropsychological deficits with schizophrenic patients. For example, high schizotypy scorers, as assessed by the STA, demonstrate attenuated hemispheric asymmetries (Broks, 1984; Broks, Claridge, Matheson & Hargreaves, 1984; Rawlings & Borge, 1987; Rawlings & Claridge, 1984), and fail to ignore irrelevant information, as assessed by negative priming (Beech *et al.*, 1989; Ferraro & Okerlund, 1996), and latent inhibition (Baruch *et al.*, 1988b; Hofer, Della Casa & Feldon, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992). Furthermore, high STA scores have been associated with high levels of nightmare distress (Claridge, Clark & Davis, 1997), reduced sensorimotor gating (Weike, Hamm & Vaitl, 2001), and out-of-the-body experiences (McCreery & Claridge, 2002).

1.7 Evidence of the 'attentional distractibiiity' within the schizophrenia spectrum

Selective attention involves selecting relevant stimuli and screening out irrelevant stimuli. This mechanism is thought not only to prevent an individual from sensory overload, as initially suggested, but also integrates the sensory inputs into coherent perceptual entities (Baddely & Weiskrantz, 1995; Pashler, 1997). It has suggested, and documented in various experimental paradigms, that schizophrenic patients demonstrate a core deficit in screening out irrelevant stimuli, resulting in sensory overload and cognitive fragmentation (Braff, 1993; Venables, 1960). This attentional distractibility has been viewed as reflecting greater responsiveness, as assessed by the Skin Conductance (SC) arousal, in minimally stimulating conditions, such as tone stimuli (Venables, 1960). Offspring of schizophrenic patients also tend to demonstrate heightened SC arousal as a response to tone stimuli (for a review see Venables, 1991), suggesting that SC arousal may be a risk factor for schizophrenia. In addition, longitudinal investigation has shown that heightened SC arousal in early childhood is a reliable predictor of persistent schizotypal traits in early adulthood (Raine, Venables, Mednick & Mellingen, 2002). It should be noted that, although attentional distractibility has been thought to be evident in various paradigms described later on in this section, there is a relative lack of longitudinal studies assessing the potential of these paradigms as risk markers.

Attentional distractibility in schizophrenia has also thought to be associated with a heightened awareness. Lawson, McGhie and Chapman (1964)

recorded the descriptions of schizophrenic patients of their own mental functioning. It was found that schizophrenic patients show a heightened awareness of bodily functions and volitional impulses that are normally held outside the rage of the conscious experience. This heightened awareness has been attributed to an increased attentional distractibility that can lead to impairments in concentration, organisation of thought, language and action (Lawson *et al.*, 1964). More recently, a similar pattern of heighten sensory awareness in schizophrenic patients has been also reported (e.g., Bunney, Hetrick, Bunney, Patterson, Jin, Potkin & Sandman, 1999; Mass, 2000). Cutting (1985), after reviewing the literature between 1960 and 1985, concluded that the weight of evidence was against a generalised attentional deficit. By contrast, consistent evidence by that time supported a deficit in the attentional shift from the one stimulus to another and in vigilance (Cutting, 1985).

Deficits in the process of stimulus selection have been assessed in various experimental paradigms. For example, when asked to name the ink colour (relevant stimuli) of colour-incongruent words (e.g., the word 'yellow' written in green ink), participants fail to suppress the intrusive effects of words (irrelevant stimuli), a phenomenon known as the Stroop effect. Schizophrenic patients are more prone to interference than controls, as indexed by both reaction time and accuracy, in various versions of Stroop (e.g., Everett, Laplante & Thomas, 1989; Verdoux, Magnin & Bourgeois, 1995). These findings have often been taken as evidence for an increased attentional distractibility in schizophrenia. However, a main limitation of the Stroop studies is that schizophrenic patients not only show the most interference in

the most difficult condition (i.e. colour-incongruent words), but in most conditions. Therefore, this pattern is likely to be due to a non-specific, generalised deficit in schizophrenia, and not due a specific attentional deficit. This possibility is also reinforced by studies that failed to identify increased Stroop interference in non-clinical, high schizotypy scores (Beech *et al.*, 1989; Steel *et al.*, 1996).

Despite the potential interpretational problems in the Stroop paradigm, there seem to be consistent evidence obtained with more direct indices of attentional response in paradigms where a minimal attentional effort is required. Schwartz and Evans (1999) administered a saccadic eye movement task to chronic schizophrenics. It was found that saccadic latency in the presence of an irrelevant stimulus is prolonged to a greater extent in schizophrenic than in non-schizophrenic patients. Additionally, schizophrenic patients demonstrate a greater percentage of error saccades directed to the irrelevant stimulus, and require a longer latency to "issue" corrective saccades following error saccades (Schwartz & Evans, 1999). Similar findings have been obtained with non-clinical participants scoring highly on schizotypy measures (Larrison, Ferrante, Briand & Sereno, 2000), further confirming a correspondence between schizotypy and schizophrenia.

Saccades are the fastest eye movements, enabling rapid shift of gaze and focusing on a selected visual target. In the anti-saccade task introduced by Hallet (1978), participants were instructed to look in the opposite direction of a visually presented stimulus. Normal individuals can perform this task successfully, although normal individuals in a small percentage of error trials make a saccade toward the target (pro-saccade) and then a saccade in the

opposite direction (anti-saccade). It has been shown that patients with schizophrenia produce significantly more errors in the anti-saccade task than healthy controls (e.g., Katsanis, Kortenkamp, Iacono & Grove, 1997; McDowell & Clementz, 1997), a pattern of performance that has been also observed in psychometrically defined high-schizotypy scorers (Gooding, 1999), and in first-degree biological relatives of schizophrenics (Clementz, McDowell & Jisook, 1994). Given that eye movements, although neither necessary nor sufficient for a target selection, typically follow an overt attentional shift, irregular anti-saccade performance can be interpreted as information processing 'irregularity' linked to the putative increased attentional distractibility in schizophrenia (Braff, 1993; Venables, 1960).

Pre-pulse inhibition is another paradigm that requires a minimal attentional effort and has been employed to investigate sensory gating deficits associated with increased distractibility in schizophrenia (e.g., Karper, Freeman, Grillon, Morgan, Charney & Krystal, 1996). Normally, a strong external stimulus, such as a sudden 100-dB tone, or a sudden bright light, elicits a series of flexion and extension responses known as the startle response. The startle response is inhibited when the startling stimulus is preceded by 30 to 500 ms by a weak pre-stimulus presented either in the same or in a different modality. It has been suggested that inhibition of the startle response is acting as a safeguard that protects the individual against cognitive overload and fragmentation (Braff, 1993). Schizophrenic patients tend to show less of the normal inhibition of the startle response in this paradigm (Judd, McAdams, Budnick & Braff, 1992; Kumari, Soni, Mathew & Sharma, 2000; Swerdlow, Braff, Taaid & Geyer, 1994). Reduced pre-pulse

inhibition has been observed in psychometrically defined schizotypy (for a review, see Cadenhead & Braff, 2002) and schizotypal personality disorder (Cadenhead, Geyer & Braff, 1993).

Unlike the Stroop and the saccadic eye movement paradigms, pre-pulse inhibition can be studied in both human and non-humans. This latter feature seems to be of a particular importance given the necessity for non-human models of the disorder on the pharmacological and physiological level of investigation. In recent years, latent inhibition has been widely employed as a non-human model of testing schizophrenia related hypotheses (Gray, 1998), a development that has facilitated integration and comparative evaluation of findings from the human and non-human literature. 'Latent inhibition' is a term used to describe impaired conditioning to a pre-exposed stimulus as compared to a non-preexposed stimulus (Lubow, 1989), a phenomenon that tends to be absent or attenuated in schizophrenia (Gray, 1998, for a review). Importantly, the latent inhibition paradigm inventively induces a situation in which a failure of inhibition causes 'better' performance in schizophrenic patients (i.e. performance to a preexposed stimulus tends to be elevated to the level of a non-preexposed stimulus), a pattern that cannot be easily explained as the result of a generalised deficit in schizophrenia.

Although both pre-pulse inhibition and latent inhibition are appropriate for comparative evaluation of human and non-human studies, latent inhibition seems to captures some unique aspects of stimulus selection. Unlike pre-pulse inhibition that is thought to reflect some type of sensory gating, i.e. low-level processing, latent inhibition seems to capture some aspects of high order processing, i.e. discriminating between 'important' and 'non-important'

events. This latter feature of latent inhibition provides a rich conceptual framework for theorising on the relationship between behavioural manifestations (symptoms) and putative underlying deficits in schizophrenia. The theoretical basis of latent inhibition and the significance of this phenomenon in investigating attentional deficits within the schizophrenia spectrum will be discussed in detail in the next chapter.

1.8 Summary of the schizotypy review

Epidemiological studies suggest that psychotic-like features are distributed in the general populations. Genetic, longitudinal and experimental data suggest a link between psychotic-like features and schizophrenia. These lines of evidence add support to dimensional views of psychosis. The historical origins of these dimensional views can be traced back to the early formulation of schizophrenia (Blueler, Kretschmer), and are relevant to the more recent conceptualisations on the nature of psychotic-like personality traits (Eysenck, Claridge, Meehl, Venables). In the last 20 years, the term 'schizotypy' seems to have been established in describing schizophrenia-like features in non-clinical participants. There is a wide range of instruments assessing these schizotypal traits, as well as different methodological approaches to schizotypy research. These differences are explainable in terms of two different views of psychosis: the personality-based, fully-dimensional view and the categorical, or 'quasi-dimensional', view. The former model was adopted in the studies presented in this thesis, given that the personality-based approach of schizotypy seems to possess certain methodological advantages

over the high-risk approach (i.e. selecting extreme high-schizotypy scorers from substantial larger samples and excluding the middle range of scores).

Both schizophrenia and schizotypy have long associated with an increased attentional distractibility. Different lines of evidence have suggested that the ability to screen out irrelevant stimuli, as indexed in different experimental paradigms, seems to be impaired in schizophrenic patients and high-schizotypy scorers. Latent inhibition is a phenomenon of particular interest for three main reasons. Firstly, latent inhibition induces a situation in where schizophrenic patients and high schizotypy scorers perform 'better' in the experimental condition, avoiding an interpretation of this performance pattern as a result of generalised deficits. Secondly, this phenomenon can be demonstrated in both humans and non-humans, facilitating comparative research in schizophrenia (animal models etc). Thirdly, unlike low-level information processing paradigms, such as pre-pulse inhibition, the latent inhibition treatment is thought to create (through repeated, non-reinforced pre-exposure) two classes of events: experimentally unimportant, non-sequential, and therefore, irrelevant events/stimuli; and novel, therefore potentially important, events. Consequently, latent inhibition may offer a valuable opportunity of studying the effects of acquired properties of past events, i.e. learning processes implicated in diverse cognitive domains, such as acquisition of social skills and formation of abstract concepts. A detailed description of the theories and the experimental paradigms of latent inhibition will be presented in the next chapter.

CHAPTER 2

The disruption of latent inhibition in schizophrenia and schizotypy

2.1 Latent Inhibition

'Latent inhibition', or the 'stimulus preexposure effect', is a term used to describe the phenomenon in which conditioning to a stimulus is retarded after repeated, non-reinforced presentation of that stimulus (Lubow & Moore, 1959), an effect that has been has been demonstrated in most mammalian organisms (Lubow, 1989). Additionally, it has been suggested that latent inhibition reflects a process of stimulus selectivity (Lubow & Gerwirz, 1995). According to this view, latent inhibition is supposed to reflect a mechanism of filtering out events that have been registered as non-consequential and, therefore, non-important, in favour of newly appeared, potentially important, events (Lubow & Gewirz, 1995).

Typically, the latent inhibition procedure involves a between-subject design, and consists of two phases (Lubow, 1989; Lubow & Moore, 1959). In the first phase, the experimental group (pre-exposed) is presented with the to-be-conditioned target-stimulus; the control group (non-preexposed) is not presented with this stimulus. In the second phase, both groups are presented with the target-stimulus followed by an important event, such as reinforcement or punishment. The preexposed group demonstrates slower conditioning in comparison to the control group. Although within-subject designs of latent inhibition have been introduced as well, these have been recently criticised as limiting the use of this learning paradigm as an indicator of subtle

performance change (Gray, Snowden, Robert, Peoples, Hemsley & Gray, 2003).

Latent inhibition is one of the methods employed in non-human studies in order to determine the amount of attention that a stimulus receives. The use of latent inhibition as a measure of attention relies on the assumption that the subjects must first attend to a stimulus, if they are to learn about the consequences of that stimulus (i.e. that it signals reinforcement, the absence of reinforcement or punishment). If this assumption was correct, then the amount of conditioning to a stimulus (stimulus associability) would provide an indication of the amount of attention that stimulus have received.

Kay and Pearce (1987) demonstrated that the experience of merely being presented with a stimulus could influence the attention paid to it. In these studies, two groups of rats were placed in a conditioning chamber containing a light bulb and a food dispenser. For the first 12 sessions, nothing happened for the non-preexposed (control) group, however, for the preexposed (experimental) group the bulb was illuminated for 10 sec at regular intervals. Both groups were then given a single pre-test session, in which the bulb was illuminated for 10 sec at regular intervals. The number of orienting responses (elicited by novel stimuli) to the light was recorded for both groups. It was found that the preexposed group had significantly lower number of orienting responses to the light than the non-preexposed group. In the next phase of the same experiment, both groups were given four conditioning sessions. As expected, the preexposed group was conditioned to the light at significantly slower rate than the non-preexposed (Kay & Pearce, 1987), suggesting that

the amount of conditioning to a stimulus constitutes a measure of the amount of attention that stimulus may have received.

2.2 Theories of latent inhibition

Although latent inhibition appears to be a rather simple phenomenon, there is little consensus on why the stimulus preexposure has a detrimental effect on subsequent conditioning. Despite the popularity of the attentional accounts of latent inhibition, often uncritically accepted in the clinical literature, the theoretical basis of the phenomenon remains controversial, and a number of diverse theories have been put forward to explain the effect. Some of these theories have focused on attentional changes during preexposure ('attentional theories'), other theories have focused on changes in the associability of the preexposed stimulus ('associative theories'), while others on an interaction between networks of critical variables ('network theories'). Until recently, critical issues such as the theoretically equivocal status of the phenomenon, as well as the fact that most theoretical accounts have been almost exclusively based on non-human data, have not been adequately incorporated in the experimental investigation of latent inhibition in schizophrenia and in schizotypy.

2.2.1 Attentional theories

One classical attentional account of latent inhibition has been provided by Mackintosh (1975). The model emphasises the changes in attention that occur as a result of stimulus preexposure, which, in turn, affect the associative strength of the stimulus. This model sets out some specific rules that govern

the relationship between attention and associative strength. The model assumes that attention to a stimulus increases when the stimulus becomes an accurate predictor of an important outcome. By contrast, attention decreases when the stimulus becomes a less accurate predictor of an outcome; consequently, the associative value of the stimulus declines. The term 'accurate predictor' refers to the extent to which a stimulus signals changes to the expected outcome or reinforcement. If the stimulus signals a change in respect to the level of reinforcement, attention increases. However, if the stimulus signals no change in the expected level of reinforcement, then attention decreases, and, consequently, the stimulus associability decreases (Mackintosh, 1975). Moreover, according to this theory, in order to attract attention a stimulus must not only be a good predictor of the level of the reinforcement, but it must be also a better predictor than the other stimuli that are present during a trial (e.g., contextual cues). The last assumption allows the theory to explain latent inhibition. According to Mackintosh (1975) subjects pay a lot of attention to a stimulus when it is novel. However, after repeated presentations of the stimulus, there will be a loss of attention to that stimulus. This happens because the preexposed stimulus is just as accurate at predicting the event that follows (i.e. nothing) as the contextual cues that accompany it (Mackintosh, 1975).

Mackintosh's account of latent inhibition has been challenged by experiments that employed the orienting response as an index of attention in a partial reinforcement paradigm (Kaye & Pearce, 1984). It was found that the frequency of the orienting response to a partially (50%) reinforced stimuli was significantly higher than the frequency of orienting response to a

continuously reinforced (100%) stimulus. In terms of stimulus predictability, a partially reinforced stimulus is a worse predictor of reinforcement than a continuously reinforced one. However, contrary to Mackintosh's predictions, the less accurate predictor (i.e. the partially reinforced stimulus) was found to attract a greater amount of attention that more accurate predictor of reinforcement (Keye & Pearce, 1984).

A different attentional approach is the 'conditioned attention theory' (Lubow, 1989), which explains latent inhibition as a result of the conditioning of an inattentional response to the preexposed stimulus. According to this account, the preexposed stimulus initially elicits an attentional response (attention with this framework is treated as a reflex). After a few exposures of the stimulus, the attentional response is conditioned to no consequences (no reinforcement), and attention to that stimulus declines. This attentional decline is assumed to obey the laws of classical conditioning (Lubow, 1989). A main shortcoming of the conditioned attention theory, as well as of any attentional account of latent inhibition, is the implicit assumption that the impairment in the associability of the preexposed stimulus during preexposure will occur under all conditions. Furthermore, it is assumed that such a performance decrement will be irreversible without further training. However, when a stimulus is preexposed in a certain context (e.g., a particular apparatus) and then tested in a different context (e.g., a different apparatus), latent inhibition appears substantially attenuated or disrupted in both humans (Gray, Williams, Fernandez, Ruddle, Good & Snowden, 2001; Kaplan & Lubow, 2001; Zalstein-Orda & Lubow, 1995) and non-humans (Lovibond, Preston & Mackintosh, 1984; Hall & Channel, 1983; Lubow, Rifkin & Alec, 1976).

The recovery from latent inhibition after a context change is problematic for most attentional theories, since it challenges fundamental assumptions that are intrinsic to any attentional account: that latent inhibition is the result of a change only in the preexposed stimulus (something seems to be learned about the context of preexposure as well); that performance decrement is not irreversible without further training (it is reversible after a context change); and, consequently, that latent inhibition will obtained after passive stimulus preexposure under any condition (latent inhibition requires a stable context).

Despite the problems with the attentional interpretation of latent inhibition, there is some evidence that the involvement of attentional processes in latent inhibition cannot be excluded. For example, latent inhibition has been shown to be a function of the masking task load during the preexposure phase (Braunstein-Bercovitz & Lubow, 1998*a*), which can be taken as an indication, albeit indirect, of the attentional modulation of latent inhibition, given that the making task load has been shown to determine critically the selection of relevant stimuli in selective attention tasks (Lavie & Tsal, 1994).

2.2.2 Associative theories

Wagner's account of latent inhibition (1981), although expressed in cognitive terms, essentially qualifies as an associative theory, mainly because it focuses on stimulus—context associations. The model postulates that the memory of a stimulus can be stored in two different states, that is, the inactive stage and the active stage. The active state consists of two component states: state A_1, when the stimulus is the centre of the subject's attention, and state

A_2, when the stimulus is in the periphery of the attention. When a subject is presented with a non-reinforced stimulus, the representation of the stimulus initially enters state A_1, and then it decays into state A_2. Finally, it ends up at the inactive state. According to this model, non-reinforced, repeated presentation of a stimulus in a certain apparatus results in the growth of stimulus-context associations. Consequently, the sight of the context during testing will activate a representation of the stimulus in the state A_2, which interfere with the acquisition of a subsequent stimulus-reinforcement association, i.e. the development of latent inhibition.

A main advantage of Wagner's proposal (1981) that stimulus-context associations are responsible for the development of latent inhibition after stimulus preexposure is that it can account for the context specificity of the phenomenon. The model predicts that if a preexposed stimulus is subsequently presented in a different context from that in the preexposure phase, the new context will not activate an A_2 representation. In that case, the stimulus will be fully attended to and, therefore, latent inhibition will be disrupted (conditioning to a preexposed stimulus = conditioning to a non-preexposed stimulus). This latter prediction can accommodate consistent evidence that latent inhibition is specific to the context in which the stimulus has been exposed (Gray *et al.*, 2001; Hall & Channel, 1983; Kaplan & Lubow, 2001; Lovibond, Preston & Mackintosh, 1984; Lubow, Rifkin & Alec, 1976; Zalstein-Orda & Lubow, 1995).

A second testable prediction that derives from Wagner's (1981) model is that an extinction of the stimulus—context association will occur, if the context is exposed by itself after the stimulus—context preexposure. Consequently,

the extinction of stimulus—context associations would result in attenuation or disruption latent inhibition, if these associations were indeed responsible for the development of latent inhibition. However, subsequent studies have failed to confirm such a context extinction effect in both non-human and human conditioning (e.g., Hall & Minor, 1984; Zalstein-Orda & Lubow, 1995), which makes the stimulus—context account problematic.

Other associative accounts of latent inhibition attempted to explain the phenomenon in terms of associative interference (Hall, Keyne & Pearce, 1985). During the preexposure phase, a stimulus—no-event association is assumed to be established which interferes with the acquisition of new stimulus—event associations during the subsequent, conditioning phase. Weiner (1990) also proposed a neuropsychological model of a switching mechanism of latent inhibition, based on the assumption of the interfering effects of stimulus—no event associations during the preexposed phase. According to the switching model, latent inhibition takes place because stimulus—no-event associations formed during the preexposed phase continue to control behaviour during the conditioning phase (Weiner, 1990; Weiner & Feldon, 1997). Both associative theories, however, are subject to the same limitations as attentional theories, given that they cannot account for the contextual effects of latent inhibition (Gray *et al.*, 2001; Hall & Channel, 1983; Kaplan & Lubow, 2001; Lovibond *et al.*, 1984; Lubow *et al.*, 1976; Zalstein-Orda & Lubow, 1995).

Apart from the problems in predicting contextual effects, an additional problem for most associative accounts is the fact that latent inhibition cannot pass a *summation* test (Rescorla, 1971). According to the summation effect,

after separate stimuli—outcome pairings (e.g., A—US, B—US), the associative strength between an outcome (US) and a compound stimulus (AB) equals the sum of the two stimuli (A—US + B—US), as each stimulus develops independently an associative bond with the outcome (US). However, it has been shown (Rescorla, 1971) that, following separate preexposures to a stimulus A and to a stimulus B, a compound stimulus AB does not result in a latent inhibition effect that equals the sum of associative strength between an outcome no—US and the two stimuli (A—no US + B—no US), making problematic any associative interpretation of latent inhibition.

Some investigators have attempted to test some competing accounts of latent inhibition on the basis of their ability to predict the effects of a compound preexposure using a blocking design. This procedure consists of three phases. In Phase I, a non-target stimulus (A) is preexposed without reinforcement. In Phase II, a compound (non-target /target) stimulus (AB) is repeatedly presented without being followed by reinforcement. In Phase III, all the subjects are conditioned to the target stimulus (B). The attentional view (Lubow, 1989) predicts an attenuation of latent inhibition in the above blocking design, based on the conditioned attention assumption: the presentation of the non-target stimulus (A) prior to the compound (target/non-target) stimulus (AB) would produce conditioning of inattention to the non-target (A) in the Phase I, which would block conditioning of inattention to the target (B) in the Phase II. The associative view (Hall *et al.*, 1985) also predicts an attenuation of latent inhibition after a blocking design based on the assumption of associative interference: the formation of non-target—no event associations in Phase I (non-reinforced preexposure of a non-target) will

prevent the formation of target—no event associations in Phase III (non-reinforced preexposure of the target/non-target compound). On the other hand, Wagner's model predicts that the blocking treatment will have no effect on latent inhibition (Wagner, 1981). In contrast to the above predictions, an enhanced latent inhibition has been obtained after blocking treatment (Reed, 1995; Reed, Anderson, & Foster, 1999; Reed & Tsakanikos, 2002), a finding that posses problems in most existing theories of latent inhibition.

As seen earlier, the context specificity of latent inhibition has been an obstacle for most of the theoretical accounts of the phenomenon. Lubow and Gewirtz (1995) attempted to explain that the disruption of latent inhibition after a context change could be attributed to an involvement of the context as an '*occasion setter*', i.e. a stimulus that modulates the expression of latent inhibition, acting as a 'reminder' for the expression of stimulus–no event associations. According to this view, an occasion setter, without having a predictive value *per se*, is able to facilitate the expression of past associations. Such a 'reminder' is absent after a context change, resulting in the attenuation or disruption of latent inhibition. If context was an occasion setter, preexposure of the context alone (context extinction) would not expected to have an effect on latent inhibition, because extinction cannot alter the properties of an occasion setter. However, contrary to predictions, preexposure of the context before stimulus preexposure seems to attenuate latent inhibition (Baker & Marcier, 1982; Grahame, Barnet, Gunther, Miller, 1994), undermining the suggestion that the context acts as an occasion setter.

2.2.3 Network models

A neural network model describing putative processes underlying the stimulus preexposure (Schmajuk, Lam & Gray, 1996) proposed that latent inhibition is the result of an interaction between storage and retrieval variables. According to this model, stimulus preexposure reduces the stimulus novelty, which is responsible not only for slower stimulus–reinforcement acquisition, but also for slower retrieval during the testing phase. This model can accommodate a large body of existing evidence on latent inhibition, although it cannot account for evidence suggesting that disruption of latent inhibition is due to retrieval, rather than acquisition impairments (Weiner, Lubow, & Feldon, 1984; Miller & Matzel, 1988).

A more recent theoretical proposal explains latent inhibition as the result of combination between stimulus—stimulus and stimulus—context associations, i.e. a dual mechanism (McLaren & Mackintosh, 2000). This is a real-time network model with all the experienced events comprised of multiple elements, each of which activates a distinct node in the network. According to this model, each stimulus is composed of different elements (i.e. size, location, intensity etc). The component elements of a stimulus are linked to each other through simultaneously activated associations, while each component element is associated separately with the context. This last feature of the McLaren and Mackintosh model (2002) can offer a plausible account of why latent inhibition often appears only attenuated, rather than completely disrupted, following a context change: despite the deletion of the stimulus—context associations, the existing within-stimulus associations maintain some level of latent inhibition. Although this dual mechanism

account of latent inhibition appears to fit reasonably well the existing data, some predictions are not consistently supported (e.g., Escobar, Arcediano & Miller, 2002). For example, the dual model predicts that long preexposure to the context after stimulus preexposure should only partly attenuate latent inhibition, because a context treatment would affect stimulus—context associations, but not the associations between the component elements of the stimulus. Contrary to prediction, complete disruptions of latent inhibition have been obtained following long preexposure of the context after stimulus preexposure (Escobar *et al.*, 2002).

2.3 Latent inhibition and schizophrenia

Different sources of converging evidence have suggested an association between disruption of latent inhibition and schizophrenia. The main evidence comes from clinical research, as latent inhibition is disrupted in schizophrenic patients (Baruch, Hemsley & Gray, 1988a; Gray, Pilowsky, Gray, & Kerwin, 1995; Lubow, Kaplan, Abramovich, Rudnick & Laor, 2000; but see Swerdlow, Braff, Hartson, Perry, & Geyer, 1996). The source of this disruption stems from the fact that schizophrenic patients learn more rapidly than controls that a preexposed stimulus is associated to an important event. This "better" performance is thought to rule out artifacts and non-specific deficits in studies with schizophrenia patients (Braff, 1993).

In addition, schizophrenic patents fail to demonstrate latent inhibition in the acute phase of the disorder, but not in the chronic phase (Baruch *et al.*, 1988a; Gray *et al.*, 1992). A possible reason for the discrepancy between chronic and acute patients could be due to differences in medication. Indeed,

a linear relationship between the duration of illness and the magnitude of latent inhibition has been found in non-medicated patients (Gray *et al.*, 1995). Additionally, latent inhibition was absent at the start of the illness in the absence of drug treatment. However, latent inhibition gradually returned to normal levels, as the illness progressed and medication was started. The crossover occurred at about one year after the first psychotic episode. Taken together, the obtained results suggest that anti-psychotic medication accelerated normalization of latent inhibition over the course of a schizophrenic illness (Gray *et al.*, 1995).

A second line of convergence evidence elucidating a link between latent inhibition disruption and schizophrenia comes from psychopharmacological studies. As mentioned earlier, the effect of acute schizophrenia on latent inhibition is largely due to changes in the preexposed condition. Acute schizophrenic patients in the preexposed condition learn faster than normal participants, ruling out artifacts due to poor motivation, distraction cased by psychotic symptoms, adverse side effects by drugs etc. In addition, administration of *d*-amphetamine, an indirect dopamine agonist *inter alia* that is thought to mimic certain neuro-physiological symptoms of schizophrenia (e.g., Carlson, 1989; Willner, 1997), disrupts latent inhibition by elevating responding in the preexposed group at the level of the non-preexposed group in non-humans (for a review, Gray, Pilowsky, Gray & Kerwin, 1995), and humans (Kumari, Cotter, Mulligan, Checkley, Gray, Hemsley, Thornton, Corr, Toone & Gray, 1999). It should be noted that the use of amphetamine as a pharmacological model of schizophrenia has often been doubted, as regular

amphetamine intake typically fails to induce psychosis (see Claridge, 1994, for a critique of the amphetamine model).

The amphetamine-induced disruption of latent inhibition can be reversed after administration of dopamine antagonists, widely used as anti-psychotic drugs, such as haloperidol and chlorpromazine (Solomon *et al.*, 1981; Christison, Atwater, Dunn & Kilts, 1988), which are thought to normalize attention. Evidence suggests that latent inhibition enhancement is specific to dopamine antagonists (e.g., Dunn, Atwater and Kilts, 1993), ruling out the possibility that administration of anti-psychotic drugs cause a non-specific improvement of learning that is confounded with the enhancement of latent inhibition. The last decade, a number of anti-psychotic agents have been consistently shown to restore selectively, amphetamine-induced disruption of latent inhibition (see Moser, Hitchcock, Lister & Moran, 2000; Weiner, Gaisler, Schiller, Green, Zuckerman & Joel, 2000, for reviews) attesting to the establishment of latent inhibition as a promising pharmacological model of schizophrenia.

On the physiological level, enhanced dopamine transmission specific to the nucleus accumbens has found to be linked to latent inhibition disruption (Gray, Moran, Grigorian, Peters, Young & Joseph, 1997). Increased dopamine release in the nucleus accumbens has been demonstrated after Pavlovian pairing of a light and a tone, but not after unpaired presentations of the light and the tone (Joseph, Young & Gray, 1996). The finding that increased dopamine release in the nucleus accumbens is triggered during the formation of associations between stimuli may suggest the involvement of an associative mechanism during the disruption of latent inhibition.

It should be noted, that some aspects of evidence on the action of dopamine-agonists and dopamine-antagonists on latent inhibition can not easily be interpreted. For example, the disruption caused by amphetamine administration is inversely dose dependent, that is, latent inhibition is attenuated in low doses, but not in high doses of amphetamine (Thornton *et al.*, 1997; Weiner, 1990). Moreover, a study that examined the effects on latent inhibition after *d*-amphetamine administration, and haloperidol, a non-selective dopamine receptor antagonist, in normal male volunteers, was found that *d*-amphetamine reduced latent inhibition, replicating past studies. However, haloperidol also reduced latent inhibition, but only in participants who scored low on the Psychoticism scale (Kumari, Cotter, Mulligan, Checkley, Gray, Hemsley, Thornton, Toone & Gray, 1999). It may well be the case that, in order to interpret some data from the psychopharmacological and physiological studies, a more detailed behavioural investigation of the parameters that modulate latent inhibition (as well of the theoretical basis of phenomenon) might be required.

A third line of convergence evidence on the link between latent inhibition disruption and schizophrenia come from studies on individual differences with non-clinical participants of different schizotypy levels. In line with the dimensional view of psychosis, latent inhibition has been found significantly attenuated in non-clinical participants who scored highly on measures of schizotypy (Allan, Williams, Wellman, Tonin, Taylor, Feldon & Rawlins, 1995; Baruch, Hemsley & Gray, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Lipp & Vaitl, 1992; Gray, Fernandez, Williams, Ruddle & Snowden, 2002; Lubow & De la Casa, 2002; Lubow, Kaplan & De la Casa,

2002; Lubow, Ingberg-Sachs, Zalstein-Orda & Gewirtz, 1992; but see Lipp, Arnold & Siddle, 1994, Experiment 3) suggesting that this phenomenon may possibly constitute a marker for schizophrenia. The experimental paradigms used to obtain latent inhibition in the above studies were the same as those employed with schizophrenic patients. A detailed description of these procedures, as well as a discussion of possible conceptual and methodological ambiguities surrounding some of the existing latent inhibition procedures, will be presented in the next section.

2.4 Experimental paradigms of latent inhibltion: conceptual and methodological limitations.

Having as a starting point the continuum hypothesis of schizophrenia, a number of studies have shown that high-schizotypy scorers demonstrate attenuated latent inhibition in comparison to low-schizotypy scorers (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Della Casa, Hofer, Weiner & Feldon, 1999; Gray *et al.*, 2002; Hofer, Della Casa & Feldon, 1999; Lipp & Vaitl, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992); a pattern of results akin to that observed in schizophrenic patients. In the majority of studies (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002), the STA scale (Claridge & Broks, 1984) has been employed (either alone or in conjunction with other schizotypy measures) to classify the participants into high- or low-schizotypy scorers (see also pp.15 for detailed description of this scale).

In the early latent inhibition/schizotypy studies, an auditory paradigm has been employed (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Della Casa *et al.*, 1999; Lubow *et al.*, 1992, Experiment 1), based on a 'masked' procedure devised by Ginton, Urca and Lubow (1975). The dependent variable was number of trials to reach a learning criterion. During the preexposure phase, after putting on headphones, participants were instructed to count how many times a particular non-sense syllable is repeated against other non-sense syllables (the masking task). The control group was only engaged in the monitoring and counting task, while the experimental group was additionally exposed to a tone (the to-be-conditioned stimulus). In the next phase, all participants were informed that they would start a new task, and were asked to predict the decrease in a score indicated on a counter. Then they were instructed to press a button every time they felt that the score was about to decrease. In order to learn the task, participants had to acquire the rule that every time they were pressing a button in presence of the tone (CS) the score on the counter was reduced (US). Participants who were preexposed to the tone learnt the association more slowly than participants with no such previous experience with the tone. In the visual variants of this paradigm (Braunstein-Bercovitz & Lubow, 1998; Gray *et al.*, 2002; Lubow *et al.*, 1992, Experiment 2), syllables were presented via a monitor, and a meaningless shape in the background operated as the to-be-conditioned stimulus. All other aspects of the procedure were the same as in the auditory paradigm described above.

One methodological issue regarding the above paradigm (both in its auditory and visual version) is the use of an explicit masking task employed to

divert the participants' attention from the preexposure stimuli. It has been shown (see, Lubow & Gewirtz, 1995, for a review) that, with the exception of the electrodermal conditioning (e.g. Lipp *et al.*, 1994), the masking task seems to be a necessary condition for the production of the latent inhibition effect in rule-learning paradigms. Given that in the non-human latent inhibition studies a similar masking task is not required, the suggestion that human and non-human latent inhibition are not mediated by equivalent attentional processes might well undermine the heuristic value of latent inhibition as a non-human model of schizophrenia. A plausible explanation for the necessity of the masked preexposure in human procedures could be that the masking task makes the experimental situation equivalent to those in non-humans by reducing the *demand characteristics* (Orne, 1962) of the experiment (for example, participants might sustain 'artificially' their attention to every element of the experimental procedure in their effort to achieve a maximum level of performance), while increasing the task difficulty in order to avoid ceiling effects. On the other hand, it could be suggested that in the non-human paradigms of latent inhibition attention is 'naturally' diverted from the target stimulus by the animal exploring the environment of the apparatus. This spontaneous activity might be equivalent to a human masking task.

Nevertheless, a rather neglected implication of the inclusion of a masking task in the above paradigm relates to the target/distractor reversal that is involved, and the interpretational problems that this might create. In the studies that have employed the early latent inhibition paradigm (i.e. Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Braunstein-Bercovitz & Lubow, 1998; Della Casa *et al.*, 1999; Gray *et al.*, 2002; Lubow *et al.*, 1992, Lubow *et al.*, 1992)

two separate phases have been employed. In Phase I (preexposure phase), participants are instructed to attend to a set of relevant stimuli, i.e. the stimuli comprising the masking task (target) in the presence of an irrelevant stimulus B (distractor). In Phase II (testing phase), the stimulus B becomes relevant (target) and the stimuli comprising the masking task irrelevant (distractor). Such a target/distractor reversal, however, constitutes an experimental convention for generating shift learning/reversal learning (Amsel, 1992), but it is not required in the non-human paradigm of latent inhibition.

It could be argued, therefore, that all the studies that employed the early latent inhibition paradigm (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Braunstein-Bercovitz & Lubow, 1998; Della Casa *et al.*, 1999; Gray *et al.*, 2002; Lubow *et al.*, 1992) might have essentially demonstrated shift learning, rather than latent inhibition. To complicate the matter further, shift learning, assessed by the Wisconsin Card Sorting Test, has been also found to be impaired in schizophrenic participants (e.g., Crider, 1997; Oades, 1997), and in non-clinical participants scoring highly on schizotypy (Gooding *et al.*, 2001). Given the target/distractor reversal employed in the past human latent inhibition paradigms, it could be argued that the obtained attenuation of latent inhibition in high psychotic-prone individuals might in fact constitute a manifestation of impaired reversal learning.

The problem of target/distractor has not been addressed in the development of more recent paradigms. For example, in order create a procedure that would presumably reflect attentional process more directly, Lubow and Kaplan (1997) introduced a second latent inhibition paradigm. Consistent with findings obtained in the earlier paradigm, latent inhibition, as

assessed by this paradigm, has been found to disrupted in schizophrenic patients (Lubow *et al.*, 2000) and attenuated in high-schizotypy scorers (Lubow *et al.*, 2002). This paradigm was based on a visual search task, as a visual analogue for the traditional preexposure and testing phase of latent inhibition. In both phases of this paradigm, participants were presented with displays of meaningless, two-dimensional figures. Each display contained 20 figures randomly placed over the screen. Some of the displays contained 20 identical figures, and some contained 19 identical figures and one unique figure. The participants had to respond quickly by pressing a certain key when the target was present (i.e. in displays containing 19 identical figures and one unique figure) and by pressing another when the target was present (i.e. in displays containing 20 identical figures). During the preexposure phase of this paradigm, the distractor and the target figures remained the same throughout the trials. During the testing phase, latent inhibition was assessed by comparing two conditions: preexposed (PE) and non-preexposed (NPE) condition. In the PE condition, the distractor figure of the previous phase became the target figure (familiar/preexposed), and the target figure of the previous phase became the distractor figure (familiar/preexposed). In the NPE condition, the target was a new stimulus (novel/non-preexposed), and the distractor (familiar/preexposed) was the one employed in the previous phase.

It should be noted that the above paradigm (Lubow & Kaplan, 1997), in an effort to manipulate preexposure, introduced a reversal in the roles of the target and the distractor from the preexposure to the testing phase. Such a reversal was not only similar to the earlier rule-learning paradigm of latent

inhibition, but also similar to paradigms of shift learning (Amsel, 1992). Consequently, the results obtained in this paradigm (Lubow & Kaplan, 1997) with schizophrenic patients (Lubow *et al.*, 2000) and in high-schizotypy scorers (Lubow *et al.*, 2002) could be interpreted as manifestation of shift learning, rather than latent inhibition. As mentioned earlier, the reversal between target and distractor *is not* required for the non-human paradigms of latent inhibition. By contrast, this target/non-target reversal *is* required in shift learning, as assessed by the Winsconsin Cart Sorting Test. Performance on the WCST has been shown to be disrupted not only in schizophrenic patients, but in high-schizotypy scorers as well (e.g., Lenzenweger & Korfine 1994). Performance deficits in the WCST consist of both perseverative and non-perseverative (random) errors suggesting constant fluctuations in the choice of the sorting principle (Barcelo & Knight, 2002). These constant fluctuations might have facilitated learning for high-schizotypy scorers in the preexposed condition in the studies that employed the first (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Braunstein-Bercovitz & Lubow, 1998; Della Casa *et al.*, 1999; Lubow *et al.*, 1992, Lubow *et al.*, 1992), and the second latent inhibition paradigm (Lubow *et al.*, 2002). Such a pattern of results (i.e. performance in the PE condition tended to be elevated at the level of the NPE condition) might have appeared as disrupted or attenuated latent inhibition.

The latter possibility might well have two main important implications. Firstly, it could undermine the claim that human latent inhibition is equivalent to the non-human latent inhibition, a critical assumption in the establishment of latent inhibition as a non-human model of schizophrenia. Secondly, it could suggest that it was shift learning, and not latent inhibition, that has found to be

disrupted within the schizophrenia spectrum, given that such target/distractor reversal paradigms has been employed in most latent inhibition studies with schizophrenic patients (Baruch *et al.*, 1988a; Gray *et al.*, 1992; Gray *et al.*, 1995), and non-clinical high-schizotypy scorers (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Braunstein-Bercovitz & Lubow, 1998; Della Casa *et al.*, 1999; Lubow *et al.*, 1992; Lubow *et al.*, 2002).

A more recent latent inhibition paradigm (De la Casa G., & Lubow, 2001; Lubow & De la Casa, 2002) has avoided the typical target/distractor reversal. In this paradigm, preexposure was achieved by presenting the stimulus concurrently with another task (masking task), in a within-participant design with reaction time and number of correct responses as independent measures. In the preexposure phase, the participants were instructed to predict the position of a blackened window, which was randomly changed across trials. The preexposed stimulus was a coloured field that contained six small windows. In the testing phase, the task remained the same as the previous phase. One position was predicted by the preexposed colour and another position by a non-preexposed colour.

In the previous paradigm (Lubow & De la Casa, 2002), latent inhibition was induced in that reaction time was slower for the CS_{PE} than for CS_{NPE}. However, there was no significant difference in terms of number of correct responses, a more traditional index of learning. This discrepancy between reaction time and correct responses appears in some way problematic. It could be questioned whether the reaction time data actually represent a latent inhibition effect which is comparable to the conventional conditioning or whether they reflect a stimulus familiarisation effect (Cantor, 1969).

According to the latter effect, participants tend to respond slower to a familiar stimulus (CS_{PE}) as compared to a novel stimulus (CS_{NPE}) in a reaction time procedure, independently of the number of correct responses.

Most existing human latent inhibition paradigms have created experimental conditions (such as the target/distractor reversal), that may introduce possible critical confounds, such as reversal shift learning. Although the employment of the some of the above preexposure methods has been imposed by the necessity of including a masking task (Lubow & Gewirtz, 1995), in certain paradigms that did not employ a masking task (e.g., Lubow *et al.*, 2002) the introduction of a target/distractor reversal does not appear theoretically justified.

Therefore, one primary aim of the present thesis was to introduce a new latent inhibition paradigm in an effort to avoid some of the highlighted methodological pitfalls, assessing performance as a function of stimulus preexposed and schizotypy level without employing a target/distractor reversal. In addition, empirical properties of stimulus preexposure were examined in conjunction with psychometrically defined schizotypy, attempting to elucidate those factors that are responsible for the latent inhibition disruption and to evaluate competing theoretical accounts of latent inhibition deficits within the schizophrenia spectrum.

2.5 Interpretations of latent inhibition deficits

Despite the difficulties regarding the theoretical basis of the latent inhibition, and the methodological/conceptual pitfalls in the human experimental paradigms of the phenomenon, a number of current theoretical proposals on

the interplay between physiological and psychological mechanisms in schizophrenia are based on evidence obtained from latent inhibition studies in clinical populations, healthy volunteers, and non-humans (e.g., Gray, 1998). Consequently, theoretical proposals on the mechanisms underlying schizophrenia could benefit from a more clear understanding of the factors that module latent inhibition within the continuum of psychosis, as well as the interpretational difficulties (some of them described in the previous sections) surrounding the human latent inhibition paradigms, related to the validity of latent inhibition as a non-human model of schizophrenia.

One possible explanation for the latent inhibition deficits in schizophrenia is that schizophrenic patients during the testing phase (Phase II) fail to utilise some past learning (e.g., that the CS_{PE} predicts nothing; CS_{PE}—no event associations) supposedly acquired during the preexposure phase (Phase II). As a result, CS_{PE} is being treated during Phase II as if it was a novel stimulus, therefore response rate to a CS_{PE} tends to be elevated at the level of a CS_{NPE} (latent inhibition disruption). This view is consistent with associative accounts of the basic latent inhibition effect (e.g., Hall *et al.*, 1985; Reed, 1995; Reed *et al.*, 1999; Reed & Tsakanikos, 2002) and with evidence on short-term memory and discrimination learning deficits in schizophrenia (Goldberg, Patterson, Taqqu, & Wilder, 1998; Hofer, Doby, Anderer & Dantendorfer, 2001; McKenna, Tamlyn, Lund, Hammond & Baddeley, 1990), and in psychometrically defined schizotypy (Lenzenweger, 2000; Tallent & Gooding, 1999). Memory deficits in schizophrenia could be responsible for the failure to transfer past learning from the preexposure to the testing phase, resulting in latent inhibition disruption. Additionally, subtle discrimination deficits may be

responsible for confusing between a CS_{PE} and a $CS_{NPE,}$ contributing further to a latent inhibition disruption within the schizophrenia spectrum.

Similarly, the 'switching model' (Weiner, 1990; Weiner & Feldon, 1997) proposed a neuropsychological associative mechanism controlled by the hippocampus. As already mentioned, the switching model assumes that CS_{PE}--no event associations are formed during the preexposure phase. In addition, the model explains the basic latent inhibition effect in terms of these past associations controlling behaviour during conditioning (i.e. CS_{PE} – event associations). The disruption of latent inhibition in schizophrenia is presumably due to a hyperactive switching mechanism, which leads to a quick switch from one response strategy (CS_{PE}—no event) to another (CS_{PE}--event) (Weiner, 1990; Weiner & Feldon, 1997).

Closely related to the associative assumption on the latent inhibition deficits is a theoretical proposal on the putative link between cognitive deficits and symptoms in schizophrenia (Hemsley, 1987; 1993). Hemsley (1987; 1993) proposed that the positive symptoms of schizophrenia derive from an inability to store past regularities of experience in order to aid in the interpretation of elements in current information processing. Due to this inability schizophrenic patients tend to perceive any sensory experience as novel, despite having had the same experience many times before. A numbers of psychotic symptoms, such as enhanced sensory awareness, which is frequently reported by schizophrenic patients (e.g., Bunney *et al.*, 1999; Mass, 2000), may derive from a failure to recognise a familiar or expected event.

Within Hemsley's (1993) framework, latent inhibition can be interpreted as the result of an initial regularity (i.e. '*stimulus A signals no reinforcement*'), which is followed by the requirement to learn a conflicting regularity (i.e. '*stimulus A signals reinforcement*'). In the absence of pathology, drug treatment, or further experimental manipulation, this sequence of conflicting regularities results in retarded learning of a preexposed target stimulus, demonstrating the basic latent inhibition effect. Schizophrenic patients, however, due to their inability to store past regularities, respond to a familiar (pre-exposed) event as if it was a novel (non-preexposed) one, failing to develop the basic latent inhibition effect.

One main problem with the most associative accounts of latent inhibition deficits, including the 'switching model' (Weiner, 1990; Weiner & Feldon, 1997), and Hemsley's (1987; 1993) model, is the assumption that schizophrenic patients are characterised by a specific weakening of the effects of previous learning on new learning. Although there is consistent evidence that schizophrenia is characterised by memory impairments (e.g., Goldberg, Patterson, Taqqu & Wilder, 1998; Hofer, Doby, Anderer & Dantendorfer, 2001; McKenna *et al.*, 1990), the assumption of a specific deficit in schizophrenia that weakens the effects of previous learning on new learning remains controversial. For example, the influence of previous learning, as assessed by proactive interference (O' Carroll, Duncan, Murray, Austin, Ebmeier & Goodin, 1993), paired associative learning (Elvevag, Egan & Goldberg, 2000; O' Carroll, 1995), and associative memory (Bazin & Perruchet, 1996) has shown to be the same level in both schizophrenic patients and controls. In addition, the associative interpretations of latent

inhibition deficits suffer from the same limitations as the associative interpretations of the basic latent inhibition effect as discussed earlier, i.e. they cannot easily account for the disruption of latent inhibition after a context change (Gray *et al.*, 2001; Hall & Channel, 1983; Kaplan & Lubow, 2001; Lubow *et al.*, 1976; Lovibond *et al.*, 1984; Zalstein-Orda & Lubow, 1995), as well as the failure to pass a summation test (Rescorla, 1971).

A second possible interpretation of latent inhibition deficits within the schizophrenia spectrum is that these deficits may reflect a core attentional deficit. A main assumption of this view is that latent inhibition stems from an inability of the preexposed stimuli to elicit an attentional response (Lubow, 1989; Mackintosh, 1975). It has been hypothesised that latent inhibition facilitates attentional selection of a stimulus, as non-reinforced preexposure is thought to make a preexposed (PE) stimulus irrelevant, and therefore less salient, as compared to a newly appeared, potentially relevant, and, therefore, more salient non-preexposed (NPE) stimulus (Lubow & Gewirtz, 1995). Consequently, disruption of latent inhibition can be explained in terms of an increased distractibility in schizophrenic patients. Due to this distractibility, schizophrenic patients fail to ignore irrelevant stimuli, and conditioning to a preexposed (and, therefore, supposedly irrelevant) stimulus progresses at the same rate as to a non-preexposed stimulus (Braunstein-Bercovitz & Lubow, 1998; Lubow, 1989; Mackintosh, 1975).

The view that latent inhibition deficits are due to a difficulty in screening out irrelevant stimuli is consistent with the notion of a disrupted attentional control (Frith, 1987), an elaborated version of an earlier proposal concerning the contents of consciousness (Frith, 1979). According to this model, positive

schizophrenic symptoms reflect a deficiency in the attentional mechanism to limit and control the content of consciousness. Due to that lack of control, inputs from the preconscious are allowed to enter awareness. As a result, a schizophrenic patient becomes aware of the ambiguous and multiple interpretations of an external or internal input, interpretations that are usually held in the preconscious. Consequently, auditory hallucinations can be explained in terms of preconscious, incorrect interpretations of an auditory input that came uncontrollably into awareness (Frith, 1979). Similarly, due to such an increased awareness, schizophrenic patients can be easily distracted by an irrelevant input (i.e. a pre-exposed, non-consequential stimulus) failing to demonstrate the basic latent inhibition effect. Unfortunately, this latter hypothesis has never been directly tested within the schizophrenia spectrum. It has not yet shown, for example, whether latent inhibition deficits in high-schizotypy scorers, are related to an increased perceptual awareness as assessed by another task.

The attentional interpretation of latent inhibition deficits is congruent with evidence that schizophrenic patients demonstrated impaired performance in various paradigms of selective attention (see pp 17-19), as well as with evidence that latent inhibition deficits are evident in conditions characterised by pronounced attentional deficits, such as the attentional deficit disorder (ADD) with hyperactivity (Lubow & Josman, 1993). However, although the attentional interpretation provides a plausible explanation for the latent inhibition deficits, it cannot fully account for conditions that modulate the basic latent inhibition effect, including the disruption of latent inhibition after a context change (Gray *et al.*, 2001; Hall & Channel, 1983; Kaplan & Lubow,

2001; Lubow *et al.*, 1976; Lovibond *et al.*, 1984; Zalstein-Orda & Lubow, 1995), as well as the facilitation of latent inhibition after a blocking treatment (Reed, 1995; Reed *et al.*,1999; Reed & Tsakanikos, 2002).

Overcoming of the interpretational problems in respect of the latent inhibition deficits could enhance the development of cognitive explanations about the psychotic phenomena. For example, a neuropsychological theory (Gray, 1998) attempted to integrate Hemsley's (1987; 1993) and Frith's (1979; 1987) cognitive models of psychotic symptoms together with recent evidence from latent inhibition studies on clinical population, healthy volunteers, and non-humans. The theory integrated four levels of explanations (Gray, 1998): a structural abnormality (*level 1*) in certain cerebral regions (limbic forebrain, hippocampal formation, amygdala, temporal and frontal neocortex) results in a functional neurochemical irregularity (*level 2*), i.e. hyperactivity of transmission in the mesolimbic dopaminergic pathway; this neurochemical irregular activity disrupts a cognitive process (*level 3*), i.e. the integration of past regularities of experience with current recognition, learning and action (as suggested by Hemsley, 1987; 1993), with the cognitive disruption producing the positive symptoms (*level 4*) of schizophrenia, which are according to the model, responsible for the negative symptoms. Although, the above proposal constitutes a positive effort towards an integrative understanding of schizophrenia, the third level of explanation, as Gray admitted (1998, pp. 261), cannot account for auditory hallucinations, for which, he proposed Frith's model (1979; 1987) provides a more adequate account. Given that those two models propose entirely different mechanisms ('associative' versus 'attentional') underlying the positive symptomatology in schizophrenia, a

synthesis of those two separate models into a single cognitive level of explanation becomes elusive.

2.6 Conclusions from the literature review

There seems to be a relatively consistent, mounting body of evidence that a high incidence of psychotic-like traits predicts performance deficits akin to those observed in schizophrenia, adding further support to the continuum hypothesis of psychosis. The parallel employment of psychometrically defined high-schizotypy scorers in the investigation of cognitive deficits in schizophrenia has the advantage of avoiding possible confounding factors, such as non-specific performance deficits, often inherent in clinical populations, and can, therefore, complement clinical research. Further evidence elucidating the continuities, as well as the non-continuities, between schizotypy and schizophrenia on basic aspects of cognitive function would contribute positively to this line of research.

Latent Inhibition deficits within the schizophrenia continuum seem to have the potential to enhance our understanding of specific cognitive impairments, and their relation to the psychotic symptomatology. This possibility is reinforced by various sources of converging evidence (pharmacological, physiological, clinical, and individual differences) on a link between schizophrenia and latent inhibition, by the fact that the phenomenon can easily studied in both humans and non-humans, despite differences between human and non-human paradigms, and by avoiding the criticism of a generalised deficit, as the latent inhibition disruption is due to 'better' performance in the preexposed phase. However, the controversial theoretical

basis of the standard latent inhibition effect, as well as the possible methodological and conceptual problems surrounding the existing human latent inhibition paradigms, obscure any theorising on the latent inhibition deficits in schizophrenia and schizotypy.

The studies reported in the present thesis explore the relationship between schizotypy, mainly assessed by the STA, and latent inhibition, as assessed in a novel visual search paradigm, in the light of conceptual and methodological issues highlighted in this chapter. Focusing on the specific parameters of stimulus pre-exposure, the studies attempted to examine potential methodological limitations in previous human paradigms of latent inhibition, and to evaluate attentional and associative interpretations of the phenomenon.

2.7 Outline and logical sequence of the empirical studies

All the experimental studies that will be presented in the next chapters were designed to test different interpretations of latent inhibition deficits in psychometric schizotypy. However, it should be pointed out that the first two studies (Experiments 1 and 2) were not directly relevant to latent inhibition. Experiments 1 and 2 were part of a preliminary step before developing a visual search paradigm of fast moving words in order to employ this technique in the later latent inhibition studies (Experiment 3 – 9). This was deemed necessary because it was important to examine first whether accuracy during search of fast moving words was related to the level of schizotypy: if accuracy in this paradigm was negatively or positively associated with schizotypy before the introduction of a pre-exposure manipulation (required in

any latent inhibition procedure) then this type of search would not be suitable for assessing latent inhibition in schizotypy in the subsequent studies. In addition, Experiments 1 and 2, examined whether self-report psychotic-like experiences, as assessed by the STA and O-LIFE, could predict 'hallucinatory' experiences produced the laboratory. This would provide an additional experimental validation of these schizotypy measures before employing them in the subsequent latent inhibition studies.

Experiment 3 introduced a novel paradigm to assess latent inhibition in high- and low-schizotypy scorers. This paradigm was based on search of fast moving words inside differently coloured round blocks. Depending on the condition (experimental versus control), the target colour (i.e. the colour consistently associated with a real word) was either preexposed or not preexposed. Experiment 4 was designed to replicate Experiment 3 after increasing the amount of pre-exposure with the target-colour in order to ensure that the obtained results were not due to insufficient amount of contact with the target. Experiment 5 was designed to replicate the previous experiments by reducing the amount of the employed colour-stimuli, in order to address interpretations of latent inhibition deficits (based on memory-load and discrimination difficulties caused by the multi-element nature of the preexposure). Experiment 6 attempted to replicate Experiment 5 under group testing conditions, in an effort to increase the difficulty of the task.

Experiments 7 and 8 were designed to examine latent inhibition and context change in schizotypy, in an attempt to test opposing predictions as derived from associative and attentional accounts. Experiments 9 and 10 examined whether latent inhibition deficits were related to increased stimulus

salience, as assessed by a visual pop-out paradigm. It was also examined which dimensions of schizotypy abolish latent inhibition. Given that latent inhibition deficits could be potentially explained as an instance of shift-learning deficits, Experiment 11 introduced a new shift-learning paradigm based on compound stimulus discrimination. Finally, Experiment 12 tested compound stimulus discrimination as a function of target reversal and different dimensions of schizotypy.

CHAPTER 3

Visual search of fast moving words as a function of different schizotypy dimensions: analysing accuracy and faise alarms

3.1 Introduction

The existence of experiences that bear a close resemblance to psychotic symptoms, as assessed by psychometric measures of schizotypy in non-clinical populations, constitutes one main source of evidence on the continuity of psychotic-like experiences. Further experimental validation of these self-report experiences, however, would require a test of whether psychotic-like experiences could predict simulations (or experimental analogues) of "psychotic-like" experiences produced under laboratory conditions. For example, such a test would require a demonstration of a link between self-reported, aberrant perceptual experiences in non-clinical participants and specific detection biases under conditions of perceptual ambiguity, akin to those seen in hallucinating patients.

Although there is evidence of a link between self-reported psychotic-like experiences and detection biases (e.g., Bentall & Slade, 1985; Rankin & O' Carroll, 1995), these results have been open to different interpretations. The investigation of such interpretations, as related to the experimental validation of self-report psychotic-like experiences, was the primary aim of the two studies reported in this chapter. More specifically, taking past evidence into account, a test was carried out in order examine whether decision biases (to respond "yes" in the absence of an appropriate stimulus), and perceptual biases (to describe in detail a stimulus in the absence of a corresponding

stimulus) are related to a psychometrically defined disposition to positive psychotic symptomatology.

3.2 Decision biases in positive symptomatology of schizophrenia

Hallucinations (perceptual experiences produced in the absence of corresponding stimuli) and delusions (irrational, idiosyncratic ideation formed and sustained in the absence of appropriate evidence) have been characterised as two main positive symptoms of schizophrenia (Crow, 1980; 1985). They are have been termed "positive" as they represent the presence of abnormal experiences, rather than the absence (or impairment) of normal functioning ("negative" symptoms). Both hallucinations and delusions are experienced as reactions to "real" events, have immediate impact on behaviour, and are beyond voluntary control (Chapman & Chapman, 1988; Slade & Bentall, 1988).

Both hallucinations and delusions have been associated with decision biases in various tasks. For instance, deluded patients required less information than non-deluded patients (a 'data-gathering' bias) before reaching a conclusion (Dudley, John, Young & Over, 1997; Garety, Hemsley & Wessely, 1991; Huq, Garety & Hemsley, 1988). However, deluded patients have not been found to be impaired, as compared to non-deluded controls, in any other aspect of their reasoning ability (Kemp, Chua, McKenna & David, 1997).

Similar decision biases have been shown in patients who experience hallucinations. Under conditions of perceptual ambiguity, schizophrenic patients who experience hallucinations, as compared to non-hallucinating

patients, demonstrate a bias towards believing that a certain type of stimulus is present, when it is actually absent (false alarms), although their overall perceptual accuracy (correct responses) remains intact (Bentall & Slade, 1985). The same decision bias has been confirmed in undergraduate students scoring highly on measures of predisposition to hallucinations (Bentall & Slade, 1985; Rankin & O' Carroll, 1995). Furthermore, patients who experience hallucinations tend to demonstrate a bias towards making more premature and erroneous judgements than non-hallucinators, when asked to guess the meaning of perceptually ambiguous words (Heilbrun & Blum, 1984).

Apart from decision biases in perceptual tasks, hallucinating psychiatric patients demonstrate a decision bias in certain aspects of meta-memory, like discriminating between externally and internally generated events (Bentall, Baker & Havers, 1991). More recently, a decision bias in discriminating between externally and internally generated events ('source monitoring') has been linked to the overall positive symptomatology of schizophrenia (Brebion, Smith, Amador, Malaspina & Gorman, 1998).

3.3 Can psychotic-like features predict decision and perceptual biases?

Despite the link between decision biases and positive symptomatology of schizophrenia, the interpretation of this relationship is not straightforward. A recently proposed, multi-factor model of psychotic symptoms (Garety, Kuipers, Fowler, Freeman & Bebbington, 2001) has suggested that decision biases constitute one potential factor, among others, contributing to the symptoms maintenance. There are still some key issues, however, on the

relationship between decision bias and psychotic experiences that deserve further experimental investigation.

For example, it is has been shown (Bentall & Slade, 1985) that perceptually ambiguous conditions can generate the confidence that a certain type of stimulus is present in the absence of that stimulus (decision bias). This decision bias has been found to be related to positive symptomatology (Bentall & Slade, 1985; Brebion *et al.*, 1998). Yet, it is not clear whether perceptually ambiguous conditions could lead someone not only to report the presence of a certain type of stimulus, but also to describe in detail an experienced stimulus in the absence of such a stimulus (perceptual bias[2]).

Perceptual bias seems a more plausible experimental analogue of a hallucinatory experience than decision bias, given that in both cases there is a detailed report of a perceived event in the absence of such an event. Consequently, given the growing interest in the measurement of psychotic traits in the general population (e.g., Claridge, McCreery, Mason, Bentall, Boyle, Slade & Popplewell, 1996), a word detection methodology would provide an opportunity to investigate whether positive schizotypy could predict both perceptual and decision bias.

The first aim of the present investigation was to employ a word detection methodology and extend the above line of research on decision bias (Bentall & Slade, 1985; Brebion *et al.*, 1998) in positive schizotypy. On the basis of the dimensional hypothesis of schizophrenia (Claridge & Broks, 1984; Eysenck & Eysenck, 1975), it was expected that non-clinical participants

[2] The term '*decision bias*' refers to the tendency to believe that a certain type of stimulus is present in the absence of such a stimulus (e.g., " yes" - there is a word -), when the task requires a binary decision (e.g., "yes"/ "no"). The term '*perceptual bias*' refers to the tendency, not only to believe that a certain stimulus is present (in the absence of such a stimulus), but also to describe this stimulus in detail, (e.g., " yes, there is the word 'PILOT' "), when the task requires a full description of every perceived target-stimulus (e.g., a different word on each trial).

scoring highly on positive schizotypy would demonstrate an increased decision bias, extending past studies on schizophrenic patients with positive symtomatology (Bentall & Slade, 1985; Brebion *et al.*, 1998), and providing, thus, an additional validation of the self-report psychotic-like experiences.

The second aim of this investigation was to explore further the relationship between positive schizotypy, false alarms and perceptual biases under conditions of perceptual ambiguity (Experiment 2). In this study, it was assessed whether the methodology that generated an increased decision bias in high psychotic-prone participants (Experiment 1), could generate biased descriptions of perceptual experiences (perceptual bias) in a similar population. If decision bias could be generated in high psychotic-prone participants within a word detection methodology, but not a corresponding perceptual bias, this result would support the view that decision bias is not necessarily related to a corresponding perceptual bias. On the contrary, if conditions of perceptual ambiguity could not only generate decision bias, but a perceptual bias as well, such a result would support the view that decision bias is related to a corresponding perceptual bias within the context of positive symptomatology.

3.4 Experiment 1

In Experiment 1, the participants were instructed to detect a fast moving word among simultaneously moving non-words in a binary decision ("yes"/ "no") task. Accuracy (number of "yes" responses in word trials) and false alarms (number of "yes" responses in non-word trials) were the dependent variables. Schizotypy was assessed through a self-report, multi-dimensional schizotypy inventory (O-LIFE: Mason *et al.*, 1995). Based on similar past studies on

schizophrenic patients with positive symptomatology (Bentall & Slade, 1985; Brebion *et al.*, 1998), it was expected that positive schizotypy would predict a decision bias (false alarms), but not accuracy (correct responses).

3.4.1 Method

3.4.1.1 Participants

Eighty undergraduate students (25 males and 55 females) took part in the study. The average age was 19.8 years, ranging from 18 to 23 years. All the participants had normal or corrected-to-normal vision.

3.4.1.2 Schizotypy measures

The Oxford-Liverpool Inventory for Feelings and Experiences (O-LIFE; Mason *et al.*, 1995) consists of 159 items. The selection of these items (See Appendix 2) was based on factor-analytic studies of older schizotypy scales. The inventory includes four scales following various factor-analytic studies that have revealed three or four factors underlying the construct of schizotypy (Bentall *et al.*, 1989; Vollema & van den Bosch, 1995). The first three scales correspond to a three-factor model of schizophrenia (Liddle, 1987; Liddle & Barnes, 1990): positive ('Unusual Experiences'), negative ('Introvertive Anhedonia'), and disorganised ('Cognitive Disorganisation'). Contributing to the experimental validity of this inventory, various studies have confirmed that high schizotypy scorers, as identified by the O–LIFE sub-scales, demonstrate similar neuro-cognitive deficits as the schizophrenic patients (e.g., Burch, Steel & Hemsley, 1998; Goodarzi, Wykes & Hemsley, 2000; Rawlings & Goldberg, 2001). More specifically, it assesses the following dimensions:

Unusual Experiences reflects the positive symptoms of psychosis, and consists of items assessing magical thinking, unusual perceptual aberrations, and hallucinatory experiences (e.g., "When in the dark do you often see shapes and forms even though there is nothing there?"; "Are your thoughts sometimes so strong that you can almost hear them?").

Cognitive Disorganization reflects the disorganised aspect of psychosis, and consists of items assessing difficulties with concentration and decision making, as well as social anxiety (e.g., "No matter how hard you try to concentrate do unrelated thoughts always creep into your mind?"; "Are you sometimes so nervous that you are blocked?").

Introvertive Anhedonia reflects the negative aspects of psychosis, and consists of items assessing the lack of enjoyment from social contact, physical activities, coupled with aversion to emotional and physical intimacy (e.g., "Are you much too independent to get involved with other people?"; "Are people usually better off if they stay aloof from emotional involvements with people?").

Impulsive Non-conformity consists of items assessing aggressive, anti-social and impulsive behaviour (e.g., "Where you ever greedy by helping yourself to more than your share of anything?"; "Do you ever feel the urge to break or smash things"?).

The inventory also included a social desirability scale (*Lie*) of the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975), which was used to assess whether decision bias is related to a bias to respond in a socially desirable way (e.g., increased false alarm rate as a result of the participants' effort to "please" the experimenter) and the schizotypal personality scale (STA; Claridge & Broks, 1984), an older and, therefore, more established,

schizotypy scale. The STA (see Appendix 1) has been constructed to reflect the DSM III-R description of schizotypal personality, has shown to have good predictive validity and test-retest reliability (Jackson & Claridge, 1991). In factor-analytic studies, STA had high loadings on "positive" aspects of schizotypy, such as hallucinatory experiences, perceptual distortions and delusion-like ideation (Bentall *et al.*, 1989; Vollema & van den Bosch, 1995).

Attesting to it's experimental validity, non-clinical participants scoring highly on the STA in various experimental tasks have been shown a pattern of performance akin to those observed in schizophrenia. For example, the STA has proven sensitive in detecting schizophrenia-like patterns of performance in terms of hemispheric asymmetries (Broks, 1984; Broks *et al.*, 1984; Rawlings & Borge, 1987; Rawlings & Claridge, 1984), negative priming (Beech *et al.*, 1989; Ferraro & Okerlund, 1996), and latent inhibition (Baruch *et al.*, 1988b; Hofer, Della Casa & Feldon, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992; Lubow, Ingberg-Sacks, Zalstein-Orda & Gewirtz, 1992). However, the STA has never been employed to assess decision biases in detection tasks under conditions of perceptual ambiguity, akin to those related to the positive symptomatology of schizophrenia.

3.4.1.3 Stimuli and apparatus

Each participant received 64 trials as a series of short animated sequences. Each trial depicted a display of four round blocks (one in each quadrant of the screen), which were identical in size to one another. The screen background was black. The blocks were grey, and appeared to move towards the observer. In each block, there was either a non-word or a real word. Words and non-words were in a white colour. The animations were constructed on a

three-dimensional model package ('3-D studio'), and were presented with a multimedia animator player ('sound script').

The animations produced an impression of motion, such that the four-block configuration appeared to loom from a distance towards the observer (see Appendix 3). Each animation was composed of 74 frames, and was presented at a rate of 9 frames per second. Based on pilot studies, the speed of the moving frames made word identification possible only at one or two blocks per trial, providing a substantial level of difficulty. The word stimuli were five-letter words of concrete nouns (*'BRAIN', 'BREAD', 'BRICK', 'DRAIN', 'ELBOW', 'GLOVE', 'GRAIN', 'HONEY', 'LABEL', 'MOVIE', 'PILOT', 'PLATE', 'SHIRT', 'SKIRT', 'THIGH',* and *'TOOTH'*). The non-word stimuli were meaningless strings of five consonants (*'ASDFG', 'FJHGK', 'GHZXF', 'HGSKC', 'JTWDL', 'KVBMR', 'LFSDX', 'MNQCP', 'NCVTP', 'RDNBG', 'RTPSD', 'QWBNF', 'VMNXC', 'WXFZT', 'YWRQS',* and *'ZCPLQ'*).

3.4.1.4 Procedure

Participants were presented with a continuous sequence of 64, fast moving, animated trials. Half of the trials contained a word among non-words (word trials) and the other half contained only non-words (non-word trials). Each participant was seated in front of a computer monitor in an individual cubicle. The participants were told that they are taking part in a word detection task, and instructed to say "yes" when there was a real word in a given trial (word trial), and "no" when there was no real word (non-word trial). They were also told that they would receive both word and non-word trials. The verbal responses were recorded by the experimenter. Accuracy (number of "yes" responses in word trials) and false alarms (number of "yes" responses in non-

word trials) were the dependent variables. Half of the participants first received the schizotypy inventory, and then the detection task. The other half first received the detection task, and then the schizotypy inventory. Detailed information about the purpose of the study was given after the session.

3.4.2 Results

Table 3.1 shows the means, standard deviations, and inter-correlations between the O-LIFE scales. The means and the standard deviations, as well as the pattern of inter-correlations, were quite similar to these reported in the original study on the development of the scales (Mason *et al.*, 1995), and to those reported in later studies (e.g., Rawlings & Goldberg, 2001).

Schizotypy Scale	*M*	*SD*	1	2	3	4
1. 'Unusual Experiences'	8.9	5.47	-			
2. 'Cognitive Disorganisation'	12.35	6.07	.43**	-		
3. 'Introvertive Anhedonia'	4.18	3.36	.09	.27*	-	
4. 'Impulsive Non-conformity'	9.20	3.76	.36**	.35**	.08	-

* $p < .05$ (two-tailed); ** $p < .01$ (two-tailed)

Table 3.1

Experiment 1. Descriptive statistics of the Oxford-Liverpooi inventory of Feelings and Experiences (O-LIFE) scales, and their inter-correlations.

The number of correct "yes" responses (mean = 13.83, SD = 5.17) in word detection did not correlate significantly ($r = -.02$, $p > .30$) with the number of incorrect "yes" responses (mean = 1.28, SD = 2.02), suggesting the absence of a trade-off between accuracy and false alarms. The effect of task order on accuracy and false alarms was not statistically significant, both t values < 1

(independent-samples *t*-tests, 2-tailed). The correlation between social desirability and false alarms was not statistically significant ($r = -.08$, $p > .10$).

To examine whether scores on the schizotypy scales could predict false alarms on the word detection task, a multiple linear regression analysis (method: enter) was performed. The Statistical Package for Social Sciences (SPSS) edition 10.1 was employed for this and all other subsequent analyses in the thesis. In this analysis, the scores on the four O-LIFE scales were the predictor variables, and the number of incorrect "yes" responses (false alarms) was the dependent variable. The overall equation was significant, $F_{(4, 79)} = 2.57$, $p < .05$ (adjusted $R^2 = .07$). However, only the positive schizotypy ('Unusual Experiences') retained as a significant predictor, $\beta = .33$, t = 2.95, $p < .01$ (see Table 3.2).

Predictor Variable	*B*	*SEB*	*Beta*	*t*
'Unusual Experiences'	.13	.05	.36	2.95
'Cognitive Disorganization'	.01	.04	.01	.14
'Introvertive Anhedonia'	-.03	.07	-.05	-.44
'Impulsive Non-conformity'	-.05	.06	-.10	-.87

* $p < .01$ (two-tailed)

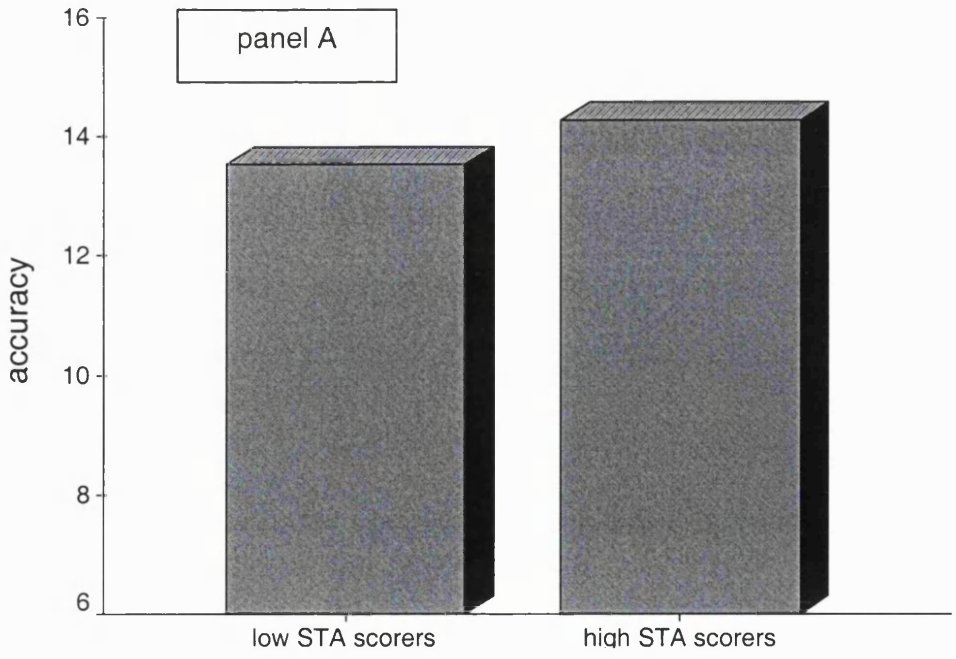
Table 3.2

Experiment 1. The O-LIFE scales as predictor variables for the number of Incorrect 'yes' responses.

To examine whether scores on the schizotypy scales could predict accuracy, a multiple regression was performed with the four O-LIFE scales as predictor variables and the number of correct "yes" responses as independent

variable. The overall equation was not significant, $F_{(4, 79)} = 1.23$, nor any of the individual predictors, smallest $p > .20$. The above analyses confirmed that false alarms were predicted by the presence of positive psychotic-like features, but were unrelated to any other variable. Furthermore, accuracy was unrelated to any schizotypy measure.

In order to confirm further that decision biases, as reflected in the increased false alarms, could be predicted by the presence of positive psychotic-like features, performance was then analysed as a function of the STA scores (mean = 14.3, median =14, SD = 6.7). The STA is a unidimensional schizotypy scale that has high loadings on positive schizotypy, and a substantial number of STA items are included in the 'Unusual Experiences' scale. The STA scale and the 'Unusual Experiences' scale were highly correlated, $r = .84$.



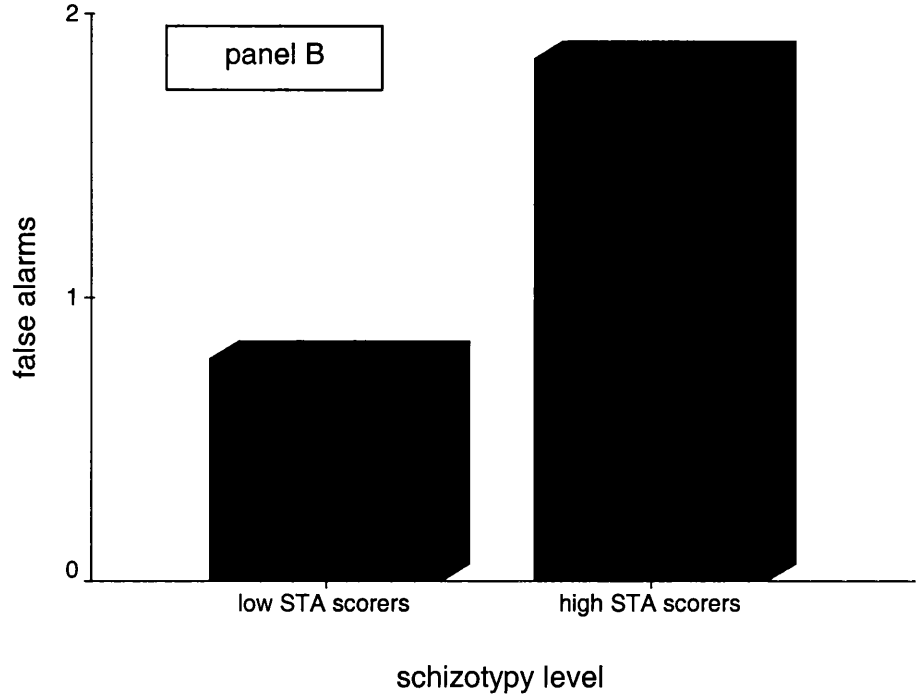


Figure 3.1

Experiment 1. Accuracy (panei A) and false alarms (panel B) as a function of schizotypy. HIgh- and low-schizotypy scorers were defined on the basis of their scores in the STA scale.

Participants were split into high- and low-schizotypy scores on the basis of the normative scores of the STA for age and gender (Claridge, 1997). Participants with STA scores below or equal to the normative mean were assigned as low-schizotypy scorers (mean STA = 8.8, median = 9, SD = 3.4; n = 42) and those with STA score above the normative mean were assigned as high-schizotypy scorers mean (STA = 20.3, median = 19, SD = 3.6; n = 38). Figure 3.1 presents accuracy (panel A) and false alarms (panel B) as a function of schizotypy level. A visual inspection of Figure 3.1 suggested that, although high- and low- schizotypy scorers did not seem to differ in terms of accuracy, there was a relative pronounced difference in terms of false alarms. To examine this, independent-samples *t*-tests (two-tailed) with schizotypy level as a grouping variable were performed on these data. In terms of accuracy, the was no statistical difference between the two schizotypy levels,

$t_{(78)} > 1$. In terms of the false alarms, there was a significant difference between high- and low- schizotypy scorers, $t_{(78)} = 2.39$, $p < .02$.

In summary, positive schizotypy (as assessed in two different scales) was associated with a decision bias during word detection (false alarms), but not with accuracy (correct responses) in a student sample. These results accord with past studies on patients with positive symptomatology (Bentall & Slade, 1985; Brebion *et al.*, 1998), providing an additional experimental validation in the measurement of psychotic traits among non-clinical population in general, and in the specific schizotypy measures employed in particular.

3.5 Experiment 2

The demonstration of a decision bias during word-detection in Experiment 1 cannot reveal whether or not participants had actually experienced words in non-word trials. A decision bias might reflect an increased willingness of an observer to decide "yes" (stimulus present) rather than "no" (stimulus absent) in an ambiguous situation. In order to assess whether the participant had actually felt that they had seen a word in the absence of such a word (perceptual bias), a more stringent detection criterion would required on the level of response, such as requiring a detailed description of a supposedly perceived word. In Experiment 2, the previous word detection paradigm was repeated in a different sample. However, unlike Experiment 1, the participants were instructed to give a detailed description of any perceived word, rather than a mere "yes" / "no" response.

3.5.1 Method

3.5.1.1 Participants

Eighty undergraduate students (32 males and 48 females) took part in the study. The average age was 20.2 years, ranging from 18 to 27 years. All the participants had normal or corrected-to-normal vision, and none of them had participated in Experiment 1.

3.5.1.2 Schizotypy measures, stimuli and apparatus

These were the same as in Experiment 1.

3.5.1.3 Procedure

As in Experiment 1, the participants were presented with sequences of 64 fast moving trials (32 word trials and 32 non-word trials). Unlike Experiment 1, the participants were asked to read aloud any real word they could see, ignoring the non-words. The number of correctly identified words was the first dependent measure. The second dependent measure was the number of words, that, although read aloud, in fact did not exist in a given trial (incorrectly identified words in non-word trials). Incorrectly identified words in word trials were recorded as well. The task order was counterbalanced as described in Experiment 1.

3.5.2 Results

Inspection of Table 3.3 shows that the descriptive statistics, and the pattern of inter-correlations between the O-LIFE scales in Experiment 2, were comparable to those in Experiment 1, as well as to past studies (Mason *et al.*, 1995; Rawlings & Goldberg, 2001).

Schizotypy Scale	*M*	*SD*	1	2	3	4
1. 'Unusual Experiences'	9.4	.06	-			
2. 'Cognitive Disorganisation'	12.11	5.82	.29**	-		
3. 'Introvertive Anhedonia'	4.17	3.43	.01	.28*	-	
4. 'Impulsive Non-conformity'	10.91	3.63	.29**	.27*	.02	-

* $p < .05$ (two-tailed); ** $p < .01$ (two-tailed)

Table 3.3

Experiment 2. Descriptive statistics of the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) scales, and their inter-correlations.

Correctly identified words (mean = 15.01, SD = 8.02) did not correlate significantly (r = -.04, $p > .30$) with incorrectly identified words (mean = 1.52, SD = 2.21), indicating the absence of a trade-off between accuracy and incorrect responses. The effect of task-order on each of the dependent measures was not significant, t values < 1 (independent-samples t-tests, 2-tailed). The correlation between social desirability and incorrectly identified words was not significant (r = .11, $p > .30$).

In order to examine whether scores on the schizotypy scales can predict falsely reported words in non-word trials, a multiple linear regression (method : 'enter') was conducted. In this analysis, the four O-LIFE scales were the predictor variables, and the number of incorrectly reported words in non-word trials (false alarms) was the dependent variable. The regression equation was significant, $F_{(4, 79)} = 3.56$, $p < .01$ (adjusted $R^2 = .11$), however, only the positive schizotypy ('Unusual Experiences') was retained as a significant predictor, $\beta = .41$, $t = 3.61$, $p < .01$ (see Table 3.4).

Predictor Variable	*B*	*SEB*	*Beta*	*t*
'Unusual Experiences'	.07	.02	.41	3.61*
'Cognitive Disorganization'	-.01	.02	-.11	-.88
'Introvertive Anhedonia'	.04	.03	.14	1.26
'Impulsive Non-conformity'	-.04	.03	-.15	-1.32

* $p < .01$ (two-tailed)

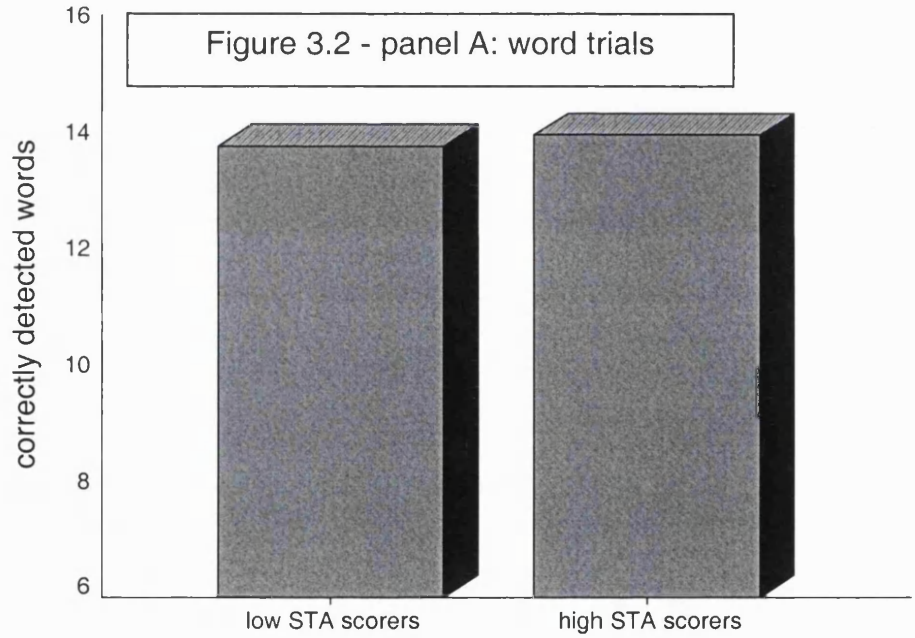
Table 3.4

Experiment 2. The O-LIFE scales as predictor variables for the number of falsely reported words in non-word trials.

To examine further whether schizotypy scores could predict falsely identified words in the word trials, a second multiple regression analysis was performed. The four O-LIFE scales were entered as predictor variables with the falsely identified words in the word trials as the dependant variable. The overall regression was not significant, $F < 1$, nor was any individual predictor (all t values < 1). A third regression analysis with the four O-LIFE scales as predictor variables, and the number of correctly detected words as dependent variable, failed to yield any significant result, smallest $p > .20$.

The above analyses showed that positive schizotypy was a significant predictor of reported words that never appeared in the trials (perceptual bias), but did not predict the number of incorrectly reported words in the word trials. Furthermore, positive schizotypy ('Unusual Experiences') was found to be unrelated to the number of correct word identifications. 'Unusual Experiences' correlated highly with the STA, $r = .81$.

Performance was then analysed as a function of the STA (mean = 15, median = 14.5, SD = 6.7), as in Experiment 1. In Figure 3.2, correctly detected words (panel A), incorrectly detected words in the absence of a real word (panel B), and incorrectly detected words in the presence of a real word (panel C) presented as a function of schizotypy level. Low- (mean STA = 9.2, median = 10, SD = 3.5; n = 39) and high-schizotypy scorers (mean STA = 20.5, median = 19, SD = 3.8; n = 41) were defined on the basis of the normative STA scores for age and gender (Claridge, 1997).



A visual inspection of Figure 3.2 suggested that there was a relatively pronounced difference between the schizotypy levels only in the number of incorrectly reported words in the absence of a real word (panel B), but not in the correctly reported words (panel A) nor in the incorrectly reported words in the presence of a real word (panel C). To examine this pattern, independent-samples t-tests (two-tailed) with schizotypy level as a grouping variable were performed on these data. In terms of the incorrectly reported words in absence of a real word (panel B), there was a statistically significant

difference between high- and low- schizotypy scorers, $t_{(78)} = 3.61$, $p < .01$. In terms of the correctly reported words (panel A), and the incorrectly reported words in presence of a real word (Panel C), however, the was no statistical difference between the two schizotypy levels, both *t*s >1.

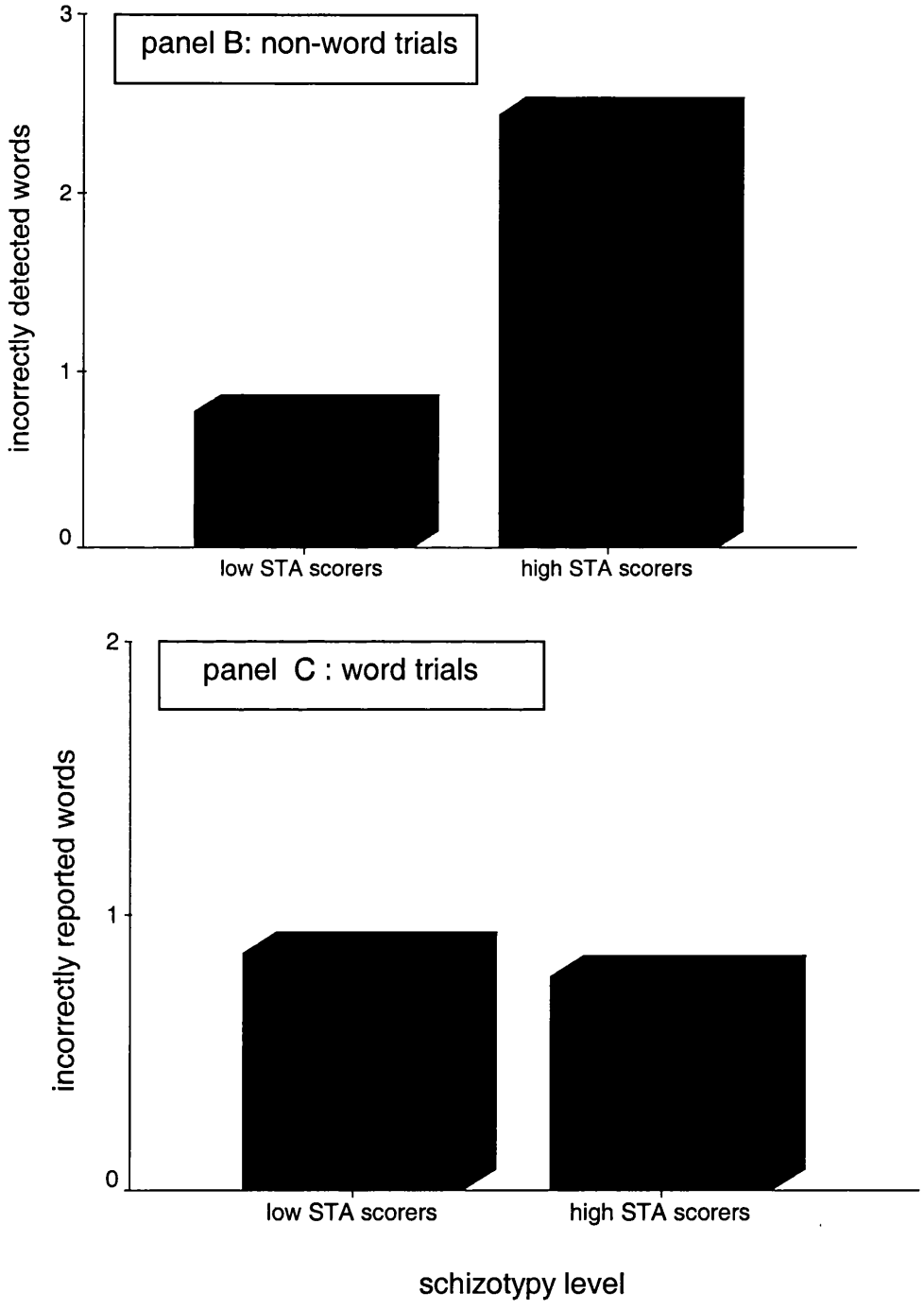


Figure 3.2

Experiment 2. Correctly reported words (panel A), incorrectly reported words in the absence of a real word (panel B), and incorrectly reported words In the presence of a real word (panel C) as a function of schizotypy (STA) level.

3.6 Discussion

In Experiment 1, participants scoring highly on positive schizotypy, as assessed by two different scales, were more likely to report that they saw a word in absence of a real word (decision bias) during a binary ("yes"/"no") task. Furthermore, the actual number of correct responses (accuracy) was not related to positive, nor to any other dimension of schizotypy. These results replicate and extend to positive schizotypy the results from the Bentall and Slade (1985) study that showed, in an auditory task, that hallucinations, as well as proneness to hallucinations, were linked to a liberal decision bias.

The fact that decision bias was related to the positive schizotypy, but not to any other dimension, argues in favour of a particular link between decision bias and positive symptomatology, replicating past studies (e.g., Brebion *et al.*, 1998). Furthermore, in accord with the continuum view of schizophrenia (Claridge & Broks, 1984; Eysenck & Eysenck, 1975), it provides an additional experimental validation to the notion that both non-clinical participants who score highly on measures of positive schizotypy, as well as psychotic patients with positive symptomatology, demonstrate a similar pattern of performance during detection of an ambiguous event.

Experiment 2 replicated and extended the results from Experiment 1. In Experiment 2, participants who scored highly on measures of positive schizotypy, as compared to low scorers, were more likely, not only to report that they saw a word (decision bias), but also to describe an actual word in the absence of any word (perceptual bias). This finding suggests that detection of a perceptually ambiguous event, apart from generating a decision bias linked to positive schizotypy, can also induce a perceptual bias. As in

Experiment 1, the number of correct responses (accuracy) was not related to either positive or any other dimension of schizotypy, indicating the absence of a detection deficit.

The absence of a relationship between false alarms and social desirability in both experiments can overcome the possibility that decision and perceptual bias are related to a bias towards socially desirable responding. Furthermore, correct and incorrect responses in both experiments were not found to be related to each other, nor were false alarms related to scores on the Impulsivity Non-conformity scale. Taken together, the latter results suggest that false alarms on the word detection task were not the result of a more "impulsive", and therefore, more prone to errors, pattern of responding.

Given the proposition that normal perceptual processing entails a basic decision-making component (e.g., Nakayama, 2001), it would tempting to suggest that decision bias is a prerequisite of a perceptual bias in positive symptomatology and positive schizotypy. This conclusion, however, would not be warranted on the basis of the present data. On the one hand, there is a possibility that a decision bias (i.e. the increased false alarm rate in a conditions of perceptual ambiguity) is being developed as an attempt to accommodate certain unusual perceptual experiences. On the other hand, decision biases might contribute, among other factors, to a certain class of distorted perceptual experiences. The fact that, under conditions of perceptual ambiguity, both perceptual and decision biases can be induced in participants who score highly on positive schizotypy, could suggest either that decision bias is a prerequisite for perceptual bias, or that perceptual bias is a prerequisite for decision bias, or that both biases are dependent upon a third,

unspecified factor. Future investigation, therefore, could attempt to deconstruct perceptual bias into more basic putative components.

It should be noted that an alternative interpretation of the present data is also possible. It could be argued that non-clinical participants who demonstrate a decision bias in detection tasks may demonstrate a similar bias when reporting positive psychotic-like symptoms in self-report schizotypy measures. Likewise, it could be claimed that clinical patients who demonstrate decision biases in detection tasks may demonstrate a similar bias to exaggerate when reporting positive symptoms during a psychiatric interview. The possibility that an exaggeration of symptoms (either in self-report measures or during an interview) might be related to decision bias cannot be excluded. Nevertheless, there is no empirical evidence that a bias to exaggerate symptoms is related to the positive symptomatology of schizophrenia, or that such a bias is related to perceptual and decision biases in detection tasks.

In conclusion, the present two-experiment investigation determined that, in a word detection methodology, perceptual and decision bias are both related to the positive schizotypy. The fact that non-clinical participants who score highly on positive schizotypy demonstrate a bias to "see" words in non-word trials might have some important implications. It could suggest that such a perceptual bias might constitute a marker of the positive psychotic symptomatology in general, or a proneness to hallucinations in particular. In both perceptual biases and hallucinatory experiences there is a detailed report of an event (which is experienced as "real") in the absence of such an event. It seems plausible, therefore, that an experimental analogue of hallucinations based on perceptual bias might enhance the understanding of

mechanisms underlying positive symptomatology, contributing further to the progress of experimental psychopathology of schizophrenia. Importantly, the obtained results suggest that self-report experiences that resemble to psychotic-like symptoms, such as hallucinations, can predict simulations/experimental analogues of these events, such as perceptual biases, produced under non-invasive laboratory conditions. From this perspective, the obtained results can be taken as an additional validation of self-report experiences that bear a close resemblance to psychotic symptoms in the general populations, as assessed by psychometric measures of positive schizotypy.

CHAPTER 4

Introducing a novel latent inhibition paradigm: visual search as a function of target preexposure and schizotypy level

4.1 Introduction

Normal attentional functioning is thought to involve a process of filtering out events that have been registered as non-important, in favour of potentially important events. The nature of this selectivity has often been studied through the mechanism of latent inhibition, that is, an observed retardation of conditioned responding after non-reinforced preexposure of the to-be-conditioned stimulus (Lubow, 1989; Lubow & Gewirtz, 1995). A typical latent inhibition procedure was a between-subject design that included two phases: preexposure and conditioning. In the first phase, only the experimental group is exposed to the to-be-conditioned stimulus (for example, a light or a tone). In the second phase, both experimental and control groups are presented with the target stimulus followed by an important event. The present chapter describes the development of a novel visual-based, between-subject paradigm of latent inhibition in order to address certain conceptual and methodological issues related to alternative interpretations of latent inhibition deficits in schizotypy.

As discussed in Chapter 2, different sources of converging evidence suggest an association between latent inhibition and schizophrenia. The main evidence comes from clinical research, as latent inhibition is disrupted in schizophrenic patients (Baruch *et al.*, 1988a; Gray *et al.*, 1995; Lubow *et al.*, 2000; but see Swerdlow *et al.*, 1996; Williams *et al.*, 1998). The source of this

disruption stems from the fact that schizophrenic patients learn more rapidly than controls that a preexposed stimulus is associated with an important event. This "better" performance is thought to rule out artifacts and non-specific deficits in studies with schizophrenia patients (Braff, 1993). A second line of evidence comes from studies on individual differences. In line the dimensional view of psychosis (Claridge & Broks, 1984; Eysenck & Eysenck, 1975), latent inhibition is significantly attenuated in non-clinical participants who score highly on measures of schizotypy (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992; but see Lipp *et al.*, 1994, Experiment 3) suggesting that latent inhibition deficits might constitute a marker for schizophrenia. A third source of evidence comes from the neuro-chemical level of investigation, as a number of antipsychotic agents have been shown to selectively restore amphetamine-induced disruption of latent inhibition (see Moser *et al.*, 2000; Weiner *et al.*, 2000).

The approach of testing healthy individuals who show some sub-clinical features of schizophrenia can facilitate experimentation on schizophrenia-related hypotheses by making feasible the introduction of more complex and demanding experimental procedures that might not have been applicable in clinical patients. However, despite this promising picture the investigation of the latent inhibition in schizotypy is obscured by a number of conceptual and methodological uncertainties.

4.2 The problem of comparability between human and non-human paradigms

The phenomenon of latent inhibition has been the subject of considerable theorising, and has been investigated extensively, mostly in non-humans (Lubow, 1989). The effect, however, is more difficult to demonstrate in human subjects. In latent inhibition paradigms, the experimental group, which has been preexposed to the target stimulus during the first phase, learns the relationship between the stimulus and the consequential event significantly slower than the control group, which has not been exposed to that stimulus. Many researchers tend to agree that latent inhibition is produced by a loss of stimulus associability due to its pre-exposure, which is demonstrated as a reduced capacity of the preexposed stimulus to elicit an attentional response (Lubow, 1989; Mackintosh, 1975; Pearce & Hall, 1980). It should be noted, however, that alternative accounts have also been recently supported (e.g. Reed & Tsakanikos, 2002).

Although there are a number of commonalities between non-human and human latent inhibition, the necessary and sufficient conditions for producing latent inhibitions in humans are quite different from those in nonhumans (Lubow, 1989; Lubow & Gerwitz, 1995). Therefore, it could be argued that different attentional mechanisms might modulate the same empirical effect in human and non-human learning. For example, most rule-learning procedures that have successfully demonstrated latent inhibition in human adults (Braunstein & Lubow, 1998a; Lubow & Kaplan, 1997), and those that have shown an interaction between schizotypy and latent inhibition (Baruch *et al.*, 1988b; Braunstein & Lubow, 1998b; De la Casa *et al.*, 1993; Gray *et al.*, 2002;

Lubow *et al.*, 1992) have included an independent masking task during the preexposure phase, such as, for example, to respond to the left button when a pair of letters were the same, and to the right button when the pair of letters were different as quickly and accurately as possible.

Inclusion of an explicit masking task in the latent inhibition paradigms can create interpretational problems. In two recent studies (Corr, 2003), for example, psychoticism has been found related to impaired implicit/declarative learning in presence of a secondary explicit/declarative mask. This latter finding might suggest that high-psychoticism scorers fail to learn about the irrelevance of the to-be-conditioned stimulus, because they were engaged in a secondary explicit task (masking task) during the preexposure phase, which disrupts automatic processing (learned irrelevance). Therefore, what appears as a disruption of latent inhibition within the schizophrenia spectrum could be due to a failure to show retardation of conditioning after preexposure of the target stimulus (latent inhibition), because of a previous engagement with an explicit masking task in the previous phase.

Furthermore, the role of a distinct masking task to divert attention from the target stimulus in the human rule learning procedures has been doubted. Graham and McLaren (1998) cast doubts on whether retardation in learning following masked preexposure in human experiments is comparable to latent inhibition following simple preexposure in non-human subjects. Moreover, McLaren, Kay and Mackintosh (1994) noted a facilitation of performance in discrimination learning tasks following unmasked preexposure, rather than the typical retardation of latent inhibition. The foregoing theoretical and empirical problems can obscure any theorising on the reported relationship between schizophrenia and latent inhibition.

In addition, in most human latent inhibition paradigms the possibility that the studies assessed reversal learning instead of latent inhibition cannot be excluded. During the preexposure phase of many studies, the stimuli in the masking task were the target, and the to-be-conditioned stimulus was the distractor; in the testing phase, the previous relationship was reversed (i.e. the to-be-conditioned stimulus became target and the stimuli of the masking task became distractors). Reversal learning is thought to occur when the reinforcement contingencies of the original training are reversed. Within this framework, the target stimulus of the original training becomes the non-target stimulus during the reversal training, and the non-target stimulus of the original training becomes the target stimulus during the reversal phase (Amsel, 1992). Interestingly, reversal learning, as assessed by the Wisconsin Card Sorting Test, has also been found impaired in schizophrenic participants (e.g., Crider, 1997; Oades, 1997), and there is some evidence suggesting that reversal shift is related to latent inhibition in non-humans (Chandra, Hosler & Smith, 2000; Ferguson, Cobey & Smith, 2001; Tsakanikos & Reed, 2000).

The possibility of having demonstrated disruption of reversal/shift learning, rather than disruption of latent inhibition in schizophrenia and schizophrenia, cannot be excluded. This possibility extends to the more recent visual search paradigm developed to assess latent inhibition (Lubow & Kaplan 1997; Lubow *et al.*, 2000). In this paradigm, the preexposed condition (A) was generated by having both target and distractor preexposed but reversed, that is, the target in the preexposure phase became distractor in the test phase and the initial distractor became target; the non-preexposed condition (B) was generated by presenting a novel target in the test phase against distractors that have been targets in the preexposure phase.

However, by using this technique latent inhibition was assessed by comparing reversal shift (condition A) versus non-reversal shift (condition B) without providing a justification for such a reversal. The main aim of the chapter is to describe the development of an alternative paradigm of latent inhibition that explicitly avoided such a reversal.

4.3 Experiment 3

Experiment 3 reported in this chapter attempted to test the possibility that latent inhibition in humans could be produced without a target/distractor reversal. To achieve this, a novel latent inhibition procedure was introduced without including an explicit masking task. Given that latent inhibition is currently used as a non-human model of schizophrenia, it is imperative to demonstrate that the effect can be demonstrated in humans after mere non-reinforced preexposure of the target, as has been demonstrated so far in the non-human studies.

The employed procedure was a visual search task, involving displays of four differently coloured, and fast moving, round blocks containing real words or non-sense words. Preexposure was manipulated through the colour of the blocks presented during the preexposure phase, in which every block always contained a non-word. In the testing phase, the real word always appeared in the block of a certain colour (the target stimulus), and learning was measured through the number of correct word identifications. The reasoning behind this procedure was that the experimental group (preexposed/PE), after being presented with the target stimulus containing a non-sense word (no-reinforcement) during the preexposure phase, would form an association between the target and the presence of a word (anticipated

event/reinforcement) more slowly than the control group (non-preexposed/NPE). This would make it more likely that the control group would make more correct word identifications than the experimental group, and would demonstrate, thus, the standard latent inhibition effect.

In terms of the latent inhibition deficits in schizotypy, the elimination of a target/distractor reversal would allow a two-directional prediction to be made. If the reported effect of schizotypy on latent inhibition were modulated by the target/distractor reversal, then an effect of schizotypy level on latent inhibition *per se* would not be possible. On the contrary, if the effect of schizotypy on latent inhibition were independent of the target/distractor reversal that has been employed in most past studies, then an interaction between schizotypy and latent inhibition would be expected. Confirmation of the last prediction could counteract the possibility that the reported disruption of latent inhibition in schizophrenic patients and high-schizotypy scorers might constitute a masked demonstration of disrupted reversal learning in schizophrenia (e.g., Crider, 1997; Oades, 1997).

If the effect of schizotypy on latent inhibition were independent of the target/distractor reversal, then the level of schizotypy would be expected to have an effect on the number of correct word identifications between conditions PE and NPE, replicating past studies (Baruch *et al.*, 1988b; Braunstein & Lubow, 1998b; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lubow *et al.*, 1992). On the other hand, if the effect of schizotypy on latent inhibition depended on the target/distractor reversal, then schizotypy level would have little impact on the number of correct word identification as a function of preexposure. Finally, on the basis of previous data with the same word-detection paradigm (Chapter 2: Experiments 1 & 2), the effect of schizotypy

was not expected to have an impact on the overall number of correct responses.

4.3.1 Method

4.3.1.1 Participants

Sixty undergraduate students (27 males and 33 females) served as participants. The average age was 21.3, ranging from 19 to 34 years. They all had normal or corrected-to-normal vision, and were naïve to the procedure, as well as the purpose of the study.

4.3.1.2 Personality questionnaire

Participants completed the STA schizotypy scale (Claridge & Broks, 1984). The STA scale is described in Chapter 1 (pp 15-16).

4.3.1.3 Stimuli and apparatus

The displays were presented to the participants as a series of short animated sequences. Each animation depicted a virtual world of four round blocks, as described in Experiment 1. Like Experiments 1 and 2, there was a string of five letters in each block, forming either a real word or a non-word. However, unlike Experiments 1 and 2, the round blocks were of different colours (see Appendix 4 for examples). The colours employed were yellow, orange, baby blue, purple, brown, dark blue, pink, red, dark green and light green. In total, 32 animations were constructed. Sixteen of these were assigned as preexposure trials and sixteen as testing trials. All animations were constructed on a three dimensional model package ('3-D Studio'), and were presented with a multimedia animator player ('Soundscript').

As described in Experiments 1 and 2, the animations produced an impression of motion, such that the block appeared to loom from a distance towards the subject. Each animation was composed of 74 frames, and was presented at a rate of 9 frames per second. Based on pilot studies, speeds higher or lower than 9 frames per second would make the task either too difficult or too easy for the observers to produce the baseline latent inhibition effect.

Sixteen five-letter words were contained in the target blocks during the testing phase. The list of words was: BRAIN, BREAD, BRICK, DRAIN, ELBOW, GLOVE, GRAIN, HONEY, LABEL, MOVIE, PILOT, PLATE, SHIRT, SKIRT, THIGH, and TOOTH. Non-sense words were a random combination of five consonants: ASDFG, FJHGK, GHZXF, HGSKC, JTWDL, KVBMR, LFSDX, MNQCP, NCVTP, RDNBG, RTPSD, QWBNF, VMNXC, WXFZT, YWRQS, and ZCPLQ.

4.3.1.4 Procedure

Participants were randomly assigned either to the preexposure condition (PE; n= 30), or to the non-preexposed condition (NPE; n = 30). For the first 16 trials (preexposure – Phase I), the four blocks always contained strings of non-sense letters. In the last 16 trials (testing – Phase II), one block (target) always contained a real word, and the remaining blocks (non-targets) always contained a non-sense word. During the Phase I, participants in PE condition were exposed to a yellow block (target stimulus) and to blocks of any other colour (non-targets) containing a non-sense word; participants in the NPE condition, however, were not exposed to a yellow block containing a non-

sense word. The non-target colours were: dark blue, pink, dark, green, red, light green, orange, baby blue, purple and brown.

The testing phase was identical for both PE and NPE condition: the yellow block (target) always contained a real word, and a block of any other colour (non-target) always contained a non-sense word. For the PE condition the target was a familiar item against novel items in the display, while for the NPE condition the target was a novel item among other novel items. Participants in all conditions were presented with a continuous sequence of 32, fast moving, animated trials. At a low spatial resolution, the coloured blocks in each animation appeared to be distant, so that the words could not be identified, but the colour could be seen. As the spatial resolution increased, and the blocks approached, the observers were able to identify the content (word or non-word) of some of them. The speed of the moving frames made identification of the content (at a readable "distance") possible only one or two blocks per trial, leaving the rest of the blocks unchecked. The participants were told that they are taking part in a visual search task, and when they detected a real word they were to name it out loud. Accuracy (number of correctly detected words) was the dependent measure. Detailed information about the purpose of the study was given after the end of each session.

4.3.2 Results

Participants were divided into high- and low-schizotypy scorers using their scores in the STA (mean = 14.7, median = 14, SD = 6.8). Participants with STA scores lower or equal to the normative mean for age and gender (Claridge, 1997) were classified as low-schizotypy scorers (mean STA = 9.3, median = 9.5, SD= 3.6), while participants with STA scores higher than the

normative mean were assigned as high-schizotypy scorers (mean = 20.6, median = 19.5, SD= 4.3). Characteristics of the sample by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level are presented in Table 4.1.

condition x schizotypy level	*n*	age	STA
	total	mean (*SD*)	mean (*SD*)
low STA			
PE	14	21.3 (*2.1*)	9.8 (*3.2*)
NPE	16	21.1 (*1.7*)	8.6 (*4.1*)
high STA			
PE	16	20.6 (*1.6*)	20.2 (*4.4*)
NPE	14	22.6 (*4.3*)	21.2 (*4.4*)

Table 4.1

Experiment 3. Descriptive statistics of age and STA scores, and number of participants by experimentai condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Figure 4.1 displays the mean number of correct words as a function of condition (preexposed versus non-preexposed) and schizotypy level (high STA scorers versus low STA scorers) across 4 blocks of 4 trials. Inspection of these data shows that performance for both schizotypy groups in the PE condition was constantly lower than in the NPE condition across the 4 blocks. However, the maximum difference between PE and NPE appears to occur in block 3 for the low schizotypy group.

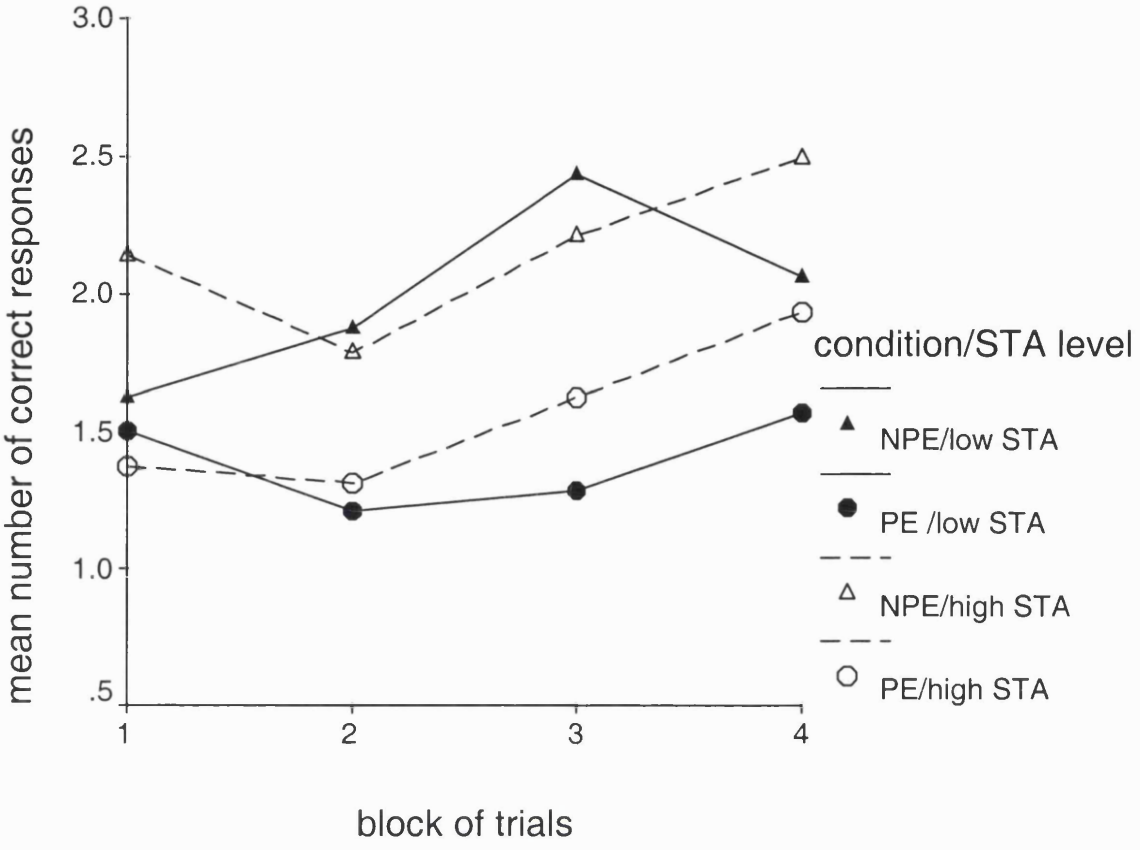


Figure 4.1

Experiment 3. Mean number of correct words for high- and low-schizotypy scorers, for preexposed (PE) and non-preexposed (NPE) condition across four blocks of trials.

These data were analysed by a three-way mixed-model analysis of variance (ANOVA), with 'condition' (PE versus NPE) and 'schizotypy level' (high STA versus low STA) as between-subject factors, and 'block' as a within-subject factor. In terms of the between-subject effects, there was a statistically significant main effect of 'condition', $F_{(1,56)} = 6.78$, $p < .01$ replicating the standard latent inhibition effect. There was no interaction between 'condition' and 'schizotypy level', and no effect of 'schizotypy', Fs < 1. However, in terms of the within-subject effects, there was a significant main effect of 'block', $F_{(3,168)} = 3.11$, $p < .05$, and an interaction between block and schizotypy level, $F_{(3,168)} = 3.88$, $p < .05$.

Analysis then was conducted separately for each schizotypy level. For the low STA scorers, a mixed-model ANOVA with 'block' and 'condition' as

factors was performed. The analysis revealed a non-significant effect of 'condition', $F_{(1,28)} = 2.54$, and 'block' $F_{(3,84)} = 1.21$, both *p*s >.10, but a statistically significant 'block' x 'condition' interaction, $F_{(3,84)} = 2.95$, $p < .05$. One-way ANOVAs on each block revealed a statistically significant difference between the PE and the NPE condition in block 3, $F_{(1,28)} = 7.35$, $p < .01$, in all other blocks the difference only being numerical, all *p*s > .10. For the high-schizotypy scorers, a similar analysis revealed an insignificant effect of 'condition', $F_{(1,28)} = 3.28$, $p = .08$, and a non-significant effect of block, $F_{(1,84)} = 2.22$, $p > .10$. There was no statistically significant 'block' X 'condition' interaction, $F < 1$. One-way ANOVAs performed on each block separately failed to detect any statistically effect of 'condition' on any block, $F <1$. Lack of a statistically significant latent inhibition effect in any block of the testing phase for the high-schizotypy scorers suggests a relative disruption of latent inhibition in psychometrically defined schizotypal individuals.

The results suggest that the standard latent inhibition effect survived the procedural changes in the present investigation and replicated previous findings (see, Lubow & Gewirtz, 1995, for reviews). These observations add empirical weight to the view that the target/distractor reversal is not a necessary condition for the production of the standard latent inhibition effect in humans. Moreover, it was shown that the maximum difference between the PE and the NPE condition was in block 3 (Figure 4.1) where latent inhibition was statistically significant when analysing each block separately for the low-schizotypy scorers. This pattern demonstrates the development of latent inhibition across the session, a dimension that has been largely neglected in human studies, which typically treat the effect in an all-or-none way.

The absence of a statistically significant latent inhibition effect in any block for the high-schizotypy scorers is in line with past findings that latent inhibition appears disrupted or attenuated in psychometrically defined high schizotypal participants (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992). Most importantly, the fact that schizotypy had a detrimental effect on the development of latent inhibition is replicated for the first time without the target/distractor reversal that has been employed in past studies, avoiding the inclusion of an explicit masking task. The latter fact counts against the suggestion that the reported latent inhibition disruption in schizophrenia is essentially a masked demonstration of the reversal learning disruption in schizophrenia and in schizotypy (if anything, it confirms that both phenomena appear to be disrupted within the schizophrenia spectrum).

Regarding the pattern of results for both low- and high-schizotypy scorers, it could be argued, that the manipulation in the present procedure might not have been powerful enough to produce a robust latent inhibition effect. The amount of preexposure (16 trials), for example, might not have been sufficient to produce a substantial difference between conditions PE and NPE, especially given that duration time of each preexposure trial was only 8.2 sec. Inspection of the data shows that the mean number of correct responses in the NPE condition for both schizotypy groups was relatively low, and that performance in the last trials (block 4) did not seem to reach asymptote. It could be argued, therefore, that the latent inhibition disruption in high schizotypy scorers could be due to any combination of chance, an attenuated latent inhibition effect, and/or a non-specific low performance in that particular

group. This argument undermines the claim that latent inhibition is disrupted in high schizotypy scorers in a procedure that does not involve any target/distractor reversal, which seems groundless in eliciting latent inhibition, although it is axiomatic in reversal/shift learning.

4.4 Experiment 4

One of the critical parameters that determine the magnitude of the latent inhibition effect is the amount of contact with the target during the preexposure phase, i.e. number of pre-exposures to the target and duration of pre-exposure. For example, the degree of latent inhibition has been found to be reduced when fewer pre-exposures were used (e.g., Allan *et al.*, 1995). Similarly, it has been shown that latent inhibition is a product of the total exposure time, as determined by multiplying the number and duration of stimulus pre-exposures (De la Casa & Lubow, 1996). Therefore, the low number of stimulus pre-exposures (16 trial) and the short duration time of the preexposure (8.2 sec) may have accounted for the pattern of reported results in Experiment 3.

To ensure that the disruption of latent inhibition in high schizotypy scorers in the present procedure was not due to chance, we replicated Experiment 3. In addition, in order to confirm that the pattern of results in terms of schizotypy level was not due to an insufficient amount of contact with the target during the preexposure period, it was decided to double the number of pre-exposures from 16 to 32, while keeping the rest of the procedural parameters the same.

In terms of the development of latent inhibition across the block of trials, if a larger amount of preexposure were able to speed up the rate of learning, it

would normally be expected that latent inhibition would be evident early on in the testing phase (in the first trials) rather than later on (in the last trials). Absence of any past parametric studies with the present procedure, however, prevented any specific prediction on whether overall performance could approach an asymptote or not.

4.4.1 Method

4.4.1.1 Participants

Sixty-one participants (26 males and 35 females) were recruited, most of them undergraduate students from the Departments of Psychology and Geography at UCL. The mean age was 22 years (range 19-32), they were all unpaid volunteers, and were naïve to the experimental procedure.

4.4.1.2 Stimuli, apparatus and procedure

As in Experiment 3, STA was administered after completing the task. Stimuli, apparatus and procedure were the same as described in Experiment 3. The only procedural difference between the two studies was that in the latter case, the number of trials in the preexposure period was increased from 16 to 32 trials for both the PE (n = 30) and the NPE (n = 31) conditions.

4.4.2 Results

Using their STA scores (mean = 14.4, median =14, SD = 6.6), participants were divided into low- (mean = 9.1, median =10, SD = 3.4) and high-schizotypy scorers (mean = 20.2, median =19, SD = 3.6) after a comparison with the normative STA scores for age and gender, as described in Experiment 3. Demographic characteristics of the sample in Experiment 4 by

experimental condition and schizotypy level, and number of participants per cell, are presented in Table 4.2.

condition x schizotypy level	*N*	Age	STA
	Total	mean (*SD*)	Mean (*SD*)
low STA			
PE	18	21.9 (*1.5*)	9.4 (*3.1*)
NPE	14	21.6 (1.7)	8.8 (*4.1*)
high STA			
PE	17	21.7 (2.1)	19 (*2.7*)
NPE	12	22.1 (3.1)	21 (*3.6*)

Table 4.2

Experiment 4. Descriptive statistics of age and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Inspection of Figure 4.2 reveals that performance in the PE condition for each schizotypy level was constantly lower than in the NPE condition across the four blocks of trials. Moreover, it appears that the maximum difference between PE and NPE occurred in block 1 only for the low-schizotypy scorers. General performance tended to approach asymptotic levels after block 2, as differences between the groups start to diminish.

A three-way mixed-model ANOVA on the four blocks of trials with 'condition' as a first factor and 'schizotypy' group as a second was performed. In terms of the between-subject effects, 'condition', $F_{(1,57)} = 1.01$, and 'schizotypy', $F_{(1,57)} = 2.41$, were not statistically significant, nor the interaction between them, $F < 1$. In terms of the within-subject effects, however, there was a significant effect of 'block', $F_{(3,171)} = 3.86$, $p < .01$ and an interaction between 'block' and 'schizotypy', $F_{(3,171)} = 4.11$, $p < .01$.

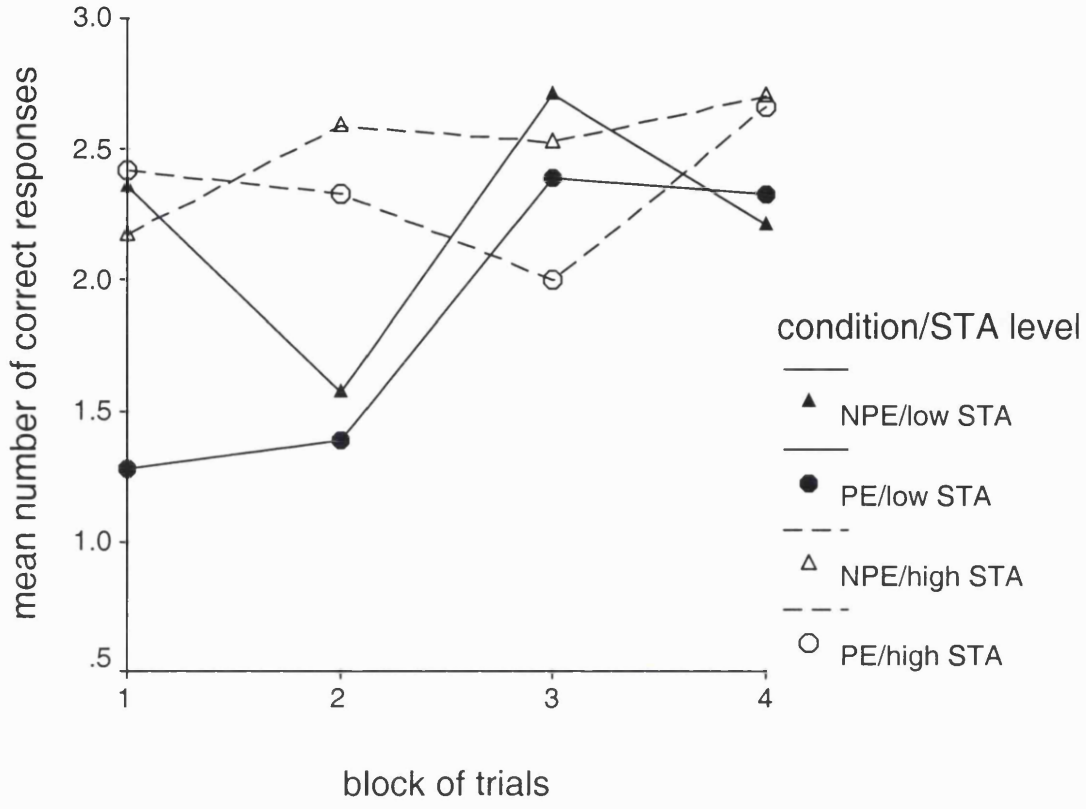


Figure 4.2

Experiment 4. Mean number of correct words for high- and low-schizotypy scorers, for preexposed (PE) and non-preexposed (NPE) condition across four blocks of trials.

An analysis was then performed for each schizotypy group separately. For the for low STA scorers, a mixed-model ANOVA with 'block' and 'condition' as factors was performed. The analysis revealed a non-significant effect of 'condition', $F_{(1,30)} = 1.41$, $p > .10$, but a significant effect of 'block', $F_{(3,90)} = 6.32$, $p < .001$, and a statistically significant 'block' X 'condition' interaction, $F_{(3,90)} = 2.95$, $p < .05$. One-way ANOVAs on each block separately revealed a statistically significant difference between the PE and the NPE condition in block 1, $F_{(1,30)} = 10.26$, $p < .003$. There was no significant difference for block 2, 3, and 4, $ps > .30$. For the for high STA scorers, a similar mixed-model ANOVA with 'block' and 'condition' as factors was performed. The analysis revealed a non-significant effect of 'condition', F

< 1, and a non-significant effect of 'block', $F_{(3,81)} = 1.04$. The interaction between 'block' and 'condition' was statistically insignificant, $F < 1$. In addition, and for the sake of comparison to the previous separate analyses for the low STA scorers, one-way ANOVAs performed on each block separately for the high STA scorers. The ANOVAs failed to reveal a statistically significant difference between the PE and the NPE condition in any block, all *ps* > .30, replicating the results of Experiment 3 with respect to the relative attenuation/disruption of latent inhibition in psychometrically defined high schizotypal individuals.

4.5 Combined analysis

Comparative inspection of the data in Experiment 3 and 4 shows that, although overall performance was increased in Experiment 4, the difference between PE and NPE did not increase. A combined analysis on the data from both experiments was performed. A four-way mixed-model ANOVA with 'condition' (PE versus NPE), 'schizotypy' group (high STA versus low STA), and 'amount of pre-exposure' (16 versus 32 pre-exposures) as between-subject factors, and block as a within-subject factor, was conducted. In terms of the between-subject effects, there was a statistically significant main effect of 'condition', $F_{(1,113)} = 5.71$, $p < .01$, and 'amount of pre-exposure', $F_{(1,113)} = 6.26$, $p < .01$. The effect of 'schizotypy' was not significant, $F_{(1,113)} = 1.69$, nor any other interaction, Fs < 1. In terms of the within-subject effects, there was a significant main effect of 'block', $F_{(3,339)} = 6.83$, $p < .001$, a significant interaction between block, amount of pre-exposure, and schizotypy level, $F_{(3,339)} = 2.63$, $p < .05$ and a significant interaction involving 'block', 'amount of pre-exposure', 'condition', and 'schizotypy', $F_{(3,339)} = 2.76$, $p < .05$.

An analysis was then performed separately for each schizotypy level on the four blocks of trials. For the low-schizotypy group, a three-way mixed-plot ANOVA with 'condition' and 'amount of preexposure' as between-subject factors and 'block' as a within-subject factor was conducted. In terms of the between-subject effect, there was a significant main effect of 'condition', $F_{(1,57)} = 4.36$, $p < .05$, a non-significant effect of 'amount of pre-exposure', $F_{(1,57)} = 1.48$, and a non-significant interaction, $F < 1$. In terms of the within-subject effects, there was a significant effect of 'block', $F_{(3,171)} = 6.51$, $p < .01$, and a significant interaction between 'block', 'condition' and 'amount of pre-exposure', $F_{(3,171)} = 2.58$, $p < .05$.

For the high-schizotypy group, a three-way mixed-model ANOVA with 'condition', and 'amount of pre-exposure' as between-subject factors, and 'block' as a within-subject factor, was performed as well. In terms of the between-subject effects, the main effect of 'condition' was not significant, $F_{(1,56)} = 2.41$, $p = .13$, confirming the relative disruption of latent inhibition in high-schizotypy scorers. There was a significant effect of amount of pre-exposure, $F_{(1,56)} = 5.27$, $p < .05$, but no significant interaction with 'condition', $F < 1$. In terms of the within-subject effects, the effect of 'block' was not significant, $F_{(3,168)} = 2.41$, nor any other interaction, smallest $p > .15$.

The latter finding suggests that overall performance for the high-schizotypy scorers in both experiments remained relatively unchanged over the blocks. On the contrary, for the low schizotypy scorers, overall performance in both experiments was significantly improved across blocks. Furthermore, for the low-schizotypy scorers in both experiments, latent inhibition ('condition') did interact with the amount of contact with the target ('amount of pre-exposure') and with the temporal manifestation ('block') during

the testing phase. This pattern was not observed for the high schizotypy scorers of both experiments.

4.6 Discussion

Latent inhibition was induced in a human paradigm that did not involve a target/distractor reversal, in an effort to make the generating conditions more equivalent to those conditions that have been used in the non-human paradigms. As latent inhibition is extensively used as a non-human model of schizophrenia (see, Gray 1998, for a review) any evidence in support of the assumption that common mechanisms modulate the same empirical effect in both human and non-human learning, contributes positively to a further validation of this line of research.

A relative disruption of latent inhibition for high-schizotypy scorers was observed in both studies, replicating results from previous experiments that employed different paradigms (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992). The fact that schizotypy level impacted on latent inhibition without employing a target/distractor reversal procedure has some notable implications. It can counteract a suggestion that the studies conducted so far that have shown purportedly an effect of schizophrenia or schizotypy on latent inhibition, have, in essence, demonstrated a disruption of reversal/shift learning in schizophrenia (see, Crider 1997, for a review on shift learning deficits in schizophrenia).

In the present experiments, latent inhibition was induced for low schizotypy scorers in block 3 (Experiment 3) and, after doubling the amount

of target pre-exposure, in block 1 (Experiment 4). The increase in the amount of contact with the target in the preexposure phase had an effect on the temporal expression ('block') of latent inhibition, possibly by increasing the rate of learning. These observations were additionally supported by a combined analysis performed on the data from both experiments separately for each schizotypy level.

The schizotypy level of the participants in Experiments 3 and 4 did not have a significant effect on the overall number of correct word identifications. This aspect of the data seems to agree with similar results obtained in Experiments 1 and 2, suggesting that the ability to detect fast moving words, in general, is independent of the schizotypy level. This consistent pattern obtained across the four studies (Experiments 1 - 4) of this thesis overcomes a possible explanation of latent inhibition deficits in the current procedure as a result of a significantly increased or decreased general performance in high-schizotypy scorers.

The difference in the maximum expression of latent inhibition between Experiment 3 and 4 seems to follow a somehow different pattern from what it would be expected. In an equivalent non-human paradigm, a maximum expression of latent inhibition would be expected at the first trials of the testing phase (in both experiments), and that the effect would be more long lasting with a larger amount of target preexposure. It should be pointed out, however, that in the case of the non-human studies the trials of the testing phase typically represent performance across daily sessions. Therefore, the temporal manifestation of latent inhibition in non-human paradigms is usually expressed in blocks of trials across sessions, rather than in blocks of trials within a single session, as in the presently presented experiments. It is

possible that, although latent inhibition can be obtained within a single session as well as across sessions, the pattern of the temporal manifestation of the effect within a single session might not correspond entirely to the pattern of the temporal manifestation of latent inhibition across sessions. On the basis of the present within-session data, it seems that latent inhibition occurs at some point of the testing phase depending on a number of parameters, with the amount of preexposure being one of them.

In terms of the basic procedure, it should be noted that it departed from certain conventions regarding the conditions for producing latent inhibition in humans. For example, in order to avoid a possible influence of the target/distractor reversal, a separate masking task was not included in the preexposure phase. Instead, participants in the testing phase were engaged in the same task as in the preexposure phase. Therefore, it could be argued, that there might be a negative transfer of stimulus-response associations from the preexposure phase to the test phase. That is, during pre-exposure, participants may learn that the target stimulus is associated with a non-word. Then, in the testing phase, they must "unlearn" this relationship, and learn that the target is associated with a real word.

However, the above argument appears to be a theoretical, rather than a methodological criticism, because it makes the explicit assumption that latent inhibition *is not* a case of associative interference. Nevertheless, there is evidence (e.g., Reed *et al.*, 1999; Reed & Tsakanikos, 2002) suggesting that an associative interference account of latent inhibition cannot be excluded. According to this account, a stimulus-no reinforcement association is established in the preexposure phase, which interferes with the acquisition of a stimulus-reinforcement association during the subsequent, conditioning

phase. Within this framework, a possible target—non-word association would be functionally equivalent to a stimulus-no reinforcement association in the preexposure phase, and a possible target—word association would be functionally equivalent to a stimulus-reinforcement association. However, given the speculative nature of the argument, the possibility of the induction of negative transfer will be empirically examined later on in this thesis (Chapter 5: Experiment 7 & 8; Chapter 6: Experiment 9) where a generation of a latent inhibition effect will be attempted without a prior target—non-word exposure.

A second methodological issue that needs to be considered relates to the non-inclusion of an explicit masking task, unlike most existing paradigms of latent inhibition. As mentioned earlier in this chapter, the inclusion of a distinct masking task not only raises questions about the comparability between human and non-human paradigms, but also appears responsible for introducing a target/distractor reversal. These issues trigger alternative interpretations (beyond the effects of the stimulus pre-exposure) of latent inhibition deficits in schizotypy. Although it has been argued that the inclusion of such an explicit masking task was avoided in the present procedure, it could be argued still that there was an 'implicit' masking task: firstly, the participants were asked to search for words in fast moving (15 frames /sec) round blocks of different colours, without being informed that only a block of a certain colour would predict words; and secondly, they were not informed that this certain colour would predict a word in the last 16 trials (testing – Phase II), but not in the first 16 trials (preexposure – Phase I). However, such a putative implicit masking task (created inevitably by the specific manipulation of the stimulus preexposure) would not have introduced any reversal in the roles of

the target and the distractors from Phase I to Phase II, and, consequently, could not have interfered with the central aim of Experiments 3 and 4.

A last methodological aspect that deserves attention relates to the familiarity/novelty conditions within which latent inhibition was assessed. In the preexposed condition, participants are faced during the testing phase with a familiar target (f) among three novel targets (nnn), creating an f-nnn condition (the first letter indicates the status of the target and the last three letters the status of the distractors). Therefore, latent inhibition was assessed here by comparing an f-nnn condition (PE), with an n-nnn condition (NPE). The preexposed condition, however, has been defined as an all-familiar condition (f-fff) in most past studies, given that the distractors could be equivalent to the 'context' in non-human studies that needs to, in order to secure the expression of latent inhibition, remain stable (see, Lubow 1997, for a discussion). Although this might appear as a plausible requirement, the above argument for using an all-familiar condition, when assessing latent inhibition, might apply to studies that have used an explicit masking task and/or have employed a target/distractor reversal. This may or may not be the case in the present procedure, as participants in Phase II (testing) were engaged in the same task as in Phase I (preexposure) providing, thus, a notably stable context, and securing the expression of latent inhibition in both experiments.

The benefit of assessing a non-reversal latent inhibition design in high- and low-schizotypy scorers seems to outweigh a possible risk of deviating from certain generating conventions of latent inhibition, the necessity of which is not beyond any question. The above alternative interpretations, however,

as related to the specific generating conditions employed in Experiments 3 and 4, will be further discussed and empirically evaluated in the next chapter.

CHAPTER 5

Schizotypy and properties of stimulus preexposure under crowded and uncrowded conditions

5.1 Introduction

In the studies reported in the previous chapter, a novel latent inhibition paradigm was introduced in order to investigate the effects of stimulus preexposure in relation to psychometrically defined schizotypy. Experiments 3 and 4 avoided a reversal in the roles of target and distractors from preexposure to testing phase, overcoming an interpretation of latent inhibition deficits in schizotypy as being a result of shift-learning deficits. A relative disruption of latent inhibition in high-schizotypy scorers was obtained, replicating past studies that employed different experimental paradigms (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992).

Nevertheless, due to a deviation from certain latent inhibition-generating conventions in Experiments 3 and 4, it was deemed necessary to examine specific aspects of the target preexposure in respect to the distractors. A closer examination of these experimental parameters would provide an evaluation of opposing interpretations of the obtained attenuation of latent inhibition in high-schizotypy scorers, as compared to their low-schizotypy counterparts. The main concern was the *multi-element* nature of the experimental design. In Phase I (preexposure phase), participants in the experimental (preexposed) condition received a target stimulus (CS_{PE}^{+} – no

US) along with three other non-target stimuli (CS_{PE}^{01} – no US; CS_{PE}^{02} – no US; CS_{PE}^{03} – no US). In Phase II (testing phase), the participants received the target stimulus (CS_{PE}^{+} – US) along with three non-target stimuli other than those presented in the Phase I (CS_{NPE}^{04} – no US; CS_{NPE}^{05}– no US; CS_{NPE}^{06} – no US). Consequently, it is possible that the obtained attenuated latent inhibition in high psychotic-prone individuals was due to the specific nature of this multi-element presentation across Phase I and Phase II, coupled with potential discrimination and memory deficits, as it will described in the next section

5.2 Properties of stimulus preexposure and alternative interpretations of latent inhibition deficits

In order for the target to acquire the status of a CS_{PE} after repeated preexposure, it seems plausible that some degree of short-term memory capacity, as well as some ability to discriminate between the eight stimuli (presented in Phase I and II) would be necessary. However, evidence has suggested the presence of stimulus discrimination and memory deficits in schizophrenic patients (e.g., Goldberg *et al.*, 1998; Hofer *et al.*, 2001), and in healthy participants scoring highly in schizotypy (e.g., Lenzenweger, 2000; Tallent & Gooding, 1999). Consequently, it is likely that the results obtained in Experiments 3 and 4 may be due to such deficits interacting with a multi-element, cognitively demanding presentation across Phase I and Phase II.

The multi-stimuli nature of Phase I (preexposure), and Phase II (testing) in Experiments 3 and 4, coupled with possible capacity limitations in short-term memory and subtle discrimination deficits in schizotypy, may have accounted for the attenuated latent inhibition effect in schizotypic individuals

in the following way: the attenuation of latent inhibition (i.e. a numerical, but not statistically significant difference between CS_{NPE}^{+} and CS_{PE}^{+}) might have actually been the result of a reduced ability in high-schizotypy scorers to discriminate between preexposed and non-preexposed stimuli due to subtle impairments in short-term memory and stimulus discrimination, treating, as a consequence, a familiar/preexposed target as novel/non-preexposed one. This possibility would be less likely, had the non-target stimuli remained the same across Phase I and Phase II, reducing in this way the total number of non-target stimuli by 50%. This alternative explanation will be tested in Experiment 5.

In addition, the claim that a relative disruption of latent inhibition in high-schizotypy scorers was obtained in Experiments 3 and 4 without engaging the participants in a separate masking task deserves more consideration. Although an explicit masking task was not included, it could be argued that the procedure served as an implicit masking task by diverting attention from the pre-exposure target: the participants were asked to search for words in fast moving (9 frames/sec) differently coloured blocks without being informed that only a single block of a certain colour would predict words, and without being informed that this certain colour would only predict a word in the last 16 trials (testing – Phase II), but not in the first 16 trials (preexposure – Phase I). This putative function of the experimental procedure as an implicit masking task may deserve further experimental attention.

In human latent inhibition paradigms, the participants are typically engaged with an explicit masking task during stimulus preexposure, for instance, they are asked to give same/different judgments in response to

visually presented letter pairs. It is has been suggested that the inclusion of a masking task serves to divert attention from the preexposed stimuli, and that latent inhibition is an inverted-U function of the masking task load (Lubow & Gewirtz, 1995). The absence of a masking task (zero load), or a very difficult masking task (high load) prevents the development of latent inhibition (Braunstein-Bercovitz & Lubow, 1998*a*). In contrast, such an explicit masking task is not required for the development of latent inhibition in non-humans.

The fact that the necessary conditions for producing latent inhibition in humans (masked preexposure) are different from those in nonhumans (unmasked preexposure), has cast doubts over the comparability of human to non-human latent inhibition (e.g., Graham & McLaren, 1998; McLaren *et al.*, 1994). This discrepancy might be theoretically important, considering that the assumption that latent inhibition is modulated by the same underlying mechanisms in both humans and non-humans has been deemed crucial to the development of latent inhibition as an animal model of schizophrenia (Gray, 1998). Nevertheless, despite the absence of an explicit masking task in the animal paradigms, it is still possible that attention is being diverted from the target stimulus while an animal is exploring the experimental apparatus. This spontaneous exploratory behaviour may well be equivalent to a human masking task. Furthermore, some investigators have demonstrated a latent inhibition effect without employing such an explicit masking task (Lubow & Kaplan, 1997), although they failed to avoid a reversal in the roles of the target and the distractors from pre-exposure to testing phase. By contrast, the possibility that Experiments 3 and 4 might have actually involved an implicit masking task does not introduce interpretational problems, given that

no such target/distractor reversal was employed. In addition, the manipulation of the difficulty level of such an implicit masking task would also help to evaluate a specific attentional account of latent inhibition deficits.

Although latent inhibition is typically found to be disrupted in high-, but not in low-schizotypy scorers under conditions of low-masking-load, this pattern has been demonstrated to reverse under conditions of high-masking-load (Braunstein-Bercovitz & Lubow, 1998*b*). In these experiments, the low-masking-load condition required same/different judgments of letter pairs, which were always upright (low difficulty); the high-masking-load condition required same/different judgments of letter pairs, which could appear in any of four possible orientations (high difficulty) (Braunstein-Bercovitz & Lubow, 1998).

The reversal of latent inhibition disruption in high- and low- schizotypy scorers under a high-masking-load condition (Braunstein-Bercovitz & Lubow, 1998*b*) has been interpreted as a manifestation of the attentional distractibility in schizotypy (Lubow, 1995). In the low-masking-load condition, high-schizotypy participants get distracted by the 'irrelevant' stimulus (preexposed CS) failing to demonstrate latent inhibition; in the-high-load condition, as the sources of distraction increase, high-schizotypy scores are prevented from maintaining their attention to the 'irrelevant' stimulus (preexposed CS), and latent inhibition develops normally. For the low-schizotypy scorers, however, latent inhibition is disrupted due to the high-masking-load condition preventing them completely from processing the preexposed CS (Lubow, 1995).

A similar reversed schizotypy/ latent inhibition pattern has been obtained in a different study that employed a version the Stroop paradigm as masking

task during stimulus preexposure (Della Casa *et al.*, 1999). Latent inhibition was found intact in low-, but disrupted in high-schizotypy scorers after a slow and regular (low difficulty/masking load) stimulus preexposure (Stroop presentations), while after a rapid and irregular (high difficulty/masking load) stimulus preexposure it was found intact in high-, but disrupted in low-schizotypy scorers (Della Casa *et al.*, 1999). Hofer *et al.* (1999) replicated the latter finding and, in addition, they demonstrated that the stimulus duration, but not the regularity, was responsible for this effect of masking load. The authors suggested that a rapid presentation was equivalent to a high-masking-load task and a slow presentation equivalent to a low-masking-load task (Hofer *et al.*, 1999), interpreting the obtained latent inhibition/schizotypy reversal pattern in terms of the attentional distractibility account (Braunstein-Bercovitz & Lubow, 1998*b*; Lubow, 1995) described earlier.

Given the reported effects of the level of difficulty in explicit masking tasks of latent inhibition (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), it would be expected that a similar pattern would be replicated in an implicit masking task, as the one identified *ad hoc* in Experiments 3 and 4. If this was the case, then latent inhibition would be disrupted in high-, as compared to low-schizotypy scores in a low difficulty level, but this pattern would be reversed in a higher difficulty level of the implicit masking task. Given that this reversed latent inhibition/schizotypy pattern has been taken as evidence in support of attentional interpretation of latent inhibition deficits (Braunstein-Bercovitz & Lubow, 1998*b*; Lubow, 1995), the generality of this finding merits further examination.

Experiment 5 examined latent inhibition as a function of stimulus preexposure and schizotypy, attempting to replicate the finding that latent inhibition is disrupted in high-schizotypy scorers without introducing a target/distractor reversal. Furthermore, the non-target stimuli remained the same through Phase I and Phase II in order to control for any possible confounding effects of memory load and stimulus discriminability (Hofer *et al.*, 2001; Goldberg *et al.*, 1998; Lenzenweger, 2000; Tallent & Gooding, 1999), testing the possibility of latent inhibition deficits in high-schizotypy scorers as a result of a multi-stimuli, cognitive demanding and, therefore, less effective preexposure in Experiments 3 and 4.

Experiment 6 was designed to replicate Experiment 5 under crowded conditions. Crowded conditions have shown to increase the difficulty level in relatively complex cognitive tasks (e.g., Bruins & Barber, 2000; Malik & Batra, 1997; Nagar & Pandley, 1987), possibly due to an increase in possible sources of distraction. Therefore, it was expected that under crowded conditions (Experiment 6) the difficulty level of the implicit masking task would be higher (high-load) than under individual-testing (low-load) conditions (Experiment 5), as the possible sources of distraction (irrelevant noise, visual cues etc) would increased from Experiment 5 (individual-testing) to Experiment 6 (group-testing). Consequently, it was tested whether such an increase of the difficulty level of the implicit masking task would result in a reversal of the latent inhibition/schizotypy deficits, similar to that observed in studies that employed explicit masking tasks (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), assessing the generality of this effect.

5.3 Experiment 5

Experiment 5 involved the same basic visual search paradigm of four fast moving blocks containing either real or non-sense words, as described in Experiment 1. The preexposure of the target was manipulated through the colour of the blocks presented during the trials of the preexposure phase, in which every block always contained a non-word. The two phases of the experiment were as described in Experiments 3 and 4: in Phase I (preexposure), participants in the experimental condition (PE) received blocks both of the target colour and the non-target colours, but participants in the control condition (NPE) received only blocks of the non-target colours; in Phase II (testing), only the target colour constantly predicted a real word. Phase II was identical for both conditions. Unlike Experiments 3 and 4, however, in Experiment 5 the non-target stimuli remained the same throughout Phase I and Phase II reducing the number of stimuli by 50%. This latter procedural change was introduced in order to test whether or not the obtained latent inhibition deficits in the last two studies were due to the multi-stimuli, and, therefore, cognitively demanding, presentation employed in the last two studies.

It was expected that participants in the preexposed condition (PE) would make significantly less correct word identifications than participants in the control condition (NPE), replicating Experiments 3 and 4. In terms of effects of schizotypy on latent inhibition, if these were independent of the multi-stimuli presentation in Experiments 3 and 4, then schizotypy would be expected to have a detrimental effect on latent inhibition. On the contrary, given the subtle

memory capacity and stimulus discriminability deficits in high-schizotypy scorers (Lenzenweger, 2000; Tallent & Gooding, 1999), if the demonstrated detrimental effect of schizotypy on latent inhibition were modulated by the multi-stimuli presentation employed in Experiments 3 and 4, then level of schizotypy would expected to have no impact on latent inhibition.

5.3.1 Method

5.3.1.1 Participants

Sixty undergraduate students (22 males and 38 females), mostly from the Departments of Psychology and Geography at UCL, participated in the study. The average age was 20.2 years, ranging from 18 to 27 years. All the participants had normal or corrected-to-normal vision, and were naïve to the experimental procedure.

5.3.1.2 Schizotypy measurement

Participants completed the STA schizotypy scale (Claridge & Broks, 1984). The scale is described in detail in Chapter 1 (see also Appendix 1).

5.3.1.3 Stimuli and apparatus

Were as described in Experiments 3 and 4.

5.3.1.4 Procedure

The participants were randomly assigned either to the preexposed (PE: target preexposed/distractors preexposed; n=30) or to the non-preexposed condition (NPE: target non-preexposed/distractors preexposed; n=30) and were tested

individually in quiet laboratory cubicles. Participants in both conditions were presented with a continuous sequence of 48, fast moving, animated trials. The preexposure phase (32 trials) was immediately followed by the testing phase (16 trials).

In the preexposed (PE) condition, the participants during Phase I received arrays of blocks of the target and the non-target colours containing non-words. In the non-preexposed (NPE) condition, the participants during the Phase I received arrays of blocks of the non-target colour containing non-words. The Phase II was identical for both PE and NPE condition. In the Phase II, the observers received arrays of blocks, each of which was of a different colour. The yellow block (target) always contained a real word, and blocks of any other colour (non-targets) always contained a non-word. Baby blue, orange, light green, dark blue, and magenta were used as distractor colours. The non-target colours remained the same from Phase I to Phase II.

Each participant was seated in front of a computer monitor. The participants were told that they are taking part in a visual search task, and when they detected a real word, they should read it out loud. Accuracy (number of correctly detected words) was the dependent variable. The STA scale was administered after the end of the experimental task. Detailed information about the purpose of the study was given at the end of each session.

5.3.2 Results

Participants were classified as high- and low-schizotypy scorers by comparing their STA scores (mean = 16.6, median = 17.5, SD = 5.4) with their normative

scores for age and gender (Claridge, 1997). Participants with a STA score equal or lower than the normative mean were assigned as low-schizotypy scorers (mean STA = 12.4, median = 13, SD = 4.2), and participants with STA scores higher than the normative mean were classified as high-schizotypy scores (mean STA= 20.6, median = 20, SD = 3.4). Table 5.1 presents the demographic characteristics of the sample and the number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

condition x schizotypy level	*N*	Age	STA
	Total	mean (*SD*)	mean (*SD*)
low STA			
PE	19	19.8 (*1.1*)	12.7 (*4.5*)
NPE	10	12.9 (*0.7*)	12.2 (*4.1*)
high STA			
PE	17	21.2 (*2.1*)	20.1 (*2.7*)
NPE	14	20.1 (*0.9*)	21.7 (*2.9*)

Table 5.1

Experiment 5. Means and standard deviations of age and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Figure 5.1 presents the mean number of correct word identifications as a function of experimental condition and schizotypy across four blocks of trials. An overall inspection of these data shows that performance was lower in the preexposed (PE) than in the non-preexposed (NPE) condition, for both high- and low-schizotypy scorers. However, the difference between PE and NPE condition appeared more pronounced for the high schizotypy scorers than for the low schizotypy scorers.

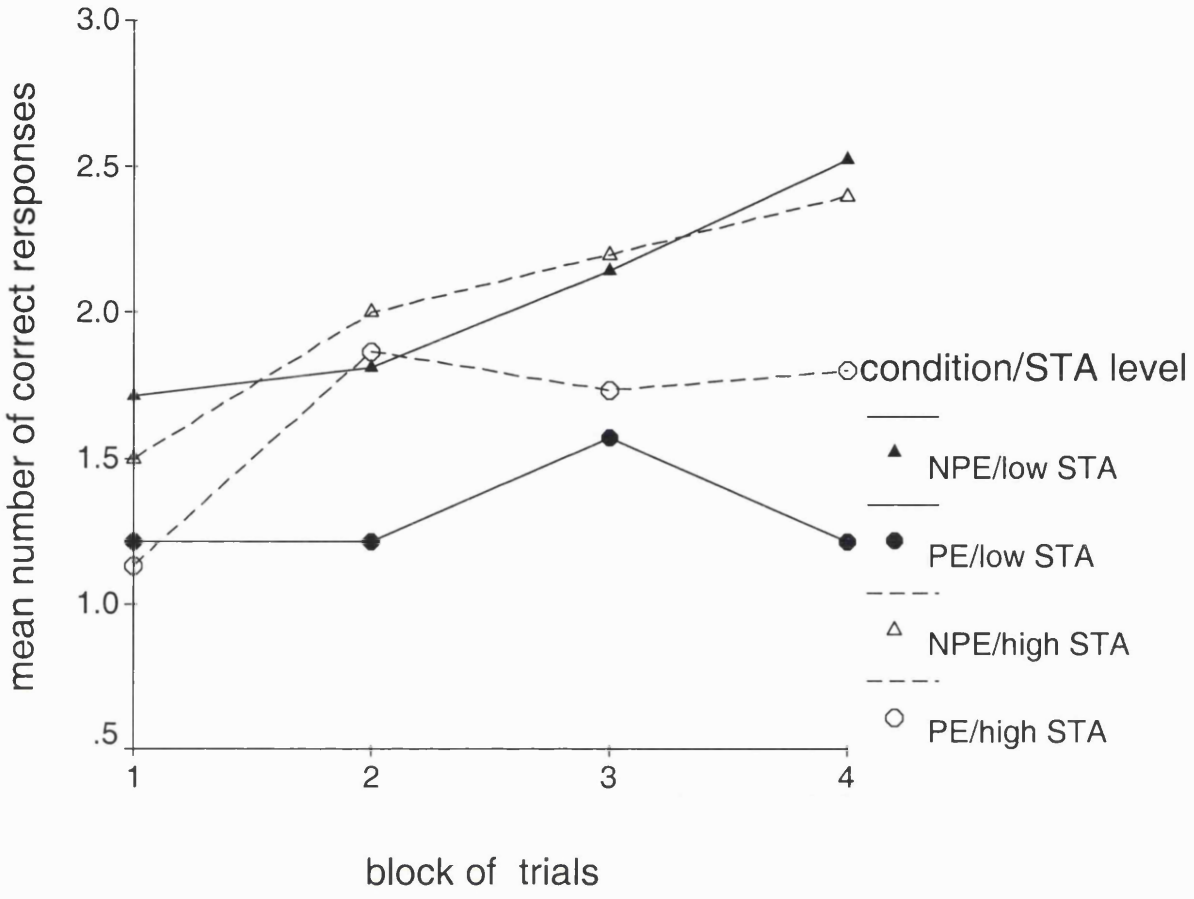


Figure 5.1

Experiment 5. Mean number of correct words for high- and low-schizotypy scorers (STA level) for the preexposed (PE) and the non-preexposed (NPE) condition across four blocks of trials.

A mixed-model analysis of variance (ANOVA) with 'condition' (NPE versus PE) and 'schizotypy' level (high STA versus low STA) as between-subject factors, and 'block' of trials as a within-subject factor was performed on these data. In terms of the between-subject effects, the above analysis revealed a statistically significant effect of 'condition', $F_{(1, 56)} = 4.93$, $p < .05$, but there was no significant effect of 'schizotypy', nor a significant interaction between 'schizotypy' and 'condition', both Fs < .10. In terms of the within-subject effects, there was a significant main effect of 'block', $F_{(3, 168)} = 5.61$, $p < .001$, but there was no interaction, all Fs < .15.

These results confirmed the presence of a significant latent inhibition effect, and that performance improved across trials. The schizotypy level did not interact with the preexposure status of the target. Despite this, visual inspection of the data (Figure 5.1) suggested that the difference between PE and NPE condition appeared more pronounced for the low- than for the high-schizotypy scorers in line with the predictions. Therefore, analysis was then performed on the number of correct word identifications for each schizotypy level separately.

For the low-schizotypy scorers, a mixed-model ANOVA with 'condition' as a between-subject, and 'block' as a within-subject factor, revealed a significant effect of 'block', $F_{(3, 90)} = 4.03$, $p < .01$, a non-significant 'block' x 'condition' interaction, $F_{(3, 90)} = 1.76$, and a significant effect of 'condition', $F_{(1, 30)} = 4.46$, $p < .05$. For the high-schizotypy scorers, a mixed-model ANOVA with 'condition' and 'block' as factors, showed that the effect of 'block' was significant, $F_{(1, 78)} = 2.41$, $p < .05$, but neither the effect of 'condition' nor the 'block' x 'condition' interaction were statistically significant, Fs <1.

In conclusion, a latent inhibition was obtained overall, and, in accord with Experiments 3 and 4, this obtained effect was relatively disrupted in high-schizotypy scorers, replicating similar findings in different procedures (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow, & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992). Importantly, the fact that the above pattern was observed without the introduction of new non-target stimuli in Phase II (unlike Experiments 3 and 4), makes less likely the contribution of

the multi-stimuli presentation as a possible source of the latent inhibition deficits, due to poor discrimination and memory in high-schizotypy scorers.

5.4 Experiment 6

Experiments 3, 4, and 5 demonstrated a relative disruption of latent inhibition in high-schizotypy scorers. A common feature of these studies was the fact that they did not employ a separate, explicit masking task. It could be argued, however, that an *implicit* masking task was involved by diverting attention from the target-colour as a result of the experimental procedure. According to Lubow and Gewirtz (1995), depending on the difficulty level of the masking task, high-schizotypy scorers, due to their increased distractibility, would show smaller or larger amount of latent inhibition than their low-schizotypy counterparts. This hypothesis has been confirmed so far in three past investigations (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999): latent inhibition was disrupted in high-, as compared to low-schizotypy scores in masking tasks of low difficulty level (low-masking-load), but this pattern was reversed in masking tasks of a higher difficulty level (high-masking-load).

Consequently, it would be informative to examine whether a latent inhibition/schizotypy reversal pattern obtained with an difficult, *explicit* masking task could be replicated in a difficult, *implicit* masking task, considering that the main purpose of both types of masking task is supposed to be the same, namely to divert attention from a preexposed target. Given that crowded conditions tend to increase the difficulty level in various cognitive tasks (e.g., Bruins & Barber, 2000; Malik & Batra, 1997; Nagar & Pandley,

1987), Experiment 6 was run under group-testing conditions in order to increase the difficulty level of the implicit masking task. It was hypothesised that the group-testing conditions in Experiment 6 would increase the difficulty level of the implicit masking task (procedural distraction + group-related distraction), as opposed to individual testing conditions in Experiment 5 (procedural distraction), because the possible sources of distraction (e.g., irrelevant noise, visual cues) would increase. It was tested, therefore, whether this manipulation would make possible the emergence of a reversed schizotypy-latent inhibition pattern, similar to that obtained in some earlier studies (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999).

5.4.1 Method

5.4.1.1 Participants

Sixty-two undergraduate students (20 males and 42 females) took part in the study as part of a course requirement. The mean age was 20.1 years (range 18-24), they were all first-year psychology students and none had participated in a similar latent inhibition experiment before.

5.4.1.2 Stimuli, apparatus and procedure

Stimuli, apparatus and procedure were as described in Experiment 5. Unlike Experiment 5, however, the participants received the latent inhibition task under group conditions in Experiment 6. Participants were tested in two group sessions in a large cluster room, and were instructed to write down all the real words they saw during the trial presentation on an answer-sheet

provided. All the other procedural parameters were the same as described in Experiment 5.

5.4.2 Results and discussion

By comparing the obtained STA scores (mean = 16.7, median = 18, SD = 5.1) with the normative STA scores for age and gender (Claridge, 1997), as described in Experiment 5, the participants were assigned as low-schizotypy (mean STA = 11.6, median = 11.5, SD = 4.3) and high-schizotypy scorers (mean STA= 22.8, median = 23, SD = 3.1). The characteristics of the sample by experimental conditions and schizotypy level are presented in Table 5.2.

condition x schizotypy level	*n*	Age	STA
	total	mean (*SD*)	mean (*SD*)
Low STA			
PE	15	18.6 (*1.1*)	10.8 (*4.5*)
NPE	17	19.4 (*1.4*)	12.2 (*4.3*)
High STA			
PE	16	19.1 (*1.5*)	23.3 (*3.7*)
NPE	14	19.2 (*1.2*)	22.1 (*1.9*)

Table 5.2

Experiment 6. Means and standard deviations of age and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Figure 5.2 presents the number of correct responses as a function of 'condition', 'schizotypy' level and 'block' of trials. Inspection of Figure 5.2 shows that, for the high schizotypy scorers, the number of correct responses was consistently lower across the blocks for the preexposed (PE) condition as compared to the non-preexposed condition (NPE), suggesting a latent

inhibition effect. For the low-schizotypy scorers, however, no clear difference appeared between PE and NPE condition.

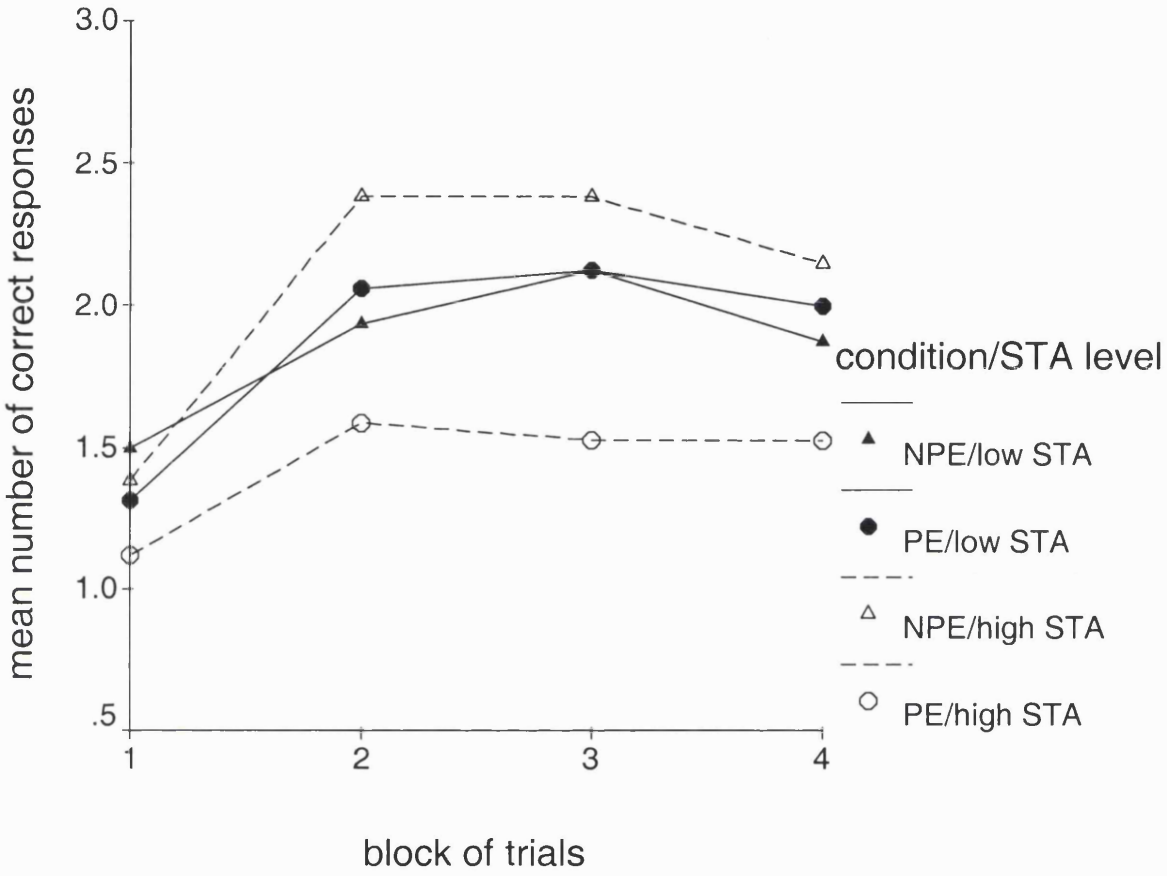


Figure 5.2

Experiment 6. Mean number of correct words for high- and low-schizotypy scorers (STA level), for the preexposed (PE) and the non-preexposed (NPE) condition across four blocks of trials.

The above observations were tested by a mixed-model ANOVA ('condition' x 'schizotypy' x 'block') performed on these data. The analysis revealed a non-significant effect of 'condition', $F_{(1, 58)} = 2.09$, $p > .15$, a non-significant 'condition' x 'schizotypy' interaction $F_{(1, 58)} = 1.02$, $p > .20$. The effect of schizotypy was not significant, $F < 1$. In terms of the within-subject effects, the was a statistically significant effect of block, $F_{(3, 174)} = 9.83$, $p < .001$, but no significant interactions, Fs < 1. The above analysis revealed that, although the overall performance was improved across trials, latent inhibition

did not reach statistical significance, nor was there any significant interaction with schizotypy. The visual inspection of this data, however, suggested that the pattern of results followed the predictions, as the difference between PE and NPE condition appeared relatively pronounced for the high-schizotypy scorers. Therefore, analysis was then performed for each schizotypy level separately.

For the low-schizotypy scorers, a mixed-plot ANOVA ('condition' x 'block') revealed a significant effect of 'block', $F_{(3, 90)} = 6.47$, $p < .001$, but neither the 'condition', nor the 'block' x 'condition' interaction were significant, Fs < 1. For the high-schizotypy scorers, a mixed-plot ANOVA ('condition' x 'block') showed that the effect of 'condition' reached statistical significance, $F_{(1, 28)} = 4.03$, $p = .05$, suggesting a latent inhibition effect. In terms of the within-subject effects, there was a significant effect of 'block', $F_{(3, 84)} = 3.91$, $p < .01$, but there was no significant 'block' x 'condition' interaction between, $F < 1$. This latter analysis suggested that latent inhibition was demonstrated for the high-schizotypy scorers, but not for the low-schizotypy scorers. This reversed pattern between latent inhibition and schizotypy under group-testing conditions appeared similar to past studies with explicit masking tasks of a high difficulty level (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999).

5.5 Discussion

Although Experiment 5 employed the same distractors throughout Phase I and Phase II, it replicated results from Experiments 3 and 4. This seems to suggest that the obtained disruption of latent inhibition in high-schizotypy was

not dependent to a multi-stimuli presentation employed in Experiments 3 and 4. In addition, latent inhibition was attenuated as a function of schizotypy despite the absence of a target/distractor reversal. This latter feature appears to reinforce the notion that, although most human studies have employed a such a reversal, attenuated latent inhibition in high-schizotypy participants (Allan *et al.*, 1995; Baruch *et al.*, 1988*b*; Burch *et al* 1998; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow *et al.*, 1992; Lubow *et al.*, 2001) cannot not be attributed solely to this change between the roles of the target and the distractor from one phase to another.

The schizotypy level of the participants, as assessed by the STA scale, did not seem to influence the overall number of correct responses in Experiment 5 and 6, a pattern congruent with the results from Experiments 1 to 4. This consistent independence between schizotypy and accuracy across studies makes it less likely that the relative disruption of latent inhibition was due to an overall increased (or reduced) pattern of responding in participants with relatively elevated psychotic-like features, as assessed by the STA. Such a pattern makes less likely the existence of generalised deficits in schizotypy, similar to those identified in schizophrenia (Chapman & Chapman, 1973). In fact, despite the evidence for an impairment in general intellectual functioning in schizophrenia (e.g., Aylward *et al.*, 1984; Bilder *et al.*, 1992; Gold *et al.*, 1999), non-clinical high-schizotypy scorers do not demonstrate a similar performance deficit on measures of general intellectual ability (e.g., Gooding *et al.*, 1999; Tsakanikos & Reed, 2003).

A distinctive feature of Experiment 5 was the absence of a distinct, explicit masking task. However, although the participants were not engaged

in an explicit masking task, attention was diverted from the pre-exposed stimuli through the procedure. It could be argued, therefore, that an implicit masking task was included after all. Given that the disruption of latent inhibition in schizotypy is reversed following an explicit masking task of high difficulty level (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), it was hypothesised that a similar pattern would be expected if the difficulty level of the implicit masking task was increased after group testing (more sources of distraction) in Experiment 6, as compared to individual testing (less sources of distraction) in Experiment 5. Although strong conclusions cannot be drawn (due to the absence of a statistically significant interaction between schizotypy level and experimental condition), the obtained data appeared in line with the expected pattern of performance. After group testing there was evidence of a relative disruption of latent inhibition in low-, but not in high schizotypy scorers.

As already mentioned, testing under crowded conditions typically tend to increase the difficulty level in complex tasks (Malik & Batra, 1997; Nagar & Pandley, 1987). In the present investigation, a first indication that group testing increased the task difficulty in Experiment 6 was suggested by the fact that the overall latent inhibition effect did not approach significance, although it was clearly significant in Experiment 5. A second indication was suggested, albeit conversely, by the fact that latent inhibition was found relatively disrupted for the low- but not for the high-schizotypy scorers after group-testing, a reversed pattern that has been obtained so far only after increasing the difficulty level of the explicit masking task (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999).

The reversed latent inhibition/schizotypy pattern has been interpreted as a manifestation of the attentional distractibility in schizotypy (Lubow, 1995), i.e. after the increase in the sources of distraction, high-schizotypy scores are prevented from maintaining their attention to the 'irrelevant' (preexposed) stimulus, and latent inhibition develops normally. Therefore, the obtained results could be taken as an additional evidence of the attentional modulation of latent inhibition. However, this reversed pattern may be also seen as latent inhibition being 'restored' for high-schizotypy scorers after increasing the sources of distraction. This restoration may suggest that disruption of latent inhibition in schizotypy (and in schizophrenia) relates to the *expression* rather than the *acquisition* of the effect. Accordingly, considering the role of dopamine neuro-regulation in the current formulations of schizophrenia (e.g., Carlson, 1989; Gray, 1998), administration of *d*-amphetamine abolishes the expression, but not the acquisition of latent inhibition (Weiner, Lubow & Feldon, 1984), while haloperidol facilitates the expression, but not the acquisition of latent inhibition (Weiner, Feldon & Katz, 1987). However, as discussed in detail in Chapter 2, a main limitation in the attentional accounts of latent inhibition deficits is that they cannot sufficiently explain a restoration of latent inhibition as a result of a specific treatment.

Given that the overall latent inhibition effect was statistically significant after individual testing (Experiment 5), but did not reach significance after group testing (Experiment 6), an alternative explanation for the obtained pattern of results needs to be considered. It could be suggested that the elevated difficulty level after group testing was not due to an increase in the possible sources of distraction, but due to an increase in the anxiety level of

the participants. Latent inhibition has been found attenuated as a function of self-report anxiety (Braunstein-Bercovitz, 2000), although anxiety scores in that study were also highly correlated with schizotypy scores. Furthermore, latent inhibition has been found disrupted after an experimental induction of anxiety (Braunstein-Bercovitz, Dimentman-Ashkenaz & Lubow, 2001), suggesting a causal effect of anxiety on the development to latent inhibition. In the light of this evidence, an overall attenuation of latent inhibition of inhibition after group testing could be attributable to increased anxiety levels due to the crowded conditions.

However, even if it was accepted that group testing did increase the anxiety level resulting in an overall attenuation of latent inhibition, such an interpretation could not account for the fact that latent inhibition was disrupted only for the low-, but not for the high-schizotypy scorers. Furthermore, the claim that anxiety *per se* can disrupt latent inhibition is not without problems. For example, a study with children and adolescents diagnosed as having an anxiety disorder, as compared to matched controls, failed to find an effect of anxiety on latent inhibition (Lubow, Toren, Laor & Kaplan, 2000). This negative result poses problems for any conceptualisation in terms of anxiety and latent inhibition.

In addition, in the two experimental studies on the effect of anxiety and latent inhibition (Braunstein-Bercovitz *et al.*, 2001), anxiety was induced though manipulating the perceived importance of the experimental task. In the first experiment, the participants were given a difficult task, supposedly measuring intelligence; in the second experiment, the participants were job seekers who were informed that the latent inhibition task was a part of the

selection procedure. Although in both studies latent inhibition was found impaired in the anxiety-evoking condition, it is possible that this latter finding could be a result of *demand characteristics* (Orne, 1962) due to the specific way of inducing anxiety in both experiments. For example, it is likely that latent inhibition was disrupted in the anxiety-evoking conditions in both experiments, as participants might have 'artificially' sustained their attention both to preexposed and non-preexposed stimuli due to the perceived importance of the task, and not due to anxiety.

In conclusion, latent inhibition was found disrupted for high-schizotypy scorers, as compared to their low-schizotypy counterparts in Experiment 5, but this pattern was reversed after group testing in Experiment 6. If it were accepted that latent inhibition reflects a mechanism of selective attention, then it would follow that crowded conditions, although they typically tend to obstruct stimulus selection, may paradoxically 'normalise' stimulus selection in high-schizotypy scorers and, possibly, in schizophrenic patients. Given the potentially interesting theoretical implications of such a reversed latent inhibition/schizotypy pattern, this will be further examined in the next chapter.

CHAPTER 6

Latent inhibition and context change in schizotypy

6.1 Introduction

In the studies reported in the previous chapters, a novel procedure of latent inhibition was employed in order to examine properties stimulus of preexposure in conjuction with psychometrically defined schizotypy traits in student samples. In Experiments 3, 4 and 5, a latent inhibition effect was demonstrated for low-schizotypy scorers, but was relatively attenuated in their high-schizotypy counterparts, replicating similar findings obtained in different experimental settings (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Gray *et al.*, 2002; Lipp & Vaitl, 1992; Lubow & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992) and further attesting to the reliability of this effect. Importantly, in Experiments 3 and 4 this effect was produced without a reversal shift between target and distractor across different experimental phases, overcoming an interpretation of latent inhibition deficits as a result of shift learning deficits.

In addition, the detrimental effect of schizotypy on latent inhibition survived in Experiment 5, despite the fact that the distactor stimuli remained the same across different experimental phases, reducing by 50% the number of the stimuli that participants received, and making less likely the contribution of subtle short-term memory and discrimination deficits to the obtained attenuation latent inhibition. Nevertheless, the specific manipulation of preexposure in these studies could allow alternative interpretations of the obtained data, as the lower number of responses in the preexposed condition

could be still attributed to a negative transfer from Phase I (CS_{PE}—non-word associations) to Phase II (CS_{PE}—word associations).

In the latent inhibition paradigm employed in the above studies, participants were asked to search for fast moving words among non-words. Within this approach, 'reinforcement' was operationally defined as the presence of words (important, sought after events), and 'non-reinforcement' was defined as the presence of 'non-words' (non-important events). Participants in the experimental condition (preexposed/PE), after being repeatedly exposed to the target stimulus containing non-words (non-reinforcement) in Phase I, they were expected to form an association between the target and the presence of a word (reinforcement) more slowly than participants in the control condition (non-preexposed/NPE) in Phase II. On the level of response, participants in the experimental condition (preexposed/PE) were expected to make less correct word identifications than participants in the control condition (non-preexposed/NPE), demonstrating the standard latent inhibition effect.

However, the above operational definition of 'non-reinforcement' may suffer from a critical limitation. It could be argued that 'non-reinforcement' should have been operationally defined as the *absence* of reinforcement, rather than the *presence* of non-important events. Likewise, within the context of the current procedure, 'non-reinforcement' should have been defined as the *absence* of 'words', rather than as the *presence* of non-words. This feature may be important because the latter operational definition of 'non-reinforcement' as the *presence* of non-words could produce a negative transfer effect, namely CS_{PE}—non-word associations formed in Phase I

interfering with CS_{PE}—word associations in Phase II. On the contrary, an operational definition of 'non-reinforcement' as the *absence* of words would avoid similar confounds. In order to address this possible limitation, 'non-reinforcement' in Experiment 7 was operationally defined as the absence of words. Consequently, the coloured blocks were preexposed in Experiment 7 without containing non-words. Experiment 7 would also serve as a preliminary step of testing competing predictions, as derived from the different theoretical assumptions on latent inhibition deficits, before introducing a context change in Experiment 8.

Two main sets of theories have been proposed to explain the disruption of latent inhibition in schizophrenia (and in schizotypy). The first set of theories could be described as *attentional*. Attentional theories are based on the assumption that latent inhibition is the result of the inability of the preexposed stimuli to elicit an attentional response (Lubow, 1989; Mackintosh, 1975). According to this assumption, disruption of latent inhibition can be explained in terms of an increased distractibility that characterizes schizophrenic patients. Due to this putative distractibility, schizophrenic patients fail to ignore irrelevant stimuli, and conditioning to a preexposed, supposedly irrelevant, stimulus progresses at the same rate as to a non-preexposed stimulus (Braunstein-Bercovitz & Lubow, 1998; Lubow, 1989; Mackintosh, 1975). The attentional assumption is further supported by evidence on impaired performance in schizophrenic patients in various paradigms of selective attention (see, Braff, 1993; Nestor & O'Donnell, 1998, for reviews).

The second set theories of latent inhibition deficits could be described as *associative* theories. Associative theories are based on the assumption that associations formed during the preexposed phase (Phase I) subsequently interfere with conditioning to the CS_{PE} during the testing phase (Phase II). These interfering formations could be either 'stimulus—context' (Miller & Matzel, 1988; Wagner, 1981) or 'stimulus—no event' associations (Reed, 1995; Reed & Tsakanikos, 2002). Similarly, from a cognitive perspective (Hemsley, 1993), latent inhibition has been explained as the result of contextual information ('the CS_{PE} does not predict a significant event'), which interferes later on with the acquisition of new information about the CS_{PE}.

According to the associative view, schizophrenic patients fail to retain (or to retrieve) past associations from the pre-exposure phase. Therefore, in the absence of any associative interference, conditioning to the CS_{PE} would tend to progress at the same rate as for the CS_{NPE} (for a review see Escobar *et al.*, 2002). The associative interpretation is consistent with evidence on short-term memory and learning deficits in schizophrenia (Hofer et *al.*, 2001; Goldberg et *al.*, 1998), and in psychometrically defined schizotypy (Lenzenweger, 2000; Tallent & Gooding, 1999), given that such deficits could explain a potential failure to retrieve the past associations required for the development of latent inhibition. Additional support for the contextual approach of the interference assumption (Hemsley, 1993) comes from the reported deficits in context processing in schizophrenia (Cohen, Barch, Carter & Servan-Schreiber, 1999; Cohen & Servan-Schreiber, 1992; Silverstein, Kovacs, Corry & Valone, 2001), although such processing deficits are not

seen in all types of context (Bazin & Perruchet, 1996; Gold, Bish, Iannone, Hobart, Queern & Buchanan, 2000).

In latent inhibition studies, the term 'context' typically refers to the surrounding environmental stimuli (or the apparatus) within which the stimulus preexposure takes place. Latent inhibition is a context-dependent effect, as the introduction of a context change from the preexposure to the testing phase has been shown to disrupt or reduce latent inhibition in both humans (Gray *et al.*, 2001; Kaplan & Lubow, 2001; Zalstein-Orda & Lubow, 1995) and non-humans (Lubow *et al.*, 1976).

Given this context dependency, a general convention of generating latent inhibition requires presentation of the target CS_{PE} with preexposed (familiar) distractors in Phase II (testing phase), which constitute part of a stable context (Lubow, 1997). Consistent with this view, in a two-experiment investigation (Gibbons & Rammsayer, 2001), it has been shown that presenting a target CS_{PE} in the context of novel distractors during the testing phase, as compared to familiar distractors, attenuates latent inhibition in a visual search paradigm. Despite the reported problems in context processing in schizophrenia (Cohen *et al.*, 1999; Cohen & Servan-Schreiber, 1992; Silverstein *et al.*, 2001; but see Bazin & Perruchet, 1996; Gold *et al.*, 2000), a similar manipulation on the context of the distractors has never been investigated in schizophrenic patients nor in psychometrically defined psychotic-prone individuals.

The introduction of a context change can also be used to test competing predictions derived from different theoretical assumptions regarding the disruption of latent inhibition in schizotypy. According to the associative assumption, high-schizotypy scorers would fail to demonstrate latent inhibition

independently of a context change. A disrupted latent inhibition would be expected for high-schizotypy scorers both within a stable context, and after a context change. However, according to the attentional assumption, latent inhibition in high-schizotypy scorers would be disrupted only within a stable context (target preexposed/distractors preexposed). On the contrary, a context change (target preexposed/distractors non-preexposed) could restore latent inhibition in high-schizotypy scorers.

This latter prediction is mainly based on the attentional assumption that high-schizotypy scorers are particularly distracted by irrelevant stimuli (distractors), coupled with evidence that novelty automatically captures attention during visual search (Johnston & Hawley, 1994; Johnston, Hawley & Farnham, 1993). This attentional bias to novelty over familiarity (*novel pop-out*) has been shown to the same extent in both schizophrenic and non-clinical participants (Lubow *et al.*, 2000), therefore, novelty *per se* would not have a differential impact on performance for high-, as compared to low-, schizotypy scorers. Nevertheless, the *additive* effects of irrelevance and novelty in the surrounding distractors (context change) would expected to reinstate latent inhibition for high-schizotypy scorers: because of this putative attentional distractibility, and given the attentional bias to novelty, it would be expected that novel irrelevant stimuli (distractors) would provide the high-schizotypy scorers with a more effective distraction from the familiar target (CS_{PE}) during the testing phase, as compared to a novel target (CS_{NPE}). Consequently, the context change (novel + irrelevant stimuli) would distract attention from the familiar target (CS_{PE}), reinstating latent inhibition (CS_{PE}—US < CS_{NPE}—US).

Two experiments were designed to test the above competing predictions in a visual search paradigm of latent inhibition. In both experiments, accuracy was investigated as a function of preexposure to the target and schizotypy level. In Experiment 7, the context remained stable (familiar distractors) throughout the experiment. In Experiment 8, a context change (novel distractors) was introduced in the testing phase.

6.2 Experiment 7

Most past investigations that have demonstrated an effect of schizotypy on latent inhibition have employed a masked preexposure (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998b; Gray *et al.*, 2002; Hofer *et al.*, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992). In a masking preexposure, participants are engaged in a secondary task (explicit masking task) during their exposure to the target. Although an attenuated latent inhibition in schizotypy has been demonstrated in various visual search paradigms without including a secondary masking task (Lubow *et al.*, 2001), as well as in the studies reported in the past chapters (Experiments 3, 4, 5, and 6), the specific manipulation of preexposure in the latter studies (namely, the presentation of target stimulus in Phase I along with a non-word) could potentially introduce a negative transfer from Phase I to Phase II. As a consequence, although the preexposed stimulus did elicit a lower number of correct responses during testing (Phase II), this could be interpreted as a result of interfering stimulus—non-word associations formed during preexposure (Phase I), and not as a result of latent inhibition. In order to

avoid such a possible confound, the target stimulus had to be preexposed without the concurrent presence of non-words.

Repeated exposure of empty coloured blocks without concurrently presenting non-words, could potentially introduce demand characteristics by making the participants suspicious about the possible role of these stimuli in a latter stage of the experiment. Consequently, the participants may become over-attentive to the colour of the blocks in the expectation that these might be very important features for an optimum task performance. Such demand characteristics would sustain 'artificially' attention to the pre-exposed stimuli, preventing the development of latent inhibition (see also Lubow & Gewirtz, 1995). In an effort to overcome this problem, a secondary task (explicit masking task) was included during preexposure (Phase II). This masking task required from the participants to make judgements in terms of the relative speeds of successively moving trials of coloured blocks. Unlike past investigations, however, (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998b; Gray *et al.*, 2002; Hofer *et al.*, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992), a reversal between the roles of the target and the distractors from Phase I to Phase II was avoided.

The introduction of such an explicit masking task could destabilise the context within which latent inhibition was produced in the last studies (Experiments 3 - 6). As it has been commented earlier, the participants in these experiments were engaged in the same task throughout Phase I (preexposure) and Phase II (testing), a feature that might have provided a notably stable context, which is a necessary condition for the development of latent inhibition. Therefore, in order to secure the development of latent

inhibition, the same distractors were present in both preexposure and testing phase, like in most past investigations (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998b; Gray *et al.*, 2002; Hofer *et al.*, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992), as well as in Experiment 3 and 4, on the premise that such a consistency would provide a stable context for latent inhibition to develop (Lubow, 1997). In addition, in order to strengthen the effect, the amount of preexposure was increased from 32 to 64 trials, given that latent inhibition seems to be a function of the amount of preexposure (Allan *et al.*, 1995; De la Casa & Lubow, 1996). Similarly, in order to increase the reliability of the measurement, the testing phase was increased from 16 to 32 trials.

It was expected that the overall mean number of correct responses would be significantly lower for the preexposed than for the non-preexposed target due to latent inhibition. For the high-schizotypy scorers, in line with past findings, a disruption of this effect was expected in that the mean number of correct responses would not be significantly lower for the preexposed than for the non-preexposed target.

6.2.1 Method

6.2.1.1 Participants

Sixty undergraduate students (33 males and 27 females) participated in Experiment 7. The average age was 20.3 years, ranging from 19 to 26 years. All the participants had normal or corrected-to-normal vision, and were naïve to the experimental procedure.

6.2.1.2 Schizotypy measurement

All the participants filled in the STA scale (Claridge & Broks, 1984) described in previous chapters.

6.2.1.3 Stimuli and apparatus

The basic characteristics of the stimuli were as described in earlier chapters. In addition, the animations in the preexposure phase were presented randomly at various speeds (7, 9, 11, 13 and 15 frames per second) and the blocks were empty. In the testing phase, the animations were presented at a rate of 9 frames per second and each block contained either word or non-word stimuli (see Appendix 5).

6.2.1.4 Procedure

The participants were assigned either to the preexposed condition (PE; target preexposed/distractors preexposed) or to the non-preexposed condition (NPE; target non-preexposed/distractors preexposed) and were tested in individual cubicles. Participants in both conditions were presented with a continuous sequence of 96 fast moving, animated, trials. The task consisted of two phases: preexposure (64 trials); and testing (32 trials).

During the preexposure phase, all participants were simultaneously exposed to trials of fast moving round blocks while making judgements (verbal responses) in terms of the relative speeds of the blocks (faster, slower or same). In the non-preexposed (NPE) condition, the participants were

exposed only to the non-target colours. In the preexposed (PE) condition, the participants exposed both to the target and to the non-target colours.

The testing phase was identical for both PE and NPE conditions. During the testing phase, the participants received arrays of differently coloured blocks. The yellow block (target) always contained a real word, and blocks of any other colour (distractors) always contained non-words. Baby blue, orange, green, dark blue, pink and magenta were used as distractor colours. The participants were told that they are taking part in a visual search task, and when they detected a real word they should name it out loud. The responses were recorded by the experimenter. Accuracy (number of correctly detected words) was the dependent variable.

6.2.2 Results

Participants were divided into high- and low-schizotypy scorers by comparing their STA scores (mean = 15.3, median = 14, SD = 7.8) with the normative scores for age and gender (Claridge, 1997). Participants with a STA score equal to the normative score or lower were classified as low-schizotypy scorers (mean STA = 8.2, median = 8, SD = 3.1), and participants with a STA score higher than the normative score were classified as high-schizotypy scorers (mean STA = 22.5, median = 23, SD = 3.2). Demographic characteristics of the sample in Experiment 7, as well as number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level, are given in Table 6.1.

condition x Schizotypy level	*n*	Age	STA
	total	mean (*SD*)	mean (*SD*)
low STA			
PE	17	20.6 (*1.2*)	9.2 (*3.1*)
NPE	13	19.7 (*0.6*)	6.7 (*2.4*)
high STA			
PE	14	19.7 (*0.6*)	22.6 (*3.2*)
NPE	16	21.2 (*2.4*)	22.4 (*3.3*)

Table 6.1

Experiment 7. Descriptive statistics of age, and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Figure 6.1 presents the mean number of correct responses as a function of condition (PE versus NPE), schizotypy level (low STA versus high STA), and block of trials (eight-trial blocks). Inspection of these data shows that, overall, the mean number of correct responses was consistently lower for the PE than for the NPE condition across trials. Furthermore, the difference between PE and NPE conditions was more pronounced for the low- than for the high-schizotypy scorers.

The data were analysed by a mixed-model analysis of variance (ANOVA) with 'condition' and 'schizotypy' level as between-subject factors, and 'block' of trials as a within-subject factor. In terms of the between-subject effects, there was a significant effect of 'condition', $F_{(1, 56)} = 8.75$, $p < .001$, a marginally insignificant 'condition' x 'schizotypy' interaction, $F_{(1, 56)} = 3.41$, $p < .07$, and no significant effect of 'schizotypy', $F < 1$. In terms of the within-subject effects, there was a significant effect of 'block', $F_{(3, 168)} = 25.64$, $p < .001$, a significant 'block' x 'condition' interaction, $F_{(3, 168)} = 3.44$, $p < .01$, and

no significant main effect of 'schizotypy', $F < 1$. One-way ANOVAs showed that the effect of 'condition' was not insignificant on block 1, $F_{(1, 58)} = 1.46$, $p > .20$, but significant on blocks 2, 3, and 4, smallest $p < .01$, after a bonferroni correction.

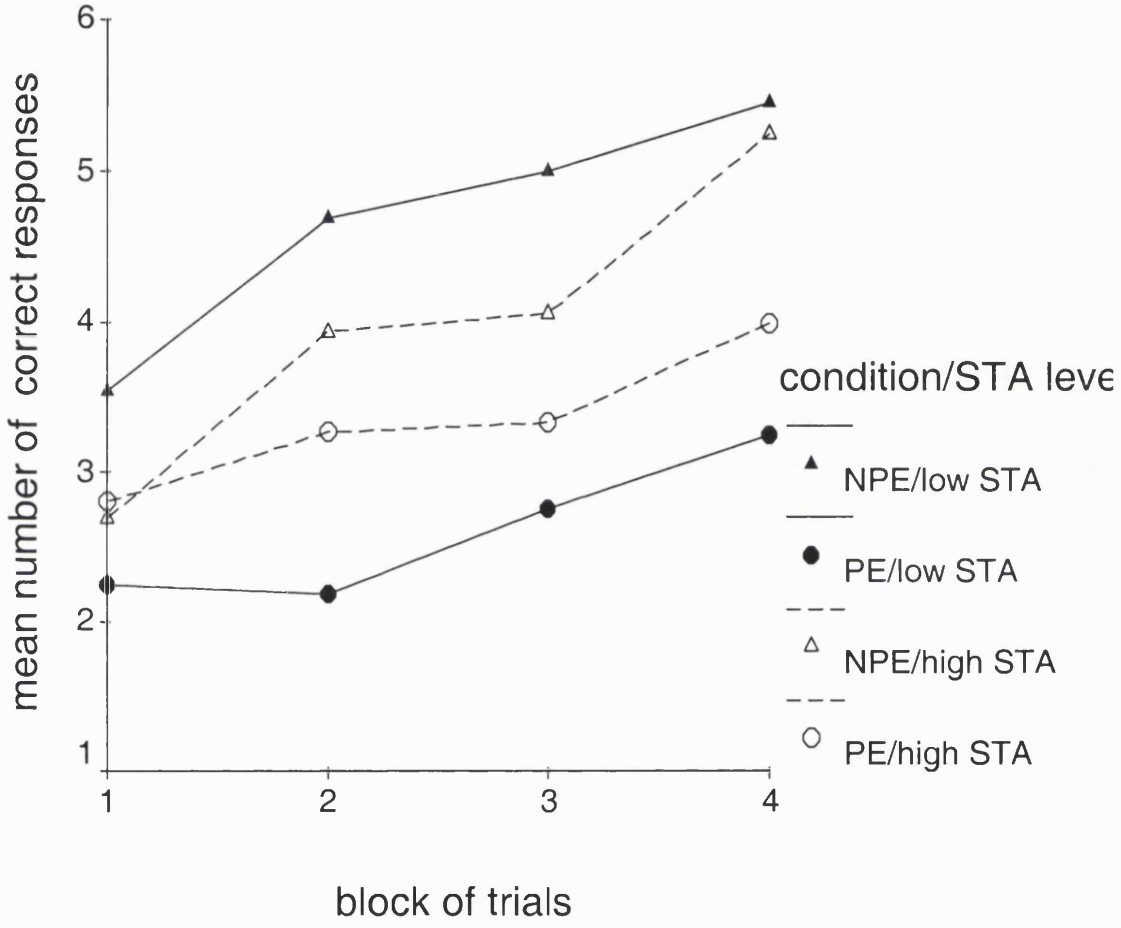


Figure 6.1

Experiment 7. Mean number of correct responses for low- and high-schizotypy scorers (STA level), for preexposed (PE: target preexposed/distractors preexposed) and non-preexposed (NPE: target non-preexposed/distractors preexposed) condition across four blocks of eight trials.

The above analyses confirmed that latent inhibition was obtained overall, as the mean number of correct responses was significantly lower for the PE than the NPE condition. The effect of 'schizotypy' on mean number of correct responses was not significant, and the 'condition' x 'schizotypy' interaction

approached, but did not reach, significance. Inspection of Figure 6.1, however, suggests that the marginally insignificant 'schizotypy' x 'condition' interaction appeared to be in line with the predictions, as the difference between the PE and the NPE condition was less pronounced for the high STA scorers than for the low STA scorers. To examine further this pattern, analyses were conducted for each schizotypy level separately.

For the low STA scorers, an ANOVA with 'condition' and 'block' as factors revealed a significant effect of 'condition', $F_{(1, 28)} = 9.52$, $p < .01$, a significant effect of 'block', $F_{(3, 84)} = 13.87$, $p < .001$, and a significant 'block' x 'condition' interaction, $F_{(3, 84)} = 3.09$, $p < .05$ (One-way ANOVAs on each block with 'condition' as a factor, showed that the effect of 'condition' was significant on every block at varying p levels: block 1, $F_{(1, 28)} = 4.78$, $p < .05$, block 2, $F_{(1, 28)} = 13.71$, $p < .001$, block 3, $F_{(1, 28)} = 6.72$, $p < .01$, and block 4, $F_{(1, 28)} = 9.26$, $p < .005$; however, statistical significance was not retained for block 1 after a bonferroni correction.) For the high STA scorers, a similar analysis failed to yield a significant effect of 'condition', $F_{(1, 28)} = 1.39$, $p > .20$. The effect of 'block' was significant, $F_{(3, 83)} = 12.81$, $p < .001$, but there was no significant 'block' x 'condition' interaction, $p > .20$. The latter analysis confirmed that high-schizotypy scorers failed to demonstrate a significant latent inhibition effect on any block of trials.

6.3 Experiment 8

A latent inhibition effect was demonstrated in Experiment 7 without employing a simultaneous target—non-word preexposure, overcoming the possibility of a possible negative transfer of target—non-word associations from Phase I to

Phase II. In addition, despite the introduced parametric changes, latent inhibition was found relatively disrupted for high-schizotypy scorers as compared to low-schizotypy scorers, providing further evidence on the reliability of this effect. However, a disruption of latent inhibition in high-schizotypy scorers could be explained both by interference and attentional theories (see introduction), making any interpretation of this performance deficit equivocal. A context change could test opposing predictions as derived from the two main sets of theories.

On an empirical level, it has been established that context change can disrupt (or attenuate) latent inhibition (Gray *et al.*, 2001; Kaplan & Lubow, 2001; Lubow *et al.*, 1976; Zalstein-Orda & Lubow, 1995). On the basis of these findings, it was expected that latent inhibition would be disrupted for the low-schizotypy scorers after a context change. For the high-schizotypy scorers, however, a prediction based on past empirical findings would not be warranted for two main reasons: firstly, although context processing deficits in schizophrenic patients have been detected in some tasks (Cohen *et al.*, 1999; Cohen & Servan-Schreiber, 1992; Silverstein *et al.*, 2001) other tasks have failed to detect similar deficits (Bazin & Perruchet, 1996; Gold *et al.*, 2000) suggesting difficulties with processing specific types of context, rather than general context processing deficits; secondly, a context change in latent inhibition has never been directly investigated in conjunction with schizophrenia or schizotypy.

On theoretical grounds (see introduction to this chapter), two different predictions can be made for the high-schizotypy scorers. According to the interference assumption, latent inhibition would be expected to remain

disrupted after a context change (as in Experiment 7). If disruption of latent inhibition were the result of a deficient interference of past associations (or contextual information), a context change could not alter this disruption. On the contrary, the attentional account would predict that, after a context change, latent inhibition would be reinstated.

Given the attentional bias to novelty over familiarity during visual search (Johnston & Hawley, 1994; Johnston *et al.*, 1993), evident to the same extent in both schizophrenic and non-clinical participants (Lubow *et al.*, 2000), the attentional-distractibility assumption would allow for the following prediction: if high-schizotypy scorers tend to be particularly distracted by irrelevant stimuli, then novel irrelevant stimuli would tend to be even more distracting than familiar irrelevant stimuli in the testing phase. In other words, if disruption of latent inhibition in schizotypy stemmed from an inability to ignore an irrelevant stimulus, then novel distractors (context change) would attract attention from the previously irrelevant (but familiar) target, to the currently irrelevant (but novel) distractors, reinstating latent inhibition for high-schizotypy scorers.

6.3.1 Method

6.3.1.1 Participants

Sixty undergraduate students (38 males and 22 females), mostly recruited from the departments of geography and medicine at UCL, participated in Experiment 8. The average age was 23.1 years, ranging from 19 to 34 years. All the participants had normal or corrected-to-normal vision, and were naïve to the experimental procedure.

6.3.1.2 Stimuli, apparatus and procedure

Stimuli, apparatus and procedure were as described in Experiment 7. As in Experiment 7, STA was administered after the experimental task. In terms of the experimental conditions, the only difference between the two experiments was that in Experiment 8 the target was presented with novel distractors in the testing phase, for both the preexposed (PE: target preexposed/distractors non-preexposed) and the non-preexposed condition (NPE: target non preexposed/distractors non-preexposed). In order to achieve this manipulation without increasing the number of the colours, participants in the PE condition received in the preexposure phase (Phase I) displays that contained only the target colour (all four blocks were yellow), and participants in the NPE condition received a colour other than the target and the not-target colours (all four blocks were grey). Examples of trials are includes in Appendix 6. As in Experiment 7, participants were engaged in the speed-judgement (masking) task during preexposure phase (Phase I). The testing phase (Phase II) was the same for both PE and NPE condition, and was as described in Experiment 7.

6.3.2 Results

Participants were divided into high- (mean = 7.5, median = 7, SD = 3.1) and low-schizotypy scorers (mean = 22.3, median = 22, SD = 5.1) using their STA scores (mean = 14.9, median = 14, SD = 8.6) in the way described in Experiment 7. Demographic characteristics of the sample in Experiment 8 by experimental condition and schizotypy level, and number of participants per cell, are given in Table 6.2.

condition x schizotypy level	*N*	age	STA
	total	mean (*SD*)	mean (*SD*)
low STA			
PE	16	22.1 (*3.3*)	7.5 (*3.4*)
NPE	12	22.7 (*3.1*)	7.3 (*2.9*)
high STA			
PE	21	24.4 (*4.3*)	23.9 (*4.3*)
NPE	11	23.3 (*3.7*)	21.6 (*5.4*)

Table 6.2

Experiment 8. Descriptive statistics of age and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

Performance in Experiment 8 is presented as a function of experimental condition, schizotypy level and block of trials in Figure 6.2. An overall inspection of Figure 6.2 suggests that the mean number of correct responses across trials was lower for the PE than for the NPE condition for both schizotypy levels, and overall performance seemed to improve across trials. The difference between PE and NPE condition appeared more pronounced for the high-schizotypy than for the low-schizotypy scorers. A mixed-model ANOVA ('condition' x 'schizotypy' x 'block') was performed on these data. The analysis showed a significant effect of 'condition', $F_{(1, 56)} = 6.51$, $p < .01$, and a significant effect of 'block', $F_{(3, 168)} = 13.94$, $p < .001$. There were no other significant main effects or interactions, Fs < 1.

The above analysis confirmed that latent inhibition was significant overall, and that performance was improved across trials. Furthermore, neither the effect of schizotypy level nor the 'schizotypy' x 'condition' interaction reached significance. Visual inspection of the data, however, suggested that the

pattern of results followed the attentional prediction, as the difference between NPE and PE conditions was most pronounced for the high-schizotypy scorers. To investigate this further, analysis was then run for each schizotypy level separately.

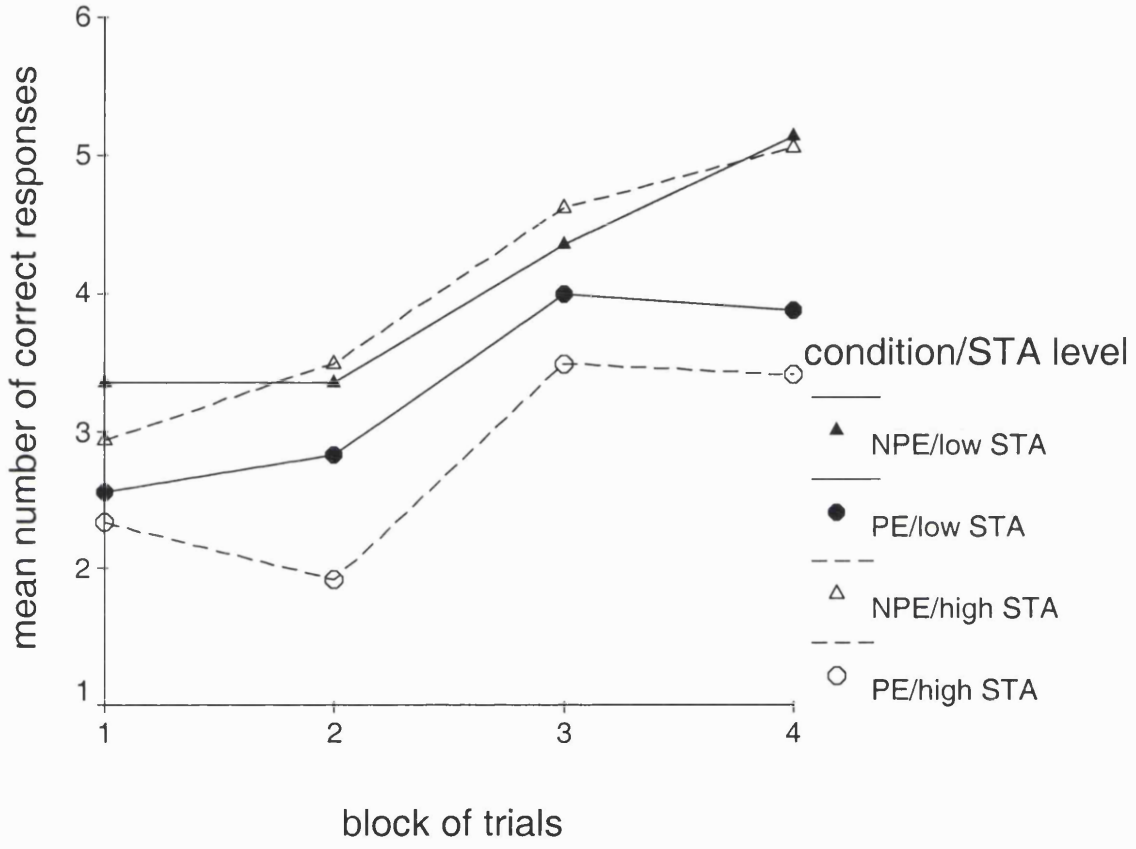


Figure 6.2

Experiment 8. Mean number of correct responses for low- and high-schizotypy scorers (STA level), for preexposed (PE) and the non-preexposed (NPE) condition across four blocks of eight trials.

For the low-schizotypy scorers, a mixed-model ANOVA ('condition' x 'block') revealed a significant effect of 'block', $F_{(3, 84)} = 15.35$, $p < .001$, but the effect of 'condition' was not significant, $F_{(1, 28)} = 2.09$, $p > .10$, neither was the interaction between 'block' and 'condition', $F < 1$. For the high-schizotypy scorers, a similar ANOVA ('condition' x 'block') showed that the effect of 'condition' was significant, $F_{(1, 28)} = 5.11$, $p < .05$, and there was a significant

effect of 'block', $F_{(3, 84)} = 6.93$, $p < .001$. There was no significant interaction between 'block' and 'condition', $F < 1$. This latter analysis confirmed that latent inhibition was significant for the high- but not for the low-schizotypy scorers.

6.4 Discussion

In Experiment 7, latent inhibition was disrupted for high-schizotypy scorers, but was intact for low-schizotypy scorers, replicating past studies that employed different experimental procedures (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; Gray *et al.*, 2002; Hofer *et al.*, 1999; Lipp & Vaitl, 1992; Lubow *et al.*, 1992; Lubow & De la Casa, 2002; Lubow *et al.*, 2002), and confirming the reliability of this effect across different paradigms. Moreover, although a simultaneous colour—no-word preexposure has been avoided in Experiment 7, the obtained pattern of results replicated Experiments 3, 4 and 5, overcoming an interpretation of the demonstrated effect as a result of negative transfer of colour—no-word associations from Phase I to Phase II.

Unlike Experiment 7, a context change was introduced in Experiment 8 by presenting the target along with novel distractors. The obtained data suggested that the context change had a detrimental effect on latent inhibition in low-schizotypy scorers. This result appears to agree with past evidence that introduction of a context change in the testing phase attenuates latent inhibition (Gray *et al.*, 2001; Kaplan & Lubow, 2001; Lubow *et al.*, 1976; Zalstein-Orda & Lubow, 1995). However, latent inhibition was intact in high-schizotypy scorers, a novel empirical finding that seems to accommodated by

the attentional, but not the interference assumption of latent inhibition (see general introduction and introduction to Experiment 8).

The obtained results in terms of the effects (as well as the conceptualisation) of the context might appear opposing to the results obtained in Experiment 3 and 4. 'Context' was operationally defined in Experiments 7 and 8 as the surrounding non-target stimuli, on the premise that these are functionally equivalent to the environmental stimuli/apparatus in the non-human latent inhibition studies (Lubow, 1997). According to this operational definition, 'context stability' was achieved in Experiment 7 by maintaining the same non-target stimuli throughout Phase I and Phase II (as in Experiments 5 and 6), while a 'context change' was introduced in Experiment 8 by introducing novel non-target stimuli in Phase II. Although novel non-target stimuli were introduced in Phase II of Experiments 3 and 4 as well, there was no evidence of a context disruption for the low-schizotypy scorers, similar to this observed in Experiment 8.

One possible factor responsible for this seeming discrepancy between Experiment 8, on the one hand, and Experiments 3 and 4, on the other, could be due to the differences in the relative stability of the surrounding environmental cues across successive experimental phases between the early (Experiments 3 and 4) and the later (Experiments 7 and 8) studies. Participants in Experiments 3 and 4 were engaged in the same visual task throughout Phase I and Phase II, providing a notably stable context of learning. It is likely, therefore, that the introduction of novel non-target stimuli in Phase II was not robust enough to disrupt this stability. On the contrary, participants in Experiments 7 and 8 were engaged in Phase I in a speed-

judgement task and received trials of fast moving, coloured blocks containing nothing; subsequently, they were engaged in a different task that required search of words and received trials of fast moving, coloured blocks containing either words or non-words. It could be argued, therefore, that the context of learning in Experiments 7 and 8 was less stable than in Experiments 3 and 4. Consequently, the introduction of novel non-target stimuli in Phase II of Experiment 8 did sufficiently disrupt the context.

Latent inhibition was found to be relatively disrupted in the low-schizotypy scorers after a context change, although it was found restored for the high-schizotypy scorers, a finding that can be predicted by the attentional view of latent inhibition deficits. However, this reversal may also suggest that disruption of this phenomenon in schizophrenia might not be due to a failure of *acquisition*, but due to a failure of *expression* of latent inhibition (see, Miller & Matzel, 1988). Correspondingly, it has been shown that administration of *d*-amphetamine abolishes the expression, but not the acquisition of latent inhibition (Weiner *et al.,* 1984), while haloperidol facilitates the expression, but not the acquisition of latent inhibition (Weiner *et al.*, 1987). Paradoxically, if is accepted that the current data lent additional support to the notion that disruption of latent inhibition in schizotypy is not due to a deficient acquisition, but due to a deficient expression (of past interfering learning), this conclusion could be taken as confirmation of the interference assumption (disruption of latent inhibition as failure to retrieve past learning).

The above paradox could be resolved, considering that the current results do not exclude the possibility of interference deficits in schizotypy or that such potential deficits could not contribute to a disruption of latent inhibition.

Interference and attentional accounts might not be necessarily incompatible, as the same effect could be modulated by both attentional and interfering mechanisms. For example, a two-component (attentional + interference) model of latent inhibition would predict that, where an increased involvement of the attentional component is required (e.g., visual search paradigms), a context change can reinstate latent inhibition for high-schizotypy scorers, however, where an increased involvement of the interference component is required (e.g., complex rule-learning paradigms) such a manipulation could not reinstate latent inhibition.

If it were accepted that the involvement of attentional process is unavoidably increased in any visual search paradigm, then the current latent inhibition procedure would provide an opportunity to test specific aspects of the attentional view of latent inhibition deficits conjointly with other attentional phenomena, such as the as the effect of different levels of perceptual salience (visual pop-out). Therefore, two different visual search paradigms were conjointly employed to in order to test whether or not the disruption of latent inhibition in high-schizotypy scorers is related to an enhanced perceptual salience of any perceived stimulus. These two studies will be described in the next chapter.

CHAPTER 7

Latent inhibition and visuai-pop out as a function of different schizotypy dimensions

7.1 Introduction

Latent inhibition deficits in schizophrenia and schizotypy have often been attributed to an increased attentional distractibility by non-target stimuli. It is less clear, however, whether such a putative distractibility is due to a general tendency to treat any stimulus as salient on the basis of its physical characteristics (enhanced stimulus salience), or due to a specific tendency to treat any stimulus as relevant (enhanced stimulus relevance). In order to test whether latent inhibition deficits are related to an enhanced perceptual salience (visual pop-out) of a perceived stimulus, participants who took part in Experiment 9 (latent inhibition), took part in Experiment 10 (visual pop-out) as well.

With the exception of two studies (Braunstein-Bercovitz, 2000; Gray *et al.*, 2002), most investigations on latent inhibition deficits have employed a unidimensional construct of schizotypy. This strategy was also adopted in the experiments reported in the previous chapters, as a single measure of schizotypy (STA) was employed to classify the participants into high- and low-schizotypy scorers. Although STA has proved to be a reliable measure, what remains to be established is whether latent inhibition deficits, as detected in the newly developed visual search procedure, are specific to the STA or are detectable to different measures of schizotypy as well. A current trend in

schizophrenia research is to examine specific deficits as a function of different symptom types, namely 'positive', 'negative' and 'disorganised' symptomatology (Liddle, 1987; Liddle & Barnes, 1990), which have shown strong similarities with corresponding schizotypy dimensions (Bentall *et al.*, 1989; Claridge *et al.*, 1996; Vollema & van den Bosch, 1995). It would be, therefore, informative to examine latent inhibition deficits in the novel visual search procedure in a multidimensional, as well as in a unidimentional schizotypy approach.

7.2 Dimensions of schizotypy and latent Inhibition deficits

The loss of latent inhibition has been primarily related to the positive symptomatology of schizophrenia, especially unusual perceptual experiences (Frith, 1979; Gray *et al.*, 1995; Hemsley, 1987; 1994). According to a set of neuropsychological models of positive symptoms of schizophrenia (Weiner, 1990; Gray, 1998), the loss of latent inhibition is due to an increased activity in the mesolimbic dopaminergic system. This hypothesis is supported by evidence that administration of d-amphetamine, an indirect dopamine agonist, disrupts latent inhibition in non-humans (for a review, Gray *et al.*, 1995), and humans (Kumari *et al.*, 1999).

Most previous investigations on latent inhibition and schizotypy (Allan *et al.*, 1995; Baruch *et al.*, 1988b; Braunstein-Bercovitz & Lubow, 1998; De la Casa *et al.*, 1993; Lipp & Vaitl, 1992; Lubow & De la Casa, 2002; Lubow *et al.*, 2002; Lubow *et al.*, 1992) have treated schizotypy as a unidimensional construct, employing a single schizotypy measure (an approach that has also been adopted in the previous studies of the thesis). Two studies (Braunstein-

Bercovitz, 2000; Gray *et al.*, 2002) are exception to this rule, although they have produced some contradictory results.

In the Braunstein-Bercovitz (2000) study, both negative and positive aspects of schizotypy, as assessed by factor-analysing subscales of SPQ (Raine, 1991), were associated with an attenuation of latent inhibition. In addition, attenuated latent inhibition was primarily predicted by negative aspects of schizotypy such as interpersonal deficits, not by the perceptual/cognitive distortion component of schizotypy, associated with positive symptoms of schizophrenia (Braunstein-Bercovitz, 2000). On the contrary, in second study (Gray *et al.*, 2002) a somehow different pattern was observed, as attenuated latent inhibition was predicted by the positive, but not the negative dimension of schizotypy, as assessed by the sub-scales of O-LIFE (Mason *et al.*, 1995). A direct comparison between the two investigations cannot be straightforward, because the above studies did not only employ different schizotypy measures, but also different latent inhibition paradigms. However, the above discrepancy deserves further investigation, because the reduction of latent inhibition has never proposed to be a model of negative symptoms in chronic schizophrenia, given the robust finding that latent inhibition remains intact in this group (Baruch *et al.*, 1988a; Gray *et al.*, 1992; Swerdlow *et al.*, 1996; Williams *et al.*, 1998). Consequently, the next study was to explore the possible contributions of different schizotypy dimensions to latent inhibition deficits.

7.3 Experiment 9

The same basic visual search paradigm of latent inhibition, as introduced in Experiments 3 and 4, was employed. The experimental parameters in Experiment 9 were kept the same as in Experiment 7. Unlike the latent inhibition studies presented in previous chapters, a multi-dimensional schizotypy inventory (O-LIFE) was employed In Experiment 9. Schizotypy was treated both as a unidimensional (like most past latent inhibition/schizotypy investigations) and as multidimensional construct. This was deemed necessary for two main reasons: firstly, in order to examine whether the deficits shown in the visual search paradigm of latent inhibition were specific to the STA measure that has been exclusively employed in the previous experiments by comparing analyses of the same data with other schizotypy scales; secondly, to explore whether these latent inhibition deficits were related to other schizotypy dimensions as well. Most importantly, all the participants in this experiment took also part in the next experiment, in order to test whether latent deficits inhibition deficits in schizotypy (Experiment 9) could be a result of an enhanced perceptual salience of perceived stimuli, as assessed in a visual pop-out task (Experiment 10).

7.3.1 Method

7.3.1.1 Participants

Eighty UCL undergraduate students, 41 males and 39 females participated in Experiment 9. The average age was 20.5 years, ranging from 18 to 26 years. All the participants had normal or corrected-to-normal vision, and were informed that they were taking part in a research project assessing individual

differences in visual search. The participants were naïve to the experimental procedure and the purpose of the study

7.3.1.2 Stimuli, apparatus and procedure

Stimuli, apparatus and procedure in Experiment 9 were identical to those described in Experiment 7 (see also Appendix 5). In addition, participants completed the O-LIFE (Mason *et al.*, 1995), a multidimensional schizotypy inventory that includes the STA (Glaridge & Broks, 1984). The O-LIFE has been described in the method section of Experiment 1.

7.3.2 Results

7.3.2.1 Latent inhibition in a unidimensional analysis of schizotypy (STA)

condition x schizotypy level	*N*			Age	STA
	total	Male	female	mean (*SD*)	mean (*SD*)
Low STA					
PE	18	9	9	20.9 (*1.4*)	12.6 (*4.1*)
NPE	21	11	10	20.1 (*1.1*)	11.6 (*4.3*)
High STA					
PE	23	14	9	20.5 (*1.9*)	21.2 (*3.7*)
NPE	18	7	11	20.8 (*2.2*)	22.8 (*3.5*)

Table 7.1

Experiments 9 and 10. Descriptive statistics of age and STA scores, and number of participants by experimental condition (PE = preexposed condition; NPE = non-preexposed condition) and schizotypy level.

The scores on the STA scale ranged from 3 to 34 (mean = 16, median = 15.5, SD = 9.9). Participants were defined as low- (mean STA = 11.1, median = 12, SD = 4.1) or high-schizotypy scorers (mean STA = 21.9, median = 21,

SD = 3.7) on the basis of the normative STA scores for age and gender (Claridge, 1997) as described in Chapter 3. Characteristics of the sample in Experiment 9 (and Experiment 10) by experimental condition and schizotypy level, as well as number of participants per cell, are presented in Table 7.1.

In Figure 7.1 the mean number of correct responses is presented as a function of schizotypy level (high- versus low- STA) and condition (PE/preexposed versus NPE/ non preexposed) across four eight-trial blocks.

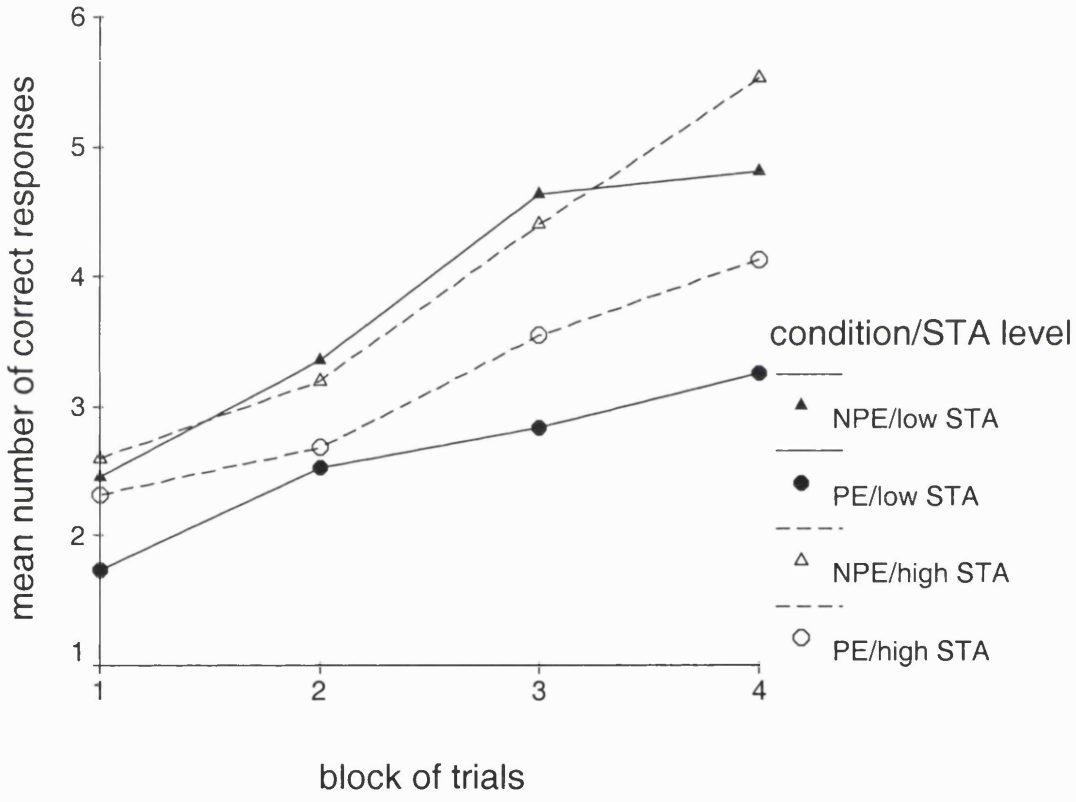


Figure 7.1

Experiment 9 (latent Inhibition). Accuracy as a function of target preexposure (condition) and schizotypy level (STA) across four blocks of trials.

Inspection of Figure 7.1 suggests that the overall mean number of correct responses was consistently lower for the PE than for the NPE condition. The difference, however, between PE and NPE condition appeared more pronounced for the low- than for the high-schizotypy scorers. These data

were analysed by a mixed-model ANOVA with 'condition' (PE versus NPE) and 'schizotypy' level (high- versus low-STA) as between-subject factors, and 'block' of trials as a within-subject factor. In terms of the between-subject effects, there was a statistically significant effect of 'condition', $F_{(1, 76)} = 8.22$, $p < .01$, but the neither the effect of 'schizotypy' nor the 'condition' x 'schizotypy' interaction were significant, $F < 1$. In terms of the within-subject effects, there was a significant effect of 'block', $F_{(3, 84)} = 94.5$, $p < .001$, and a marginally insignificant 'block' x 'condition' interaction, $F_{(3, 228)} = 2.48$, $p = .06$. No other interaction approximated statistical significance, Fs < 1.

The above analysis confirmed the presence of a latent inhibition effect, and that the overall performance was improved across the blocks of trials independently of the schizotypy level. The interaction between 'schizotypy' and 'condition' was not statistically significant. Visual inspection of these data, however, suggests that the pattern of results was in expected direction, as the difference between PE and NPE condition appeared smaller for the high- as compared to the low-schizotypy scorers. To investigate this pattern further, analyses were run for each schizotypy level separately.

For the low-schizotypy scorers, a mixed-model ANOVA with 'condition' and 'block' as factors was performed on the data. This analysis revealed a statistically significant effect of 'condition', $F_{(1, 38)} = 6.09$, $p < .05$, a significant effect of 'block', $F_{(3, 114)} = 20.51$, $p < .001$, and a marginally insignificant 'block' x 'condition' interaction, $F_{(3, 114)} = 2.56$, $p = .06$. For the high-schizotypy scorers, however, a similar ANOVA revealed that, although the effect of 'block' was significant, $F_{(3, 114)} = 19.92$, $p < .001$, the effect of 'condition', $F_{(1, 38)} = 2.39$, and the 'block' x 'condition' interaction, $F_{(3, 114)} =$

1.94, were not significant, *p*s > .10. The last of analyses confirmed that latent inhibition was found relative disrupted for the high-schizotypy scorers.

7.3.2.1 Latent inhibition in a multi-dimensional analysis of schizotypy (O-LIFE)

Table 7.2 presents the means, standard deviations, and inter-correlations between the O-LIFE scales. Although the means appear slightly elevated in the first three scales, the overall pattern was comparable to Experiments 1 and 2.

schizotypy scale	mean (*SD*)	1	2	3	4
1. '*Unusual Experiences*'	12.1 (*5.7*)	-			
2. '*Cognitive Disorganization*'	13.3 (*5.5*)	.39**	-		
3. '*Introvertive Anhedonia*'	6.4 (*4.6*)	.22*	.30**	-	
4. '*Impulsive Non-conformity*'	9.3 (*3.7*)	.51**	.26*	.13	-

Table 7.2

Experiments 9 and 10. Means and standard deviations of the scales of the Oxford-Liverpool Inventory of Feeling and Experiences (O-LIFE), and their inter-correlations.

The nature of this statistical analysis was exploratory, i.e. to identify the minimum number of schizotypy dimensions that could predict LI performance, rather than testing a specific hypothesis. The number of correct responses were collapsed across blocks of trials and were analysed by two multiple regression analyses (method: stepwise; entry criterion: *p of F* value < 0.05). Given the exploratory nature of this investigation, the 'stepwise' method of the

SPSS (version: 10.1) was employed, as recommended by Brace, Kemp and Snelgar (2000). Unlike the standard (simultaneous) multiple regression analysis were the researcher decides how many predictors to enter, and the hierarchical multiple regression were the researcher determines both the number and the order of the predictors (based on some theoretical considerations), in the stepwise multiple regression the number of predictors to be selected and the order of entry are both decided by statistical criteria (entry or removal criterion). The latter method is typically used to identify the minimum number of variables needed to predict a dependent variable, resulting in the most parsimonious model (Brace *et al.*, 2000).

In the first regression analysis, the mean number correct responses on the preexposed (experimental) condition were entered as a dependent variable, and the four O-LIFE scales were entered as predictor variables. One regression model was formed, $F_{(1, 40)} = 5.07$, $p < .05$, accounting for about 9% of the total variance (adjusted R^2). Only 'Unusual Experiences' was included as a significant independent predictor, $t = 2.25$, $\beta = .39$, $p < .05$, indicating that an average increase on this scale was associated with an increase in the number of correct responses in the preexposed condition. In terms of the 'excluded' variables (see Table 7.3), 'Introvertive Anhedonia' appeared to have a marginally significant individual contribution, $t = -1.99$, $\beta = -.33$, $p = .054$, suggesting that an average increase on this scale was associated with an average decrease in the number of correct responses in the preexposed condition. The independent contributions of 'Cognitive Disorganisation' and 'Impulsivity Non-conformity' scales were clearly not statistically significant, both ps < .30. A second regression analysis, with the

correct responses in the non-preexposed (control) as dependent variable, and the four O-LIFE scales as predictor variables, was then performed. The overall regression equation was not significant, $F < 1$, nor did any individual predictor approximate significance, all $ps < .30$.

Included variable	*Beta*	*t*	*p*
'Unusual Experiences'	.39	2.25	.030
Excluded variables			
'Cognitive Disorganization'	.03	.18	.852
'Introvertive Anhedonia'	-.33	-1.19	.054
'Impulsive Non-conformity'	.18	.93	.358

Table 7.3

Excluded and included predictor variables in the stepwise model. Independent variable = total number of correct responses in the PE condition.

As discussed in Chapter 2, the typical loss of latent inhibition in schizophrenia derives from an elevated performance on the preexposed condition. Therefore, the critical condition in the analysis of latent inhibition deficits is the preexposed condition. Indeed, the above set of regression analyses revealed that schizotypy was associated with the preexposed, but not the non-preexposed condition. However, the analyses suggested that the latent inhibition deficits stemmed from two independent sources: predominantly, from elevated performance ('*over-responding*') in the preexposed condition associated with positive schizotypy, and, at least to

some extent, from attenuated performance ('*under-responding*') in the preexposed condition associated with negative schizotypy.

7.4 Is the disruption of latent inhibition a result of enhanced stimulus salience?

Latent inhibition has defined as reduced conditioning responding to a stimulus following a repeated, non-reinforced preexposure (Lubow, 1989). According to a certain view (Lubow & Gewirtz, 1995), latent inhibition can promote attentional selection, as non-reinforced preexposure is thought to make a preexposed (PE) stimulus *irrelevant*, and, therefore, *less salient*, as compared to a newly appeared, potentially *relevant*, and, therefore, *more salient* non-preexposed (NPE) stimulus.

Nevertheless, what remains to be established is whether this relative loss of latent inhibition in schizophrenia (and schizotypy) is due to a tendency to treat any stimulus as relevant (*enhanced stimulus relevance*), or due to a tendency to experience any stimulus as salient (*enhanced stimulus salience*). A stimulus is typically considered relevant when it is designated as a target-stimulus, or signals a significant event within the context of an experimental task (acquired relevance). However, a stimulus is classified as salient when it possesses a feature that rapidly elicits an attentional response. Apart from stimulus intensity, attention is automatically captured by features such as biological significance and acquired relevance (Mackintosh, 1975), as well as novelty (Johnston & Hawley, 1994). In addition, the combination of categorical and perceptual target/distractor similarity is also a salient feature, as it rapidly captures attention during visual search (Treisman & Gelade,

1980). This latter effect has been termed as 'pop-out', because the participants report that the unique feature seems to 'pop out' from a display.

For instance, a visual target in a unique colour becomes perceptually salient, as it is tends to 'pop out' from a display of homogeneously coloured distractors (Carter, 1982; Gerhardstein, Renner & Rovee, 1999; Mounts, 2000). Despite uncertainties regarding whether an absence of latent inhibition in schizophrenia is related to an idiosyncratic response to the relevance of a preexposed stimulus in particular, or to its' salience in general, this latter type of pop-out effect has never been investigated in conjunction with latent inhibition within the schizophrenia spectrum.

Dopamine release specific to the nucleus accumbens, a cerebral structure of the limbic system that has been linked to the pathophysiology of schizophrenia and the disruption of latent inhibition (Gray, 1998, for a review), has been suggested to heighten sensory awareness, adding salience to the perceived stimuli (Gray, 1995). It is likely that such a mechanism could give rise to the heightened sensory experiences that are frequently reported by schizophrenic patients (e.g., Bunney *et al.*, 1999; Mass, 2000). This account does also correspond to the clinical observation that schizophrenic patients demonstrate a loss of their ability to segregate salient from non-salient aspects of the environment (Hemsley & Richardson, 1980). It is possible, therefore, that the disruption of latent inhibition (response rate to a preexposed stimulus elevated to the level of a non-preexposed stimulus) within schizophrenia spectrum could be due to a relatively increased responsiveness to the perceived stimuli, due to their increased perceptual salience. In line with this view, increased distractibility related to the physical

characteristics of a stimulus has been observed in schizophrenic patients (Lieb, Merklin, Rieth, Schuettler & Hess 1994; but see Carr, Dewis & Lewin, 1998), as well as in high psychotic-prone, non-clinical participants (Lieb, Denz, Hess, Schuettler, Kornhuber & Schreiber, 1996).

In Experiment 10, the participants who were previously took part in Experiment 9 (latent inhibition) were also tested in a visual pop-out task. Following past findings on the increased attentional salience of a uniquely coloured stimulus in a display of homogeneously coloured stimuli (Carter, 1982; Gerhardstein *et al.*, 1999; Mounts, 2000), three levels of target salience (high - medium - low) were produced. For the low schizotypy scorers, it was expected that the detection accuracy would follow the hierarchical pattern of the target salience across the three levels (i.e. high salience → high accuracy, medium salience → medium accuracy, low salience → low accuracy). However, for the high-schizotypy scorers two competing predictions were derived from different assumptions. If the disruption of latent inhibition were due to an experienced enhanced stimulus salience, then their performance would be less hierarchically differentiated across the salience levels, as compared to their low-schizotypy counterparts. Specifically, the source of such a non-differentiation would be expected to stem from elevated accuracy on the medium and low salience levels. Nevertheless, if disruption of latent inhibition were not due to a putative tendency to experience any stimulus as salient (enhanced stimulus salience), then it would be more likely that their performance across the three hierarchical levels of target salience would match that of their low-schizotypy counterparts.

7.5 Experiment 10

Experiment 10 employed a letter detection paradigm. This paradigm was developed according to the principles of the visual pop-out effect (Treisman & Gelade, 1980). According to the pop-out effect, a stimulus, when it possesses a unique feature (e.g. colour, orientation, shape etc), rapidly captures attention during visual search. For example, it is easier to detect the presence of a single horizontal line (target) in a display of vertical lines (not targets) than in a display of crosses (non-targets). In the former case, the target (horizontal line) becomes perceptually salient because it is characterised by a unique feature (orientation) as compared to the non-targets (vertical lines); in the latter case, both target (horizontal line) and non-targets (crosses) share a common feature, as a cross constitutes a combination of one vertical and one horizontal line (Treisman & Gelade, 1980). A unique colour can also elicit a visual pop-out effect: a target in a unique colour becomes perceptually salient in a display of homogeneously coloured distractors and detection accuracy seems to be a function of the relative uniqueness of the target colour (Carter, 1982; Gerhardstein *et al.*, 1999; Mounts, 2000). For example, it is easier to detect a single green stimulus (target) among red stimuli (non-targets) than among red and green stimuli (non-targets). Given that colour was used as a preexposed/non-preexposed stimulus in the latent inhibition experiment (Experiment 9), it was decided, for the sake of comparability between the two studies, to manipulate the target salience in the visual pop-out experiment (Experiment 10) through the relative uniqueness of the target colour. However, the two basic colours

employed in Experiment 10 (i.e. green and red) were different from those used in Experiment 9.

All the participants received very brief (75ms) displays of target and non-target letters of different salience levels, as manipulated by the relative uniqueness of the colour of the target stimulus (Carter, 1982; Gerhardstein *et al.*, 1999; Mounts, 2000). For the low schizotypy scorers, it was expected that the accuracy rate would follow the hierarchical pattern of the target salience across the three levels (i.e. high salience → high accuracy, medium salience → medium accuracy, low salience → low accuracy). For high schizotypy scorers, however, if they experienced any stimulus as salient (enhanced stimulus salience), it would be expected that their accuracy rate in the medium and low salience level would be relatively elevated to the level of high salience.

7.5.1 Method

7.5.1.1 Participants

Participants were the same as described in Experiment 9.

7.5.1.2 Stimuli and apparatus

The trials were projected tachistoscopically on a 14" screen TV/video set. Each trial always contained eight letters arranged in a clockwise display. The duration of each trial was 75 ms. Letters were capital 'F's, 'E's and 180° clockwise inverted mirror images of the letter 'F'. In terms of the letter size, each vertical line had a length of 3 cm and each horizontal line had a length of 1.5 cm. In terms of the arrangement, letters were situated in eight standard positions (45^0) in a circular arrangement around the centre of the screen,

which was indicated by a central fixation point (white dot). Each trial was followed by a 10 s inter-trial interval. During each interval, the letters disappeared, and the numbers (from 1 to 8) appeared on each of the above positions, providing backward masking. The digits were white, the background black, and each letter was either green or red, depending on the detection conditions.

7.5.1.3 Procedure

For all the participants, the letter 'E' was always the target. The letter 'F' and the 180° clockwise inverted mirror image of the letter 'F' were always the non-targets/distractors. These two types of distractors were designed so that, when overlapped, they would look like the letter 'E'. The salience of the target was manipulated through the uniqueness of the target's colour in each trial, as compared with the colour of the non-targets. The target trials fell into three levels of target salience (see Appendix 7).

In the high level of salience (target salient/ distractor non-salient), the target appeared in a colour different from the distractors. In half of the trials, the target was green among red distractors; in the rest the target was red among green distractors. In the medium level of salience (target non-salient/distractor non-salient), the target appeared in the same colour as the distractors. In half of the trials, the target was green among green distractors; in the rest the target was red among red distractors. In the low level of salience (target non-salient/distractor salient), the target appeared in the same colour as the distractors, but one of the distractors was in a different colour from the rest of the letters. In half of the trials, the target was green

among green distractors and one red distractor; in the rest the target was red among red distractors and one green distractor.

There were 16 trials in each of the above target salience levels. The target appeared twice in each of the eight positions. In addition to the 48 target trials, 48 non-target trials were included. Half of non-target trials were monochromatic (in half of them all non-targets were red, and in the other half all non-targets were green), and the rest were dichromatic (half of them consisted of one red and seven green non-targets, and the other half consisted of one green and seven red non-targets). The trials were randomised across and within conditions through a computer-generated random sequence.

The participants sat approximately 55 cm from the screen. Given the very brief duration (75msec) of each display, they were advised to maintain fixation at the centre of the screen (white dot), and to report "yes" when the target was present, and "no" when the target was absent. They were also informed that sometimes the target would be present and sometimes it would be absent. Number of correct responses (accuracy) in target-trials was the dependent measure.

7.5.2 Results

As in Experiment 9, for the sake of comparison between the two experiments, data were first analysed with a single measure of schizotypy (unidimensional analysis), and then with four scales tapping into different aspects of schizotypy (multidimensional analysis).

7.5.2.1 Visual pop-out in a unidimensional analysis of schizotypy (STA)

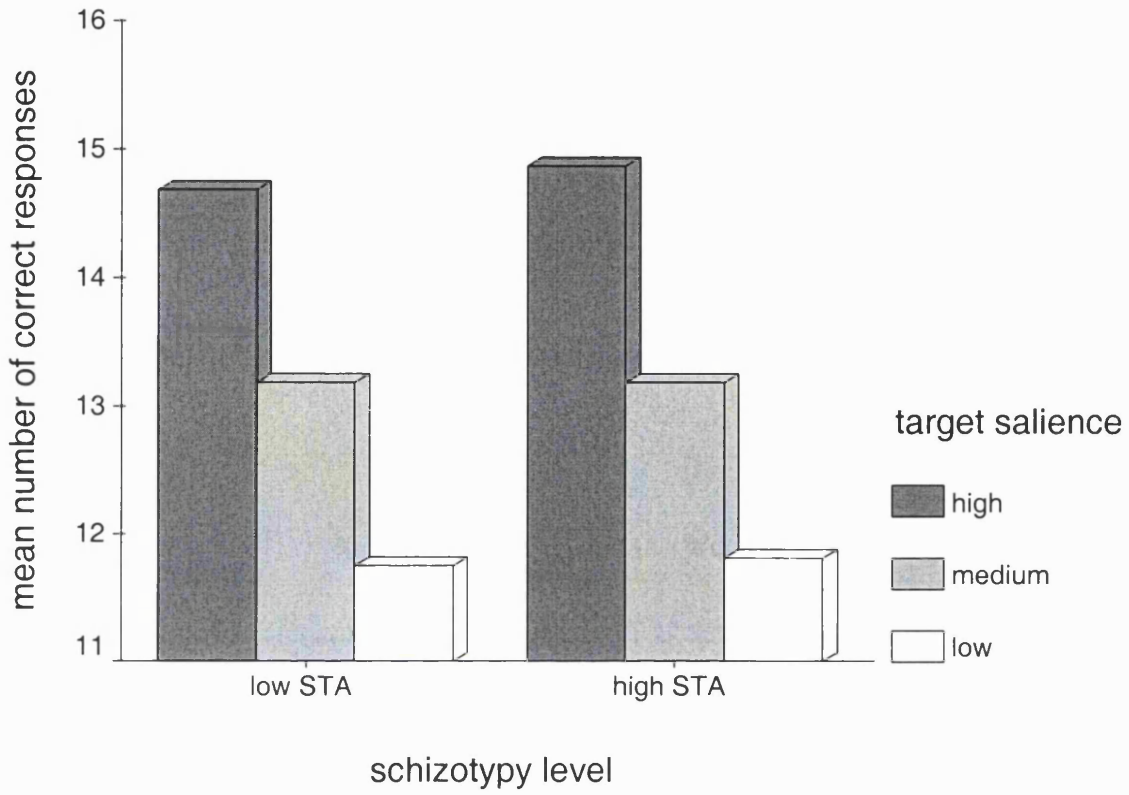


Figure 7.2

Experiment 10 (visual pop-out). Accuracy as a function of target salience and schizotypy level (STA). Levels of target salience: high (target salient/ distractor non-salient), medium (target non-salient/ distractor non-salient), and low (target non-salient/ distractor salient).

The schizotypy level of the participants was determined on the basis of STA in the way described in Experiment 9. Figure 7.2 presents accuracy as a function of salience level of the target and schizotypy level. Inspection of the data shows that performance varied hierarchically across the three levels of target salience. The accuracy rate reached its' highest level at the high salience level (the target was in a unique colour), was relatively lower at the medium salience level (the target shared the same colour with the distractors), with the lowest accuracy at the low salience level (one of the

distractors was in a unique colour). This pattern appeared the same for both high- and low-schizotypy scorers.

The data were analysed by a 2 x 3 mixed-model ANOVA with 'schizotypy' as between-subject factor and 'target salience' as within-subject factor. This analysis revealed a significant effect of 'target salience', $F_{(2,156)} = 32.4$, $p < .001$, but there was no significant effect of 'schizotypy', nor a significant 'target salience' x 'schizotypy' interaction, Fs < 1. Within-subject contrasts (repeated) confirmed that the accuracy was significantly higher in the 'high salience' level than in the 'medium salience' level, $F_{(1, 78)} = 30.2$, $p < .001$, and that it was significantly higher in the 'medium salience' level than in the 'low salience' level, $F_{(1, 78)} = 16.4$, $p < .001$.

Analysis was then run for each schizotypy level separately, as in Experiment 9. For the low-schizotypy scorers a repeated-measures ANOVA with 'target salience' as factor, showed a significant effect of 'target salience', $F_{(2, 78)} = 19.9$, $p < .001$. Within-subject contrasts (repeated) showed that the accuracy was significantly higher in the 'high salience' level than in the 'medium salience' level, $F_{(1, 39)} = 16.3$, $p < .001$, and that it was significantly higher in the 'medium salience' level than in the 'low salience' level, $F_{(1, 39)} = 10.2$, $p < .001$. For the high-schizotypy scorers a similar ANOVA, showed that the effect of 'target salience' was statistically significant, $F_{(2, 78)} = 12.7$, $p < .001$. Within-subject contrasts (repeated) revealed that the accuracy was significantly higher in the 'high salience' level than in the 'medium salience' level, $F_{(1, 39)} =$, 13.9, and that it was significantly higher in the 'medium salience' level than in the 'low salience' level, $F_{(1, 39)} = 6.3$, both ps < .001.

In line with past findings (Carter, 1982; Gerhardstein *et al.*, 1999; Mounts, 2000), the analysis confirmed that detection accuracy was higher when a target is in a unique colour in a display of homogeneously coloured distractors (high salience), than when both target and distractors were homogenously coloured (medium salience). Respectively, detection accuracy for the latter level of salience was higher than when one of the distractors was in a unique colour, and the target, as well as the rest of the distractors, were homogeneously coloured (low salience). However, this pattern of performance remained the same for both high- and low- schizotypy scorers, suggesting that participants in both groups did not respond differentially across the different salience levels of the target. This latter result does not support the view that high-schizotypy scorers tend to perceive any stimulus as salient (enhanced stimulus salience).

7.5.2.2 Visual pop-out in a multidimensional analysis of schizotypy

Three regression analyses were carried out (see pp. 166), one for each salience level separately. In every regression equation, the scorers on the four O-LIFE scales were entered as independent variables, and the number of correct responses as dependent variable. No equation reached significance, all Fs > 1, nor any of the individual predictors, all ps > .20. These negative results confirmed that performance on the visual pop-out task across different levels of perceptual salience were unrelated to any aspect of schizotypy, as assessed by the O-LIFE scales.

7.6 Discussion

7.6.1 Latent inhibition, visual pop-out and schizotypy

In the present investigation, high- and low- schizotypy scorers were tested in two different visual paradigms. In Experiment 9, latent inhibition was found intact in low-, but disrupted in high-schizotypy scorers, replicating past findings. In Experiment 10, the same participants were engaged in a letter detection task with three levels of target salience. The accuracy followed the level of attentional salience of the target, as predicted by the principles of the visual pop-out. However, the same pattern of performance was observed for both high- and low-schizotypy scorers.

These results do not support the view that high-schizotypy scorers tend to perceive every stimulus as salient, given that their performance was found hierarchically differentiated across the different levels of target salience, as in their low-schizotypy counterparts. Furthermore, the data do not support the hypothesis that latent inhibition is significantly reduced in high-schizotypy scorers due to the fact that both preexposed and non-preexposed stimuli are experienced as salient (enhanced stimulus salience). The latter findings seem in line with evidence from different visual search paradigms, that schizophrenic patients treat the various salience levels of a target stimulus the same way as controls (Carr *et al.*, 1998; Lubow *et al.*, 2000).

A possible methodological limitation of the present investigation is that the two experimental tasks were not matched in terms of their difficulty and reliability, and, therefore, in terms of their discriminatory power (Chapman & Chapman, 1973). Consequently, it could be argued that the latent inhibition task was psychometrically more "sensitive" to detect an existing difference

between high- and low-schizotypy groups, than the visual pop-out task. However, it should be noted that the task matching approach has been predominantly developed in order to eliminate artifactual differences stemming from a possible interaction of the task's discriminatory power and generalised performance deficits in schizophrenia (Miller, Chapman, Chapman & Collins, 1995). It has been argued that, as schizophrenic patients tend to perform worse than normal controls in almost any task (generalised performance deficits), they would show the greater performance deficit in the task of the higher discriminating power (Miller et al. 1995).

However, this argument could not apply to psychometrically defined, high-schizotypy scorers, as there is no evidence that non-clinical participants who score highly on measures of psychotic-proneness demonstrate generalised performance deficits. Additionally, there is no evidence that high schizotypy scorers show all the types of performance deficits that have been observed in schizophrenic patients. For example, despite the often-reported intellectual decline in schizophrenia (Bilder *et al.*, 1992; Gold *et al.*, 1999), non-clinical participants who score highly on various schizotypy measures, do not demonstrate a corresponding performance deficit on psychometrically standardised measures of general intelligence (Gooding *et al.*, 1999; Tsakanikos & Reed, 2003).

Furthermore, the task matching approach *per se* is not a problem-free psychometric remedy, as it has been criticised for introducing potential confounds (Knight & Silverstein, 2001; Strauss, 2001). For example, matching on the difficulty and reliability of the items can "unmatch" on the investigated domain by selecting items that might not be representative of the

to-be-investigated behaviour. The research strategy employed in the present investigation could be more appropriately described as a process-oriented approach (Knight & Silverstein, 2001), an alternative strategy designed to avoid the pitfalls of task matching. In line with the above approach, the enhanced stimulus salience hypothesis predicted a specific pattern of superior performance (rather than a performance deficit) for high-schizotypy scorers in the medium and the low level of salience in the visual pop-out task.

It could be claimed that the present results might question the assumption (often uncritically adopted in the clinical literature) that latent inhibition reflects an attentional mechanism, given that an associative account of latent inhibition cannot be excluded (e.g., Reed & Tsakanikos, 2002). However, such a conclusion would not be warranted, since there is still a possibility that a disruption of latent inhibition in high-schizotypy scorers could be due to the possibility that both preexposed and non-preexposed stimuli are experienced as potentially relevant (enhanced stimulus relevance).

In conclusion, the obtained findings did not support the hypothesis that the attentional distractibility in schizotypy was related a general tendency to treat any stimulus as salient on the basis of its physical characteristics (enhanced stimulus salience). Although latent inhibition was found to be disrupted in high-schizotypy scorers, no evidence for an enhanced stimulus salience, as assessed by a visual pop-out paradigm, was found for the same participants. Accuracy rate for both high- and low- schizotypy scorers followed the hierarchically differentiated pattern of the perceptual salience level of the target (high salience → high accuracy, medium salience→medium accuracy, low salience → low accuracy), failing to support the view that latent

inhibition is attenuated in high-schizotypy scorers because they tend to treat any stimulus as salient on the basis of physical characteristics.

7.6.2 Latent inhibition deficits in different schizotypy dimensions

Evidence of latent inhibition deficits was obtained both with STA and 'Unusual Experiences'. This was not surprising, given that about one-third of the items comprising the 'Unusual Experiences' scale have been supplied by the older STA. In addition, as it was shown in Experiments 1 and 2 (Chapter 3), an effect of schizotypy on performance (decision and perceptual biases) was demonstrated both with STA and 'Unusual Experiences'. The 'Unusual Experiences', however, seems like a more pure measure of positive schizotypy than STA, as all of its items correspond to positive psychotic symptoms, such as odd beliefs and aberrant experiences of perceptual nature. On the contrary, STA includes also items that refer to social anxiety and difficulties with concentration. Therefore, it could be argued that latent inhibition deficits in participants scoring highly on STA was be simply the result of elevated levels of anxiety, coupled with concentration problems. Nevertheless, the present results make this account less likely.

Latent inhibition deficits are typically due to elevated responding to a pre-exposed stimulus. This pattern of responding has been associated with the positive symptomatology in schizophrenia (Gray, 1998, for a review) and in positive schizotypy (Gray *et al.*, 2002) as assessed by the 'Unusual Experiences' scale of O-LIFE (Mason *et al.*, 1995). The results from Experiment 9 replicated the Gray *et al.* study (2002) in a different experimental paradigm. Increased responding to the preexposed stimulus

was primarily associated with the 'Unusual Experiences'. Nevertheless, a second source of latent inhibition deficits was also suggested. Unexpectedly, although the statistical significance was marginal, negative schizotypy ('Introvertive Anhedonia') was associated with lower responding to the preexposed stimulus. This was an unpredicted, novel finding.

With respect to the negative schizotypy, a clear comparison of the obtained results with the Braunstein-Bercovitz (2000) study is not feasible. The main obstacle for such a comparison is that Braunstein-Bercovitz (2000) did not report the precise direction (positive or negative) of the relationship between negative schizotypy and correct responses to the preexposed stimulus after the critical statistical analysis. Attenuated latent inhibition could be attributed to either elevated performance in the preexposed condition or relatively low performance in general. In addition, schizotypy was analysed as two factors derived from a principal component analysis of the 9 subscales of SPQ (Raine, 1991). In the Braunstein-Bercovitz (2000) study, negative schizotypy was a composite score on the subscales of 'Social Anxiety', 'Odd or Eccentric Behaviour', 'No Close Friends', 'Odd Speech', 'Constricted Affect', and 'Suspiciousness', making difficult a comparison with the 'Introvertive Anhedonia' which was employed a measure of negative schizotypy in this study.

Given that the typical attenuation of latent inhibition related to the positive symptomatology of schizophrenia, and positive schizotypy, is due to an increased performance in the preexposed condition, the fact that negative schizotypy tended to be associated with decreased performance in the preexposed condition may need a more careful consideration. One possible

explanation for this pattern relates to the intrinsic problem of the acquired stimulus properties after a repeated, non-reinforced preexposure. It is possible that non-reinforced preexposure (Phase I) makes a target *irrelevant*. Due to a putative distractibility (associated with the positive psychotic-like symptoms) participants scoring highly in positive schizotypy may sustain their attention to a preexposed stimulus in Phase I (preexposure phase: the stimulus is irrelevant) throughout Phase II (testing phase: the stimulus become relevant).

However, it is also important to point out that a degree of set shifting (shift learning) appears to be involved in the experimental procedure. Is equally plausible that, although non-reinforced preexposure (Phase I) may make a stimulus irrelevant, subsequent testing (Phase II) is making relevant a *previously* irrelevant stimulus (i.e. a *shift* in the status of the stimulus from Phase I to Phase II). Given that set shifting deficits have been associated with the negative symptomatology in schizophrenia (Berman, Viegner, Merson, Allan, Pappas & Green, 1997; Butler, Jenkins, Sprock & Braff, 1992; Voruganti, Heslegrave & Awad, 1997) participants scoring highly on the negative schizotypy might be less able to shift from the first (stimulus A → irrelevant) to the second (stimulus A → relevant) learned response. The relationship between set shifting and different schizotypy dimensions will be empirically investigated in the next chapter.

CHAPTER 8

Stimulus discrimination following set shifting in schizotypy

8.1 Introduction

A main argument for developing a new latent inhibition procedure was to assess the hypothesis that latent inhibition deficits might be the result of primary reversal/shift learning deficits (Chapter 4). This is important considering that most past latent inhibition paradigms have employed a target/distractor reversal from Phase I (preexposure) to Phase II (testing), and given the reported set-shifting deficits in schizophrenia (Crider, 1997; Oades, 1997). In the experiments reported in the previous chapters, a relative attenuation of latent inhibition was observed in high-schizotypy scores without employing a target/distractor reversal. These results suggested that the inclusion of such a reversal was not a necessary condition for latent inhibition deficits to be observed in high-schizotypy scorers.

The obtained data, however, did not exclude the possibility that reversal/shift learning deficits may contribute to latent inhibition deficits. In addition, in the last latent inhibition study (Chapter 7) it was shown that, although enhanced performance in the preexposed condition was associated with positive schizotypy, impaired performance in the same condition was associated with negative schizotypy. It was proposed that this might have been the result of the dual nature of the pre-exposed stimulus: firstly, as an *irrelevant* stimulus to elicit increased number of responses, due to an

increased distractibility associated with the positive symptomatology of schizophrenia; secondly, as a part of *set-shifting* (irrelevant in Phase I → relevant in Phase II) to elicit a decreased number of responses, due to set-shifting deficits associated with the negative symptomatology of schizophrenia and negative schizotypy.

The above account is largely based on the premise that set-shifting deficits are related to the negative schizotypy, akin to those seen in schizophrenia. Nevertheless, conflicting evidence in relevant literature (presented in the next section) in terms of whether such deficits are related to positive or negative schizotypy, coupled with certain methodological uncertainties, make this premise tentative, and, therefore, the above account becomes obscure. The next two studies will attempt to address these issues by testing the premise that set-shifting deficits are related to the negative schizotypy.

8.2 Shift learning deficits with the schizophrenia spectrum

Paradigms of learned inattention have been often used to investigate the nature of putative attentional deficits in schizophrenia (see Crider, 1997; Oades, 1997, for reviews), given that they can be employed in both humans and in non-humans. These paradigms study the influences of past associations on learning stimulus-response contingencies. In shift learning, or 'set shifting', for example, the participants initially learn that a stimulus A, but not a stimulus B (nor any other event), signals a significant event. Later on, the task requirement is reversed; the participants have to learn that it is now the stimulus B, and not the stimulus A (nor any other event) that exclusively

signals a significant event (Amsel, 1992). Shift learning has been found to be impaired in schizophrenic patients (Crider, 1997; Oades, 1997), and has been linked to the pathophysiology of schizophrenia (Jentsch & Taylor, 2001). Furthermore, there is evidence suggesting that, in non-humans, shift learning is related to latent inhibition (Chandra *et al.*, 2000; Ferguson *et al.*, 2001; Tsakanikos & Reed, 2000), which has established in the past decade as a widely employed non-human model of schizophrenia (Gray, 1998; Moser *et al.*, 2000).

The Winsonsin Card Sorting Task (WCST), a neuropsychological test associated with the function of the prefrontal cortex (see Lezak, 1995; Reitan & Wolfson, 1994, for reviews), has been widely employed to assess attentional set shifting in schizophrenia. On the behavioural level, the WCST can be construed as measure of shift learning *inter alia,* given than the participants are presented with a series of cards and are asked to identify through trial-and-error a sorting principle, which is then shifted (without warning, and after a certain performance criterion is met) several times. Nevertheless, WCST is a multifaceted, complex task that is thought to involve interplay of domains such as spatial working memory, planning, abstract thinking, problem solving and response inhibition (see Lezak, 1995), all of which are likely to be impaired at some extent within the schizophrenia spectrum.

Impaired performance on the WCST has been consistently associated with the severity of 'negative' symptoms (i.e. symptoms involving the 'absence' of normal functions) in schizophrenia, but not with 'positive' symptoms (i.e. symptoms involving the 'presence' of abnormal experiences,

such as hallucinations and delusions), in several investigations (e.g., Berman *et al.*, 1997; Butler *et al.*, 1992; Voruganti *et al.*, 1997), albeit not all (Abbruzzese, Ferri & Scarone, 1997, Collins, Remington, Coulter & Birkett, 1997; Franke, Maier, Hain & Klingler, 1992).

Furthermore, performance in the WCST has been found impaired in non-clinical participants who score highly on measures of schizotypy (e.g., Lenzenweger & Korfine, 1994; Poreh, Ross & Whitman, 1995; Suhr, 1997). However, there is some inconsistent evidence in this research area. According to some studies impaired performance in WCST has been exclusively associated with 'negative' schizotypy (Laurent, Duly, Murry, Foussard, Boccara, Mingat, Dalery & d'Amato, 2001), in some others with 'positive' schizotypy (Lenzenweger & Korfine, 1994; Poreh *et al.*, 1995; Suhr, 1997), while in some other with both 'negative' and 'positive' schizotypy (Gooding *et al.*, 2001; Tallent & Gooding, 1999). Therefore, one main aim of the present investigation was to assess shift learning in different schizotypy dimensions employing a paradigm other than the WCST.

WCST is made up of two sets of 64 different testing cards, containing all possible combination of colour (red, green, yellow or blue), shape (triangle, star, cross or circle), and number (1, 2, 3, or 4 coloured shapes). As a result of its complexity, the specificity of this task as a measure of shift learning remains controversial. The participants often get confused by the large number of different cards, and seem to have a difficulty in keeping in mind previous steps and relevant information needed to find a rule after a reversal (Barcelo & Knight, 2002). It has been suggested (Lezak, 1995) that most participants would be able to find the rule, if the problem-solving character of

this task was reduced. These controversial features of the WCST cast doubts on whether schizotypy scores in non-clinical participants are specifically associated with impaired performance on rule discrimination following a reversal shift. Consequently, it remains unclear whether an association between psychometrically defined schizotypy and impaired performance on the WCST could suggest that shift learning *per se* is a possible marker psychotic-proneness. Such an uncertainty could be moderated if non-clinical participants were assessed on psychometrically defined schizotypy, and were tested in less complex paradigm of reversal shift.

The aim of the next two studies was to develop a simple shift-learning paradigm (Experiment 11), assessing rule discrimination as a function of reversal shift and different dimensions of schizotypy in a sample of undergraduate students (Experiment 12). Given past conflicting evidence regarding different dimensions of schizotypy and WCST performance, the present investigation examined whether performance after a reversal shift would be associated with negative, positive or both negative and positive schizotypy.

8.3 Experiment 11

Experiment 11 was designed to assess initial compound stimulus discrimination and subsequent reversal shift in a within-participant experimental procedure. The procedure consisted of a computerised, rule-learning paradigm in which participants had to identify a rule through trial-and-error. The participants were presented with three simple geometrical shapes (A, B and C), in three possible positions on the computer screen (1, 2, and 3).

In Phase I (discrimination), one shape was randomly defined as a target shape (for example, shape C), and one position was randomly defined as target position (for example, position 1). The combination between the target shape and the target position was the to-be-found rule (i.e. the compound stimulus C2). In Phase II (reversal shift), the role of the target and some of the dictators were reversed. One shape of the previously defined distractors was assigned as target shape (for example, shape B), and one position of the previously defined distractors was assigned as target position, (for example, position 3), creating a new rule (i.e. the compound stimulus B1). An example of four successive trials can be found in Appendix 8. The dependent measure was the number of correct responses, a traditional index of learning. Based on the principles of shift learning (Amsel, 1992), the learning rate would expected to be slower after the target/distractor reversal (Phase II) than during the initial target/distractor discrimination (Phase I).

8.3.1 Method

8.3.1.1 Participants

Eighteen undergraduate students (10 males and 8 females) participated in Experiment 11. The average age was 20.6 years, ranging from 18 to 26 years. All the participants had normal or corrected-to-normal vision.

8.3.1.2 Stimull and apparatus

Three geometrical shapes were used as component stimuli (see Appendix 8): a circle with diameter 4 cm (shape A), an isosceles triangle with side 4.5 (shape B), and a 4 x 4 cm square (shape C). In addition, three positions across the centre of a PC monitor were used as component stimuli: left

(position 1), middle, (position 2) and right (position 3). Each position was 8.5 X 8.5 cm squared panel. The distance between each panel was 2.5cm. Every shape was black displayed on a white panel/position against a black background screen. The stimuli (Bitmap Image Files) were controlled by specially designed MS-DOS software, through which number of correct responses was also recorded.

8.3.1.3 Procedure

The participants were informed that are taking parting in a computerised rule-learning task and were seated in front of a PC in an individual cubicle. They were explained that they would be presented with three different shapes (A, B, and C) in three different positions (1, 2 and 3) and they would have to work out thought the feedback ("correct " or "wrong") what the rule was. Two responses on the keyboard were possible, choosing either the '*Y*' ('yes' - the rule is present") or the '*N*' key ('no' - the rule is not present). Immediately after each response, the stimuli disappeared, and the feedback appeared on the screen. The rule for each set of trials was a random combination of a certain shape (for example, shape C) and a certain position (for example, position 1) creating a certain rule (i.e. the compound stimulus C1).

The participants received two sets of 18 trials. In the first set of 18 trials, (Phase I /discrimination), they had to find out what the target compound was. In the second set of 18 trials (Phase II /reversal), the rule was reversed and the participants were explicitly told so. The current target compound was one of the previously non-target combinations and the previously target compound became a non-target compound. In both phases, there was no time limit and

the target compound was present at 50% of trials. The shape/position combinations were counterbalanced across participants. The number of correct responses was the dependent variable.

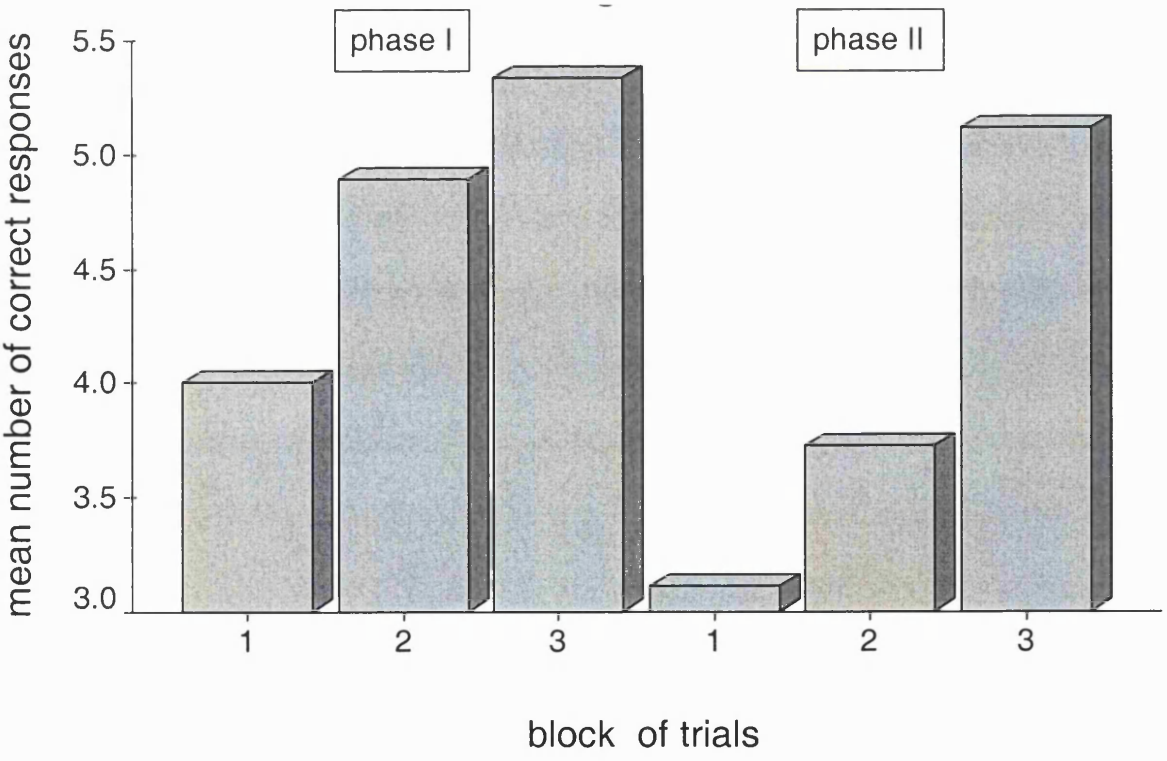
8.3.2 Results

In Figure 8.1 correct responses in the rule-learning task are presented as a function of learning phase (Phase I/discrimination versus Phase II/ reversal), and block of trials (six-trial blocks). In Phase I, the mean number of correct responses seemed to increase across blocks. In Phase II, correct responses appeared to drop at the beginning of this phase (block 1) when the rule was reversed, and then increased again across blocks 2 and 3. The overall performance in the Phase II, as compared to Phase I, appeared lowered, mainly in blocks 1 and 2.

These data were analysed by a 2 x 3 repeated-measures analysis of variance (ANOVA), with 'learning phase' (Phase I/ discrimination versus Phase II/ reversal) as a first within-subject factor, and 'block' of trials (block 1–3) as a second within-subject factor. The analysis revealed a statistically significant effect of 'learning phase', $F_{(1, 17)} = 5.29$, $p < .05$, and a significant effect of 'block', $F_{(2, 34)} = 31.39$, $p < .001$. The interaction between 'learning phase' and 'block' did not reach statistical significance, $F_{(2, 34)} = 2.59$, $p = .09$.

The above analysis confirmed that overall performance was improved across trials for each learning phase. Furthermore, according to the predictions, the learning rate during the reversal shift (Phase II) was significantly lower, as compared to the initial discrimination (Phase I). This pattern of results confirms the distinction between two types of learning in

Phase I and Phase II. If the two learning phases were of the same type, enhanced performance rather than impaired would be expected due to practice effects. Additionally, the obtained pattern of results is particularly interesting, as participants in the present rule-learning paradigm (unlike the WCST) were explicitly warned that the rule would change from Phase I to Phase II. Finally, accuracy level was rapidly increased across within few trials, suggesting that the present compound stimulus discrimination procedure was a relatively simple task. During the initial discrimination, accuracy reached 67% after the first 6 trials, 82% after 12 trials, and 88% at the end of the phase (Figure 8.1).



phase I - stimulus discrimination

phase II - reversal shift

Figure 8.1

Experiment 11. Mean number of correct responses as a function of learning phase (Phase I versus Phase II) and block of trials (three, six-trial blocks).

8.4 Experiment 12

Experiment 12 was designed to replicate Experiment 11, and to further assess compound stimulus discrimination as a function of reversal shift and psychotic-like traits in non-clinical participants. Given some inconsistencies in the past literature on the relationship between WCST performance and different schizotypy dimensions (e.g., Gooding *et al.*, 2001; Tallent & Gooding, 1999; but see, Laurent *et al.*, 2001), coupled with doubts about the specificity of the WCST (Barcelo & Knight, 2002; Lezak, 1995), the main aim of the present study was to assess shift learning in relation to different schizotypy dimensions. Given that reversal shift deficits has been associated with the negative symptoms of schizophrenia, it was expected that performance after a reversal shift would be negatively associated with negative schizotypy.

8.4.1 Method

8.4.1.1 Participants

Seventy-two undergraduate students (28 males and 44 females) participated in Experiment 11. The average age was 21.1 years, ranging from 18 to 28 years. All the participants had normal or corrected-to-normal vision, and none of them had taken part in Experiment 11.

8.4.1.2 Stimuli and apparatus

Were the same as described in Experiment 11 (see also Appendix 8).

8.4.1.3 Procedure

The basic experimental procedure was as described in Experiment 11. In addition, participants completed the Oxford-Liverpool Inventory for Feeling and Experiences (O-LIFE; Mason, Claridge & Jackson, 1995) described in previous chapters.

8.4.2 Results

8.4.2.1 Schizotypy scores

schizotypy scale	mean (*SD*)	1	2	3	4
1. '*Unusual Experiences*'	8.7 (*5.6*)	-			
2. '*Cognitive Disorganization*'	10.6 (*4.1*)	.39**	-		
3. '*Introvertive Anhedonia*'	3.6 (*3.4*)	.27*	.51**	-	
4. '*Impulsive Non-conformity*'	9.8 (*3.9*)	.48**	.14	-.01	-

* $p < .05$ (two-tailed); ** $p < .01$ (two-tailed)

Table 8.1.

Means and standard deviations of the scales of the Oxford-Liverpool Inventory of Feeling and Experiences (O-LIFE), and their inter-correlations.

Table 8.1 shows the means, standard deviations, and inter-correlations between the O-LIFE scales. The descriptive statistics and the pattern of inter-correlations were comparable to those reported in the previous studies of the thesis.

8.4.2.2 Compound stimulus discrimination

Figure 8.2 presents mean number of correct responses in Experiment 12 as a function of learning phase (Phase I/discrimination versus Phase II/ reversal), and block of trials (six-trial blocks). A first visual inspection of Figure 8.2 suggested that the pattern of results was comparable to that in Experiment 11 (Figure 8.1). In Phase I, performance appeared to increase gradually across the trials. In Phase II, performance initially dropped when the rule was reversed (block 1), but then gradually increased across trials. The overall performance in Phase II appeared lower than in Phase I, especially in blocks 1 and 2.

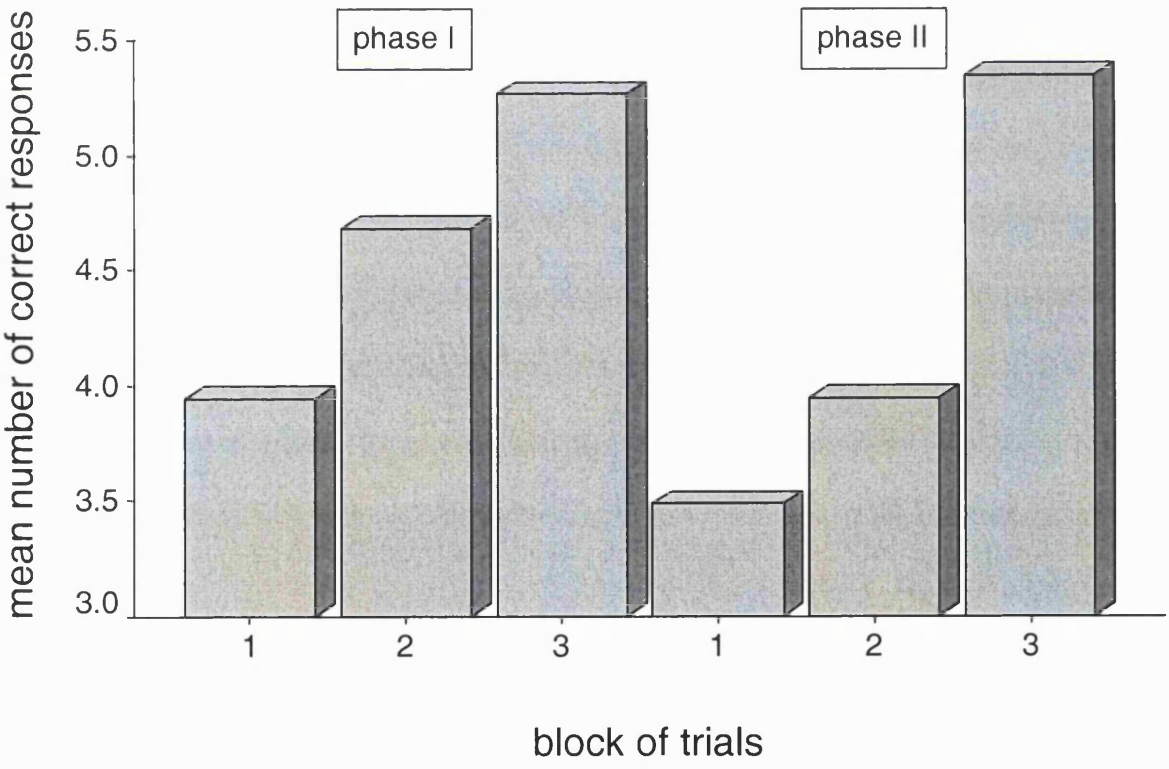


Figure 8.2

Experiment 12. Mean number of correct responses as a function of learning phase (Phase I versus Phase II) and block of trials (three, six-trial blocks).

These data were analysed by a 2 x 3 repeated-measures ANOVA, with 'learning phase' (Phase I versus Phase II) and 'block' of trials (1 - 3) as within-subject factors. The analysis revealed a statistically significant effect of 'learning phase', $F_{(1, 71)} = 5.26$, $p < .05$, 'block', $F_{(2, 142)} = 102.11$, $p < .001$, and an interaction between 'learning phase' and 'block', $F_{(2, 142)} = 5.16$, $p < .01$. Repeated-measures *t*-tests (two-tailed) showed that the mean number of correct responses was significantly lower in block 1 of Phase II than in block 1 of Phase I, $t_{(71)} = 2.89$, and that that mean number of correct responses was significantly lower in block 2 of Phase II than in block 2 of Phase I, $t_{(71)} = 2.63$, both *p*s < .05 following a bonferroni correction. There was, however, no statistically significant difference between block 3 of Phase I and block 3 of Phase II, $t < 1$.

The above analyses confirmed that performance was significantly improved across trials for each learning phase separately. As in Experiment 11, when the rule was reversed, the learning rate became significantly lower in Phase II than in Phase I. The 'learning phase' X 'block' interaction was significant in Experiment 2, however, this interaction only approximated, but did not reach statistical significance in Experiment 1. This partial discrepancy could be attributed to increased statistical power in Experiment 2 (N=72) due to its larger sample size, as compared to Experiment 1 (N=18). Overall, the above results suggested that reversing the initial rule of Phase I, had a detrimental effect on learning rate during the Phase II, especially during the early and middle stage (block 1 and 2) of this phase.

8.4.2.3 Compound stimulus discrimination and schizotypy scores

To investigate whether scorers on different schizotypy measures could predict performance impairment on discrimination and reversal learning, and to control for their inter-correlations, multiple regression analyses were performed (method: enter; SPSS 10.1). The mean number of correct responses were collapsed across trials for each phase. In all subsequent analyses, the schizotypy measures were entered as predictor variables with the mean number of correct responses as the dependent variable.

Predictor Variable	*B*	*SEB*	*Beta*	*t*
'Unusual Experiences'	-.05	.06	-.11	-.81
'Cognitive Disorganization'	.00	.07	.00	.08
'Introvertive Anhedonia'	-.28	.09	-.34	-2.75**
'Impulsive Non-conformity'	-.17	.08	-.26	-2.11*

* $p < .05$* (two-tailed), ** $p < .01$ (two-tailed)

Table 8.2
Experiment 12. The O-LIFE scales as predictor variables for the number of correct words in Phase II (reversal).

For Phase I (discrimination), the overall regression equation failed to reach statistical significance, $F < 1$, as did all individual predictor, smallest $p > .30$. For Phase II (reversal), the regression equation was statistically significant, $F_{(4,67)} = 5.29$, $p < .001$, accounting for about 19% of the total variance (adjusted R^2). However, only the negative schizotypy ('Introvertive

Anhedonia'), $\beta = -.34$, $t = -2.75$, $p < .01$, and the impulsive aspect of schizotypy ('Impulsivity Non-conformity'), $\beta = -.26$, $t = -2.11$, $p < .05$, were retained as significant predictors (see Table 8.2). The regression slopes for all the predictors were negative, indicating that an average increase in each of them was associated with a decrease in the dependent variable.

Predictor Variable	*B*	*SEB*	*Beta*	*t*
'Unusual Experiences'	.00	.02	.00	.02
'Cognitive Disorganization'	-.02	.02	-.13	-.95
'Introvertive Anhedonia'	-.03	.03	-.15	-1.14
'Impulsive Non-conformity'	-.06	.03	-.29	-2.27*

* $p < .05$ (two-tailed)

Table 8.3

Experiment 12. The O-LIFE scales as predictor variables for the number of correct words in Block 1 (Phase II).

Given that the obtained 'block' x 'learning phase' interaction (see previous section) suggested that the reversal of the rule had a detrimental effect on learning rate during block 1 and 2 of Phase II, separate regression analyses were then performed for these blocks. For block 1, the regression equation was significant, $F_{(4,67)} = 3.10$, $p < .05$, accounting for about 10% of the variance (adjusted R^2), but only 'Impulsivity Non-conformity' made a significant contribution, $\beta = -.30$, $t = -2.27$, $p < .05$ (see Table 8.3). For block 2, the overall regression equation was significant, $F_{(4,67)} = 3.09$, $p < .05$, accounting for about 11% of the variance (adjusted R^2). However, only 'Anhedonia' made

a significant independent contribution, $\beta = -.33$, $t = -2.45$, $p < .05$ (see Table 8.4).

Predictor Variable	*B*	*SEB*	*Beta*	*t*
'Unusual Experiences'	-.06	.04	-.19	-1.36
'Cognitive Disorganization'	-.05	.05	.15	1.13
'Introvertive Anhedonia'	-.16	.07	-.32	-2.45*
'Impulsive Non-conformity'	-.05	.06	-.11	-.91

* $p < .01$ (two-tailed)

Table 8.4
Experiment 12. The O-LIFE scales as predictor variables for the number of correct words in Block 2 of Phase II.

Overall, the above set of regression analyses revealed that schizotypy scores were associated with an impaired performance during reversal shift, but not during the initial discrimination. Specifically, the impulsive aspect of schizotypy ('Impulsivity Non-conformity') was a significant predictor at the early stage of reversal learning, while negative schizotypy ('Introvertive Anhedonia') was a significant predictor of performance decrement at the next stage of the same phase. This latter pattern of results suggests that different schizotypy dimensions may contribute differentially in successive stages of learning.

8.5 Discussion

In Experiment 11, a simple discrimination learning procedure involving reversal shift was introduced. In Experiment 12, the results of Experiment 11 were replicated, and it was additionally shown that performance impairment following reversal shift was associated with certain dimensions of schizotypy. Performance impairment was associated with the negative (Introvertive Anhedonia) and the impulsive (Impulsivity Non-conformity) dimension of schizotypy, but not with the positive (Unusual Experiences) nor with the disorganised (Cognitive Disorganisation) dimension. None of the schizotypy measures was associated with performance on discrimination learning before the reversal shift.

The above results suggest that reversal shift, as assessed by compound stimulus discrimination, was associated with negative, but not with positive schizotypy. In view of the fact that reversal shift has never been investigated in conjunction with schizotypy in a task other than the WCST, a comparison between the present and past results is not straightforward. It should be noted, however, that the above results are in concurrence with some past schizotypy studies (e.g., Laurent *et al.*, 2001) that have employed the WCST. It seems also consistent with evidence that shift learning, as assessed by the WCST, is primarily related to the severity of negative symptoms in schizophrenic patient (e.g., Berman *et al.*, 1997; Butler *et al.*, 1992; Voruganti *et al.*, 1997).

The obtained pattern of results did not fully replicate past findings that shift learning, as assessed by the WCST, is associated with both negative and

positive schizotypy (Gooding *et al.*, 2001; Tallent & Gooding, 1999). A possible reason for this discrepancy could be due to fact that in the latter studies extreme schizotypy scorers were selected from a larger sample of non-clinical participants, and schizotypy has been treated as a categorical variable. In addition, these extreme scorers were tested on the WCST, a complex task that is likely to involve a number of different processes associated with both types of schizotypy. On the contrary, in the present investigation schizotypy was treated as a continuous variable, testing a single sample of undergraduate students in a less complex paradigm of reversal shift, and assessing their performance in relation to their scores on different schizotypy scores. These methodological differences might have accounted for this partial discrepancy between the present and past investigations (Gooding *et al.*, 2001; Tallent & Gooding, 1999).

One main argument for developing a new paradigm of shift learning was that the WCST is a multi-factor task, which is likely to involve many different processes (spatial working memory, planning, abstract thinking, problem solving and response inhibition; Lezak, 1995), reducing the task's specificity as a measure of shift learning. It could be argued, however, that the present compound stimulus discrimination procedure could involve similar confounding factors. Although this is a plausible criticism, the main aim of the present investigation was to develop a less complex paradigm of shift learning, making less likely, albeit not completely excluding, the potential involvement of other processes.

In the present paradigm a single shift learning was employed, and the participants were warned about this reversal. In contrast, multiple successive

reversals are employed in the WCST, and the participants are not informed about the reversals. Furthermore, the stimuli in the present paradigm were a combination of shape (triangle, circle or square,) and position (left, middle or left). In contrast, each card-stimulus of the WCST is a combination of shape (triangle, circle, star or cross), of colour (red, green, yellow or blue), and number (1, 2, 3, or 4 coloured shapes). Consequently, the present discrimination learning procedure is a comparatively less complex task than the WCST, and, therefore, less prone to possible confounds such as problem solving and memory capacity.

In summary, the present investigation showed in a compound stimulus (position/shape) discrimination paradigm that performance deficit after a single reversal shift was exclusively associated with the negative and impulsive dimension of schizotypy in a sample of undergraduate students, suggesting that shift learning might constitute a marker for psychotic-proneness. Furthermore, separate analyses on different block of trials following a shift learning showed that performance deficit was initially (block1) associated with impulsivity, but later on (block 2) with negative schizotypy suggesting that psychotic-like personality traits contribute differentially to performance deficits across successive stages of learning.

The obtained pattern of results support the premise that negative schizotypy is associated with a set shifting deficits, akin to these seen in the negative symptomatology of schizophrenia. Given that a preexposed stimulus in any latent inhibition paradigm inevitably involves a shift from Phase I (the stimulus is irrelevant; no significant event is predicted) to Phase II (the stimulus is relevant; a significant event is predicted), the obtained results may

explain why a measure of negative schizotypy ('Introvertive Anhedonia') was associated with impaired performance in the preexposed condition in the last latent inhibition study (see Chapter 7). Taken together, the results support the proposition that the dual nature of a preexposed stimulus relates differentially to different schizotypy dimensions: as an *irrelevant* stimulus to elicit a increased number of responses, due to an increased distractibility in positive schizotypy; as a part of *set-shifting* (irrelevant in Phase I → relevant in Phase II) to elicit a decreased number of responses, due to set-shifting deficits in negative schizotypy.

CHAPTER 9

Conclusions

9.1 Introduction

This thesis investigated specific aspects of putative cognitive irregularities in non-clinical participants who tend to report a relatively increased number of psychotic-like experiences (i.e. high-schizotypy scores), as compared to participants that report less experiences of this nature (i.e. low-schizotypy scorers). A personality-based approach to experimental psychopathology was adopted in the present thesis. This strategy, apart from avoiding potential confounding problems (e.g., medication, generalized deficits, distraction caused by active symptoms) often inherent in schizophrenia research, can also evaluate potential marker-deficits of schizophrenia. As discussed in the literature review (Chapter 1), accumulating evidence in the last 20 years indicates that high-schizotypy scorers tend to demonstrate a pattern of performance akin to that seen in individuals with schizophrenia over a range of attentional and learning tasks said to be sensitive in detecting cognitive irregularities. The assumption that certain cognitive irregularities seen in schizophrenia and in schizotypy may contribute to the maintenance (and possible to the genesis) of psychotic and psychotic-like experiences, continues to motivate a large amount of research (see Chapter 1).

Even if all the biological/structural factors that contribute to a fully-fledged psychosis were completely understood, the need for a functional level of explanation of the psychotic symptomatology would be still warranted. A purely biological explanation would be incomplete without an account of certain underlying functions linked to a corresponding overt behavioural manifestation. Although most investigators tend to agree on the multi-factor nature of psychotic etiology, attentional irregularities in schizophrenia (Chapter 1), often regarded as evidence of a core attentional deficit, have been taken as a starting points in the development of cognitive accounts of the psychotic symptoms (e.g. , Hemsley, 1987; 1993; Frith, 1979; 1987).

Converging evidence from behavioural, psychopharmacological and physiological level of investigation over the last decade has suggested that the phenomenon of latent inhibition has the potential to illuminate our understanding of psychosis by elucidating the nature of putative cognitive mechanisms underlying the psychotic symptoms (e.g., Gray 1998). Although different lines of evidence have suggested a link between latent inhibition and schizophrenia, the interpretation of this relationship remains elusive for a number of reasons. First, the theoretical basis of latent inhibition is still equivocal. For example, it remains unclear whether the disruption of latent inhibition reflects attentional (Braunstein-Bercovitz & Lubow, 1998) or associative deficits (Escobar *et al.,* 2002). Second, the basic latent inhibition effect has been investigated mostly in non-humans. However, given that latent inhibition is currently employed as an animal model of schizophrenia (Moser *et*

al., 2000; Weiner *et al.*, 2000), the assumption that human and non-human latent inhibition paradigms are equivalent phenomena needs further experimental and theoretical support. Third, it is possible that the human latent inhibition paradigms have created conditions vulnerable to methodological problems. Consequently, results obtained with these paradigms are open to multiple interpretations. The studies presented in the preceding chapters were designed to address some of the above issues. This concluding chapter discusses the main experimental findings presented in the thesis, and makes some suggestions for future research.

9.2 Cognitive biases as a function of psychotic-like traits: implications

In a preliminary step of the investigation (Chapter 3), prior to the development of a novel visual-based latent inhibition paradigm, visual search was tested as function of the schizotypy level of the participants. The task involved a relatively difficult visual search of fast moving words. In both experiments (Experiment 1 & 2), accuracy was not related to schizotypy. This result suggested that high-schizotypy scorers did not differ from their low-schizotypy counterparts in their ability to detect fast moving words. However, participants scoring highly on two measures of positive schizotypy (O-LIFE & STA) tended to report the presence of words that were not there. It was found that high-schizotypy scores were more prone towards believing that an event of a certain type (i.e. a word) was present in the absence of such an event, when the task required a yes/no response (Experiment 1). In addition, they tended to give

detailed descriptions of never-presented events, when the task required a simultaneous description of every perceived event (Experiment 2).

These data provide an additional validation of the psychometric scales employed, supporting the notion of the continuity of psychotic-like experiences (Claridge & Broks, 1984; Eysenck & Eysenck, 1975). Participants that reported a high incidence of hallucinatory and delusional-like experiences when processing visual information, tended to demonstrate decision biases similar to those linked to the positive symptomatology schizophrenia (see Garety *et al.*, 2001, for a review). Given that undergraduate students, rather than clinical participants, were employed in these studies, the observed decision biases cannot be easily attributed to the presence of active, clinically significant symptomatology. If anything, the results suggest that information processing biases may be a main cognitive mechanism underlying behavioural dispositions that can be psychometrically classified as 'positive schizotypy'.

It has been proposed (Garety *et al.*, 2001) that information-processing biases constitute one potential factor, among others, that contributes to the maintenance of the positive symptoms in schizophrenia. On the basis of the data in Chapter 3, the same proposal could be extended to positive schizotypy. In addition, the fact that cognitive biases were predicted by a hypothetical, psychometrically defined disposition to positive symptomatology (positive schizotypy), rather than clinically significant symptoms, suggests that such biases might contribute in the early formation of these behavioural manifestations. For example, an increased cognitive readiness to 'see' events,

as well as to 'see' relationships between unrelated events under perceptually ambiguous situations might contribute to the formation of hallucinatory and delusional-like experiences in non-clinical population.

The fact that cognitive biases were obtained in Experiment 1 and 2 during processing of *visual* information deserves further consideration. In Chapter 3, it was proposed that such a type of bias could serve as an experimental model of hallucinations, facilitating laboratory investigation of unusual perceptual experiences in non-clinical population. Such an experimental analogue of hallucinatory experiences could be developed in the same way, for example, as the delayed auditory feedback has been employed in the investigation of the cognitive underpinnings of stuttering, as well as the development of therapeutic techniques (e.g., Howell, 1990). It should be pointed that previous studies that have revealed a type of detection bias in schizophrenic patients and non-clinical participants (Bentall & Slade, 1985; Rankin & O' Carroll, 1995), unlike Experiments 1 and 2 of the present thesis, employed auditory stimuli. This methodological choice has been typically based on the fact the auditory hallucinations are the most common type of hallucination in schizophrenia. Therefore, the obtained type of cognitive bias during visual search of fast moving words (Experiments 1 and 2) suggests that the bias to 'see' words that never appeared is the result of a supra-modality mechanism, rather than a modality-specific effect.

A comparative evaluation of the present data (Experiments 1 and 2) with past evidence (Bentall & Slade, 1985; Rankin & O' Carroll, 1995) suggests that

a putative supra-modality mechanism (responsible for a biased detection) is present during information processing of any type (visual, auditory etc) under conditions of perceptual ambiguity. Such a supra-modality mechanism might constitute a biased *attributional process*, activated when dealing with an ambiguous situation. For example, it has been proposed (Garety *et al.*, 2001) that a main attribution bias contributing to the formation and maintenance of the psychotic symptomatology relates to the *externality hypothesis*.

According to this proposal (Garety *et al.*, 2001), basic cognitive disturbances lead to anomalous conscious experiences at the onset (e.g., Hemsley, 1987; 1993; Frith, 1979; 1987), such as heightened perceptions and thoughts experienced as voices. Such experiences are typically confusing, bear an emotional significance, and trigger a search for explanation when they are experienced for the first time. For example, an experienced 'voice' with critical and threatening content, can be perceived as a familiar, self-generated cognition (rejection of the externality hypothesis). By rejecting the externality hypothesis, it is more likely for someone to accept the possibility that the experienced 'voice' is an internally generated event rather that an externally generated voice. Rejection of externality can in this way serve as a self-corrective mechanism. On the contrary, if the experienced 'voice' is perceived as the result of an external agent (acceptance of the externality hypothesis) the initial anomalous experience can be then transformed into psychotic symptom (Garety *et al.*, 2001).

The data from Experiments 1 and 2 may be interpreted as evidence of a bias to accept the externality hypothesis (Garety *et al.*, 2001) in participants scoring highly on positive schizotypy. Although the externality hypothesis has been put forward to explain fully-blown psychotic symptoms, it seems plausibly applicable to psychotic-like features in non-clinical participants. At an early stage, simultaneous presentation of fast moving non-words may have generated past associations and verbal representations of corresponding words on their basis of some superficial similarity. For example, a fast moving presentation of the non-word 'ZBRW' may generate representations of the word 'ZEBRA'. Such an experience could be interpreted either as an internally generated event ("I thought I saw the word 'ZEBRA' but it was not actually there" – rejection of the externality hypothesis) or as an externally generated event ("I saw the word 'ZEBRA" – acceptance of the externality hypothesis). Future research should be explore further the possibility that the tendency to 'see' words is a result of a bias to accept the externality hypothesis, as a one factor (among others) contributing to positive psychotic symptoms and, as it is suggested in this thesis, psychotic-like experiences in non-clinical participants.

9.3 The role of the masked preexposure in latent inhibition deficits

As it has been discussed in Chapter 2, with the exception of electrodermal conditioning[3] (e.g., Lipp *et al.*, 1994), most latent inhibition paradigms have

[3] Data from electrodermal conditioning studies need to be interpreted cautiously, as they may reflect habituation of electrodermal responding to a preexposed stimulus.

demonstrated a disruption of latent inhibition in schizophrenia and schizotypy after a masked preexposed, that is, participants are engaged in some irrelevant task (for example, syllables counting) while the stimulus is pre-exposed. The requirement of masked preexposure has been the subject of recent criticism for different theoretical reasons (e.g., Corr, 2003; Graham & McLaren, 1998).

However, although the properties of masking task seem to modulate the disruption of latent inhibition (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), a review of the evidence suggests that the presence of a masking task *per se* is not a necessary requirement for the demonstration of such latent inhibition deficits when procedures other than instrumental learning paradigms are employed (Lipp *et al.*, 1994; Lubow *et al.*, 2000; Lubow *et al.*, 2002). Consistent with the above evidence, the studies reported in the present thesis showed that latent inhibition was found relatively disrupted in high-schizotypy scorers under two masking conditions: without a explicit masking task (Experiments 4, 5 and 6), and after their engagement with an explicit (i.e. speed-judgment) masking task (Experiments 7 and 9).

Although the obtained results support the argument that an explicit masking task *per se* cannot account for the latent inhibition deficit, it was hypothesized that the experimental design of the early latent inhibition studies (Experiments 3–5) inadvertently introduced an *implicit* masking task. Consequently, a distinction between *implicit* and *explicit* masking task was proposed in the thesis. If the role of the explicit masking task is to divert

attention from the preexposed stimulus, in order to avoid demand characteristics (Orne, 1962), as it has been suggested (Lubow & Gewirtz, 1995), then any aspect of the experimental design serving to divert attention during the preexposure phase from the preexposed stimulus might function as an implicit masking task. The above argument could be extended to most existing latent inhibition paradigms. It could be argued that even studies that did not employed an explicit making task (Lubow *et al.*, 2000; Lubow *et al.*, 2002), may have still employed a implicit masking task (according to this proposed 'explicit/implicit' distinction), as the experimental design of these paradigms appear to divert attention from the preexposed stimulus during the preexposure phase.

In the presently employed latent inhibition procedure, participant were asked to look for words appearing in four fast moving blocks, simultaneously looming from each quadrant of the computer screen. Consequently, despite the absence of an explicit masking task, it could be argued that this procedural diversion of attention from the colour of the blocks served as an implicit masking task. Given that an increase in the difficulty level of the masking task has been associated with a reversed schizotypy/latent inhibition pattern, that is, attenuated latent inhibition in low- but not in high-schizotypy scorers (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), it was attempted to increase the difficulty level of this implicit masking in by group testing (e.g., Malik & Batra, 1997; Nagar & Pandley, 1987). It was shown that latent inhibition was found to be disrupted for high-schizotypy

scorers as compared to their low-schizotypy counterparts under conditions of individual testing (Experiment 5), this pattern seemed to be relatively reversed under conditions of group testing (Experiment 6).

More recently, in a study carried out in our laboratory, a reversed schizotypy/latent inhibition pattern was obtained after increasing the difficulty level of the speed-judgment by asking the participants to make difficult successive speed discriminations (1 frame/second). The accuracy rate of this speed-judgment approximated chance level, attesting to the proposal that a masking task of high difficulty is able to disrupt latent inhibition in low-schizotypy scorers, but not in the high-schizotypy counterparts. This reversal of the typical schizotypy/latent inhibition pattern after increasing the difficulty level of the masking task has been interpreted as evidence of the attentional distractibility in schizotypy (Lubow & Gewirtz, 1995): after the increase in the sources of distraction, high-schizotypy scores are prevented from maintaining their attention to the preexposed stimulus, consequently latent inhibition develops normally. It should be noted that associative accounts cannot easily explain this reversed pattern.

If it is accepted that the presence of latent inhibition is an index of efficiency of the attentional system (i.e. efficiently screening out irrelevant stimulation avoiding information overload), and that the absence/attenuation of latent inhibition results from a defective attentional selection, then the reversed schizotypy/latent inhibition pattern may be viewed as an instance of a 'restored' attentional selection in high-schizotypy scorers. Conditions that increase the

sources of attentional distraction (e.g., difficulty level of the masking task, crowded conditions etc) may paradoxically 'normalize' attention in high-schizotypy scores. This possibility may worth investigating in clinical participants as well, after including appropriate control measures for individual differences. Correspondingly, a number of compounds with anti-psychotic properties seem to 'reverse' an amphetamine-induced disruption of latent inhibition (e.g., Moser *et al.*, 2000). Although it is possible that different factors might independently restore a disruption of latent inhibition, future research could investigate whether amphetamine-induced disruption of latent inhibition could be reversed after an increased in the sources of distraction introduced by the masking task (masking load). If disrupted latent inhibition in schizophrenia reflects a failure of a central mechanism to inhibit irrelevant information (resulting in anomalous experiences), any factor (such as the masking load) that may be responsible for a restoration of latent inhibition, could potentially function as a corrective cognitive mechanism. For example, a further possibility for future investigation would be to examine the effect of different levels of environmental distraction on the intensity and frequency of specific psychotic symptoms. The outcome of such an investigation could contribute to the design of novel cognitive-behavioural interventions targeting the positive symptomatology in schizophrenia.

9.4 Evaluating the evidence for memory and attentional-based explanations of latent inhibition deficits

The review of the latent inhibition literature (Chapter 2) suggests relative agreement that the phenomenon is involved in stimulus selection. It is often assumed that such a stimulus selection occurs by degrading the future associability of repeatedly presented events, not linked to an important event. However, the theoretical basis of the phenomenon *per se* remains debatable, as latent inhibition could be either the result of deficient acquisition or retrieval of past associations (i.e. that stimulus leads to nothing) or deficient attentional selection (i.e. fail to ignore the irrelevant preexposed stimulus).

Consistent with memory-based explanations of latent inhibition, the attenuation of latent inhibition might occur as a result of insufficient memory storage of the amount of pre-exposure of the target. Latent inhibition appears to be a function of the amount of the target preexposure, as latent inhibition has been attenuated when fewer target presentations were used (e.g., Allan *et al.*, 1995; De la Casa & Lubow, 1996). Consequently, it could be argued that subtle short-memory deficits in high-schizotypy scorers (Lenzenweger, 2000; Tallent & Gooding, 1999) may actually 'reduce' the effectiveness of the amount of stimulus pre-exposure (due to a failure to store or retrieve information related to the amount of contact with target) resulting in attenuation of latent inhibition.

The above memory-based account appears less likely on the basis of the obtained results. A relative attenuation of latent inhibition in high-schizotypy

scorers was observed following 16 pre-test target presentations (Experiment 3), 32 target presentations (Experiments 4 and 5), and 64 presentations (Experiments 7 and 9) respectively. If anything, this consistent pattern suggests that attenuated latent inhibition in high-schizotypy scores is not dependent on the amount of contact with the target. Consequently, is seems less likely that latent inhibition deficits are due to 'attenuated' effectiveness of the amount of pre-exposure in high-schizotypy scorers. In addition, in line with the proposal that latent inhibition is a function of the amount of preexposure, a more reliable latent inhibition effect was obtained overall in the later studies (Experiment 7 and 9) than in the earlier studies of this thesis (Experiment 3 and 4).

An alternative memory-based explanation could be that the relative disruption of latent inhibition in high-schizotypy scorers in the first two latent inhibition studies (Experiments 3 and 4) was a result of the multi-element nature of the preexposure. The target colour in Experiments 3 and 4 was exposed along with three other non-target colours creating a multi-element preexposure. Given the reported short-memory deficits associated with schizotypy and schizophrenia, it could be suggested that high-schizotypy scorers failed to demonstrate latent inhibition because the multi-stimuli preexposure increased the memory load of the task; the participants had to keep in mind that 4 different types of colour were 'irrelevant' (one preexposed target + three preexposed non-targets). In associative terms, a multi-stimuli preexposure could be responsible for the formation of a larger number of

associations (CS_1 – no event, CS_2 – no event, CS_3 – no event, and CS_4– no event associations) than a single-stimulus preexposure (CS_1 – no event associations). However, this account seems less likely as a relative disruption of latent inhibition in high-schizotypy scorers was observed after a single-stimulus preexposure (Experiment 5), during which they had to keep in mind that one stimulus was 'irrelevant' (one preexposed target).

In general, associative interpretations of latent inhibition deficits are also memory based-accounts, since such accounts imply that attenuation of latent inhibition in high-schizotypy scorers is due to a failure to store (or retrieve) past stimulus—no events associations from the pre-exposure phase to the testing phase. Despite the fact that associative explanations of latent inhibition seem to be better supported than attentional theories (e.g., Escobar *et al.,* 2002; Reed & Tsakanikos, 2002), the evidence obtained in this thesis on the latent inhibition deficits in high-schizotypy scorers cannot be easily accommodated by associative interpretations.

Latent inhibition was found to be disrupted in high-schizotypy and intact in low-schizotypy scores under individual testing condition (Experiment 5), but this pattern was reversed under group testing (Experiment 6). This reversal, which has been demonstrated so far after an increase in the difficulty level of the explicit masking task (Braunstein-Bercovitz & Lubow, 1998*b*; Della Casa *et al.*, 1999; Hofer *et al.*, 1999), has been interpreted as evidence of the attentional distractibility in schizotypy (Lubow & Gewirtz, 1995). Similarly, although latent inhibition was disrupted for high-schizotypy scores when the

non-target stimuli remained the same from preexposure to testing phase (Experiment 7), this pattern was reversed after the introduction of novel non-target stimuli in the testing phase (Experiment 8). Again, this reversal seems congruent with attentional, but not associative interpretations of latent inhibition deficits. It is likely that high-schizotypy scorers were distracted by the novel non-target/irrelevant stimuli when these stimuli were presented along with the familiar target/relevant stimulus in the testing phase, reinstating latent inhibition i.e. lower number of correct responses associated with a familiar (preexposed) as compared to a novel (non-preexposed) target.

Although the relative reversal of the typical attenuation of latent inhibition in high-schizotypy scorers, obtained under certain experimental conditions (Experiments 6 and 8), appeared explainable in terms of an increased attentional distractibility in high schizotypy scorers, this interpretation is not without its' own problems. For example, a fundamental assumption of the distractibility hypothesis is that the disruption of latent inhibition in high-schizotypy scorers is the result of maintaining attention to the preexposed target stimulus. However, the introduction of a context change appeared to disrupt latent inhibition in low-schizotypy scorers (Experiment 8) in line with past evidence that latent inhibition is specific to the context in which the stimulus has been exposed (Gray *et al.*, 2001; Hall & Channel, 1983; Kaplan & Lubow, 2001; Lovibond *et al.*, 1984; Lubow *et al.*, 1976; Zalstein-Orda & Lubow, 1995). This disruption seems groundless unless it is accepted that something is learned about the context as well. Consequently, a main problem

with the distractibility hypothesis, which is largely based on the attentional assumption of latent inhibition, is that it fails to interpret latent inhibition deficits after a context change in *low-schizotypy* scorers.

The above problems cannot be easily addressed without considering the possibility that attentional and associative accounts need not to be necessarily incompatible. Latent inhibition might be the synergic result of both associative and attentional factors (a two-component model). If this were the case, then an increased involvement of attentional component would be expected in visual search-based paradigms of latent inhibition (like the one employed in the present thesis). This might provide a plausible explanation as to why the attentional hypothesis of latent inhibition appears to fit better the present data than any alternative associative explanation. However, a two-component model of latent inhibition leaves open four theoretically important possibilities. A first possibility is that, although latent inhibition might be the synergic result of both attentional and associative factors, the disruption of latent inhibition in high-schizotypy scorers might primarily reflect attentional deficits. Conversely, a second possibility is that the disruption of latent inhibition might be the sole result of a core associative deficit. A third possibility is that disruption of latent inhibition may be the combined result of both attentional and associative deficits; and a fourth possibility is that the disruption of latent inhibition may reflect independently attentional and associative deficits. As it will be argued next, this last possibility seems to be better supported on the basis of the data obtained in the context of the present thesis.

9.5 One or more sources of latent inhibition deficits?

A relatively neglected issue in the latent inhibition literature is the potential *multiple properties* of a stimulus following a repeated, non-reinforced preexposure. Latent inhibition deficits might stem from independent deficits specific to different properties of the preexposed stimulus. Following a number of presentations in Phase I (preexposure phase), a stimulus becomes a *familiar* event in Phase II (testing phase). Therefore, it could be argued that disruption of latent inhibition in schizophrenia may reflect a bias to treat familiar events as novel. However, there is a lack of experimental evidence in support of such an explanation. There is a general attentional bias to novelty over familiarity during visual search, a phenomenon known as the 'novel pop-out' (Johnston & Hawley, 1994; Johnston *et al.*, 1993). If schizophrenic patients experienced systematically familiar events as novel, then the advantage of novelty over familiarity, as assessed in the novel-pop out paradigm, would be attenuated, if not completely disrupted. Contrary to such a prediction, the novel pop-out during visual search is evident to the same extent in both schizophrenic and non-clinical participants (Lubow *et al.*, 2000), suggesting an intact discrimination between familiar and novel experimental events.

A second property of a preexposed stimulus is *irrelevance*. It is common experience that any repeated event not associated with an interesting outcome tends to be ignored. Likewise, a preexposed stimulus in the context of many latent inhibition studies tends to be considered as an experimentally 'irrelevant' event (Lubow & Gewirtz, 1995). Schizophrenic patients and high-schizotypy

scorers, as assessed by numerous paradigms, seem to fail to ignore irrelevant stimuli (see Chapter 2, pp 17-20), possibly due to an increased attentional distractibility. Correspondingly, it was proposed that, despite the highlighted theoretical difficulties, the attentional distractibility account fits best the data of the present thesis. In addition, it was argued that such in latent inhibition deficits were not associated with an inadequate discrimination between different levels of perceptual salience, due to a hypothesized enhanced perceptual awareness (Experiment 10). Typically, latent inhibition deficits in schizophrenia seem to stem from an increased response to the preexposed stimulus. Increased number of correct responses related to the pre-exposed were related to positive schizotypy (Experiment 9) in line with past evidence (Gray *et al.*, 2002), and with the proposal that that latent inhibition can serve as model of the positive symptomatology of schizophrenia (Gray, 1998). It is suggested, that positive schizotypy might be related to a failure to ignore an irrelevant, preexposed stimulus. Such elevated, excessive pattern of responding to a preexposed stimulus may be taken as an indication of attentional deficits tapped by latent inhibition.

Nevertheless, a third property of any preexposed target, as it enters Phase II (testing phase), is an *identity shift*: in Phase I, the to-be-target stimulus is irrelevant, as it signals no significant event; in Phase II the same stimulus *becomes* relevant, since it signals the presence of a significant event. Although it was suggested that latent inhibition deficits are not the result of a single reversal between the roles of target and distractors (Experiment 3 and

4), any existing human and non-human paradigm inevitably involves an identity shift of the preexposed target (i.e. stimulus A is non-target, that latter on becomes a target). Additionally, given that latent inhibition and shift learning paradigms have been found to share some common amount of variance in non-human studies (Chandra *et al.*, 2000; Ferguson *et al.*, 2001; Tsakanikos & Reed, 2000), it was hypothesized that some degree of shift-learning is involved in latent inhibition paradigms. Negative schizotypy was found to be independently associated with under-responding to the preexposed target (Experiment 9), possible due to the shifted identity of such a stimulus. Shift learning deficits, as assessed by the WCST, have been associated with the severity of negative symptoms (e.g., Berman *et al.*, 1997; Butler *et al.*, 1992; Voruganti *et al.*, 1997). In the present thesis, negative schizotypy was associated with a deficient shift learning (Experiment 12), as assessed by a compound-stimulus (shape/position) discrimination procedure (Experiment 11), although initial stimulus discrimination was not associated with any schizotypy dimension.

Taken together the above data suggest that latent inhibition deficits may be the synergic result of more than one factor. Latent inhibition may be better understood as a synthesis of associative and attentional changes during a repeated, non-reinforced stimulus preexposure. Similarly, latent inhibition deficits could mirror both associative and attentional changes. On the one hand, it is possible that excessive responding to the preexposed target reflects a failure to inhibit irrelevant stimulation, associated with positive symptoms of

schizophrenia and positive schizotypy (e.g., Gray *et al.*, 2002). On the other hand, it seems likely that restrained responding to the preexposed target reflects a shift-learning deficit, associated with negative symptoms of schizophrenia (Berman *et al.*, 1997; Butler *et al.*, 1992; Voruganti *et al.*, 1997) and negative schizotypy (Laurent, 2001). Such a two-component model of latent inhibition provides a new working hypothesis for further investigating cognitive irregularities underlying psychotic and psychotic like symptoms, while addressing the issue of the relative inadequacy of single attentional or associative explanations to explain latent inhibition deficits.

9.6 Summary

In summary, the thesis introduced a number of new experimental paradigms for investigating specific aspects of 'cognitive irregularities' in psychometrically defined schizotypy, akin to those seen in schizophrenia. A further validation of these procedures in clinical population could be the next step of a programmatic investigation. The studies reported in the thesis were designed to address potential methodological and theoretical problems surrounding the research of latent inhibition with human participants. This was deemed necessary given that latent inhibition has been claimed to be a promising non-human model for schizophrenia on the cognitive-behavioural, pharmacological and physiological level of investigation. Although attentional accounts appeared to accommodate the obtained data better than associative accounts, theoretical difficulties with the attentional assumption of latent inhibition were

highlighted. It was suggested that attentional and associative account might not be necessarily incompatible given that latent inhibition could be seen as the result of both attentional and associative changes, namely a two-component model. The last studies of the thesis provided some evidence on the potential *dual identity* of the preexposed target, as over-responding was associated with positive schizotypy ('Unusual Experiences') and under-responding was associated, at a lesser extend, with negative schizotypy ('Introvertive Anhedonia'). A two-component model of latent inhibition deficits has the potential to improve our understanding of the cognitive mechanisms underlying psychotic and psychotic-like experiences, elucidating the interplay between situational factors and behavioural dispositions within the continuum of psychosis.

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Appendix 1

The schizotypal personality scale (STA; Claridge & Broks, 1984). All the items are scored for a 'yes' response.

1. Do you believe in telepathy?
2. Do you often feel that others have it for you?
3. When in dark do you often see shapes and forms even though there is nothing there?
4. Does your own voice ever seem distant, far away?
5. Does it often happen that almost every thought immediately and automatically suggests an enormous number of ideas?
6. Do you ever become oversensitive to light or noise?
7. Do you often have vivid dreams that disturb your sleep?
8. When you are worried or anxious do you have troubles with your bowels?
9. Have you ever felt when you looked at the mirror that your face seemed different?
10. Do you feel it is safer to trust nobody?
11. Do things sometime feel as if they are not real?
12. Do you feel lonely most of the time, even when you are with people?
13. Do everyday things sometimes seem unusually small or large?
14. Are you often bothered by feelings that other people are watching you?
15. Do you feel that you cannot get 'close' to other people?
16. Do you dread going into a room by yourself where other people are already gathered and are talking?
17. Does your sense of smell sometimes get unusually strong?
18. Have you ever had the sensation of your body or part of it changing shape?
19. Are you sometimes sure that other people can tell what you are thinking?
20. Do you ever feel sure that something is about to happen even though there doesn't seem to be any reason for you thinking that?
21. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
22. Do you ever have a sense of vague danger for reasons that you cannot understand?
23. Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?
24. Do your thoughts ever stop suddenly causing you to interrupt what you are saying?

Appendix 2

The Oxford-Liverpool inventory of Feelings and Experiences (O-LIFE; Mason *et al.*, 1995) scales. Scoring: 'Y' indicates that the item is positively scored when confirmed and 'N' when the item is positively scored when disconfirmed.

UNUSUAL EXPERIENCES

1. Are the sounds that you hear in your daydreams usually clear and distinct? Y
2. Are your thoughts sometimes so strong that you can almost hear them? Y
3. Are your thoughts sometimes as a real as actual events in your life? Y
4. Does it often happen that nearly every thought immediately and automatically suggests an enormous number of ideas? Y
5. Do you think that you could learn to read other's mind if you wanted to? Y
6. Do ideas and insights sometimes come to you so fast that you cannot express them all? Y
7. Can some people make you aware of them just by thinking about you? Y
8. Does a passing thought sometimes seem so real that it frightens you? Y
9. Does your voice ever seem so distant, faraway? Y
10. Do you sometimes feel that your accidents are caused by mysterious forces? Y
11. Do people in your daydreams sometimes seem so true to life that you sometimes think they are?
12. Is your hearing sometimes so sensitive that ordinary sounds become uncomfortable? Y
13. Have you felt that might cause something to happen just by thinking too much about it?
14. Are you so good at controlling others that it sometimes scares you? Y
15. Do you ever have a sense of vague danger for reasons that you cannot understand? Y
16. Have you sometimes had the feeling of gaining or loosing energy when certain people look at you or touch you? Y
17. Have you ever thought you heard people talking only to discover that it was in fact a nondescript noise? Y
18. Have you occasionally felt that your body does not exist? Y
19. On occasions, have you seen a person's face in front of you when no one was in fact there? Y
20. Do you often have a day when indoors lights seem so bright that they bother your eyes? Y
21. Have you wondered whether the spirits of dead can influence the living? Y

22. Now and then, when you look in the mirror, does your face look different than usual? Y
23. Have you ever felt as though your head or limbs were somehow not your own? Y
24. Do you ever feel that your thoughts don't belong to you? Y
25. Do you ever feel suddenly distracted by distant sounds that you are not normally aware of? Y
26. When in dark, do you often see forms and shapes even though there is nothing there? Y
27. Have you sometimes sensed an evil presence around you, although you could not see it? Y
28. Does your sense of smell sometimes become unusually strong? Y
29. Do you ever feel sure that something is about to happen, even though there does not seen to be any reason for you thinking that? Y
30. Have you ever felt that you have special, almost magical powers? Y

COGNITIVE DISORGANISATION

1. Do you often hesitate when you are going to say something in a group that you know more or less? Y
2. Do you often have a difficulty in starting doing things? Y
3. Do you often worry about things you should not have done or said? Y
4. When in crowded room, do you often have a difficulty in following a conversation? Y
5. No matter how hard you try to concentrate, do unrelated thoughts always creep into your mind? Y
6. Are you easily hurt when people find fault with you or the work you do? Y
7. Do you easily loose courage when criticised or failing in something?
8. Do you seem like a person whose mood goes up and down easily? Y
9. Are you sometimes so nervous that you feel blocked? Y
10. Do you find it difficult to keep interested in the same thing for a long time? Y
11. Do you dread going to a room by yourself when other people have already gathered and are talking? Y
12. Do you often have difficulties in controlling your thoughts when you are thinking? Y
13. Do you often feel that there is no purpose in life? Y
14. Do you worry about awful things that might happen? Y
15. Are you easily distracted from work by daydreams? Y
16. Are you easily confused if too much happens at the same time? Y
17. Do you worry too long after an embarrassing experience? Y
18. Do you often feel lonely? Y

19. Do you often experience an overwhelming sense of emptiness? Y
20. Do you often feel fed up? Y
21. Would you call yourself a nervous person? Y
22. Is it hard for you to make decisions? Y
23. Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense? Y
24. Are you easily distracted when you read or talk to someone? Y

INTROVERTIVE ANHEDONIA

1. Have you had very little fun from activities like walking, swimming or sports? Y
2. Do you enjoy many different kinds of play and recreation? N
3. Has dancing, or the idea of it, always seemed dull to you? Y
4. Is trying new foods something that you have always enjoyed? N
5. Are there very few things that you have ever enjoyed doing? Y
6. Are you much too independent to really get involved with other people? Y
7. Do you think having close friends is as so important as some people say? Y
8. Are you rather lively? N
9. Does it often feel good to massage your muscles when you are tired or sore? N
10. Do you like mixing with people? N
11. On seeing a soft, thick, soft carpet have you sometimes had the impulse to take off you shoes and walk barefoot on it? N
12. Are people usually better off if they stay aloof from emotional involvements with most others? Y
13. Can just being with friends make you feel really good? N
14. Have you ever felt uncomfortable when your friends touch you? Y
15. When things are bothering you, do you like to talk to other people about it? N
16. Do you have many friends? N
17. Do you prefer watching television to going out with people? Y
18. Is it true that your relationships with other people never get very intense? Y
19. Do you love having your back massaged? N
20. Is it fun to sing with other people? N
21. Do people who try to get you know better usually give up after a while? Y
22. Can you usually let yourself go and enjoy yourself at lively party? Y
23. Are the bright lights of a city exiting to look at? N
24. Do you usually have very little desire to buy new kinds of foods? Y
25. Do you like going out a lot? N
26. Do you feel very close to your friends? N

27. Do you feel that making new friend isn't worth the energy it takes?Y

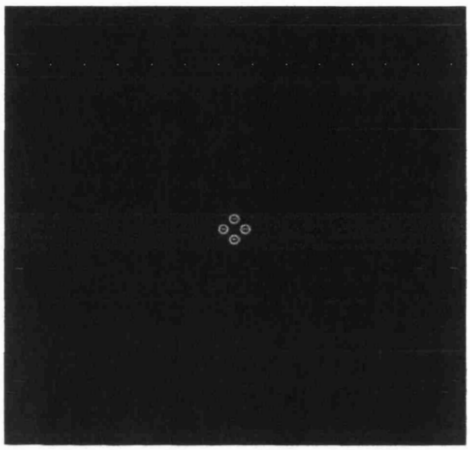
IMPULSIVITY NONCONFORMITY

1. Do you often overindulge in alcohol or food? Y
2. When with groups of people, do you usually prefer to let someone else to be the centre of attention? N
3. When you catch a train, do you often arrive at the last minute? Y
4. Do you often change between intense liking and disliking of the same person? Y
5. Have you ever cheated at a game? N
6. Do you at times have an urge to do something harmful or shocking? Y
7. Are you usually in an average sort of mood, not too high and not too low? N
8. Would you take drugs, which may have strange or dangerous effects? Y
9. Do you stop to think things over before doing anything? N
10. Have you ever blamed someone for doing something you know was really your fault? Y
11. Would being in debt worry you? N
12. Do you think people spend too much time safeguarding their future with savings and insurance? Y
13. Do you ever have the urge to break or smash things? Y
14. Have you ever felt the urge to injure yourself? Y
15. Would it make you nervous to play the clown in front of other people? N
16. Do you consider yourself to be pretty much an average kind of person? N
17. Have you ever taken advantage of someone? Y
18. Would you like other people to be afraid of you? Y
19. Do you often have the urge to hit someone? Y
20. Do people who drive carefully annoy you? Y
21. Do you sometimes talk about things you know nothing about? Y
22. Do you often feel the impulse to spend money, which you know you can't afford? Y
23. Do you sometimes feel like doing the opposite of what other people suggest, even though you know they are right? Y

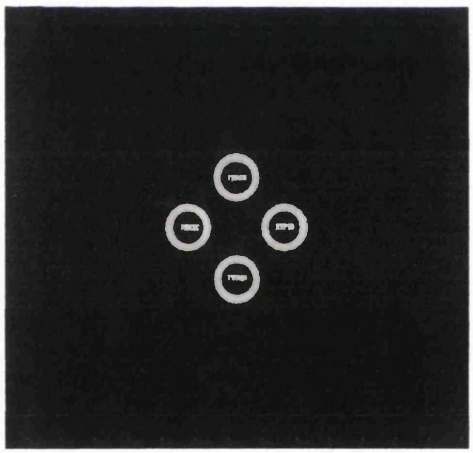
Appendix 3

Experiments 1 and 2. An example of an animated image created through a succession of single static frames. The four round blocks appear looming from distance (I – 9th frame), rapidly moving towards the observer (II – 19th frame), and reaching a distance where the verbal content is readable (III – 29th frame) before disappearing. The speed was 9 frames/sec. The same motion-generation technique was used in all subsequent latent inhibition experiments.

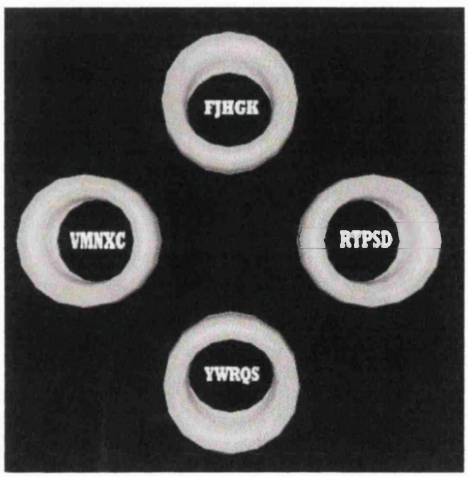
I



II



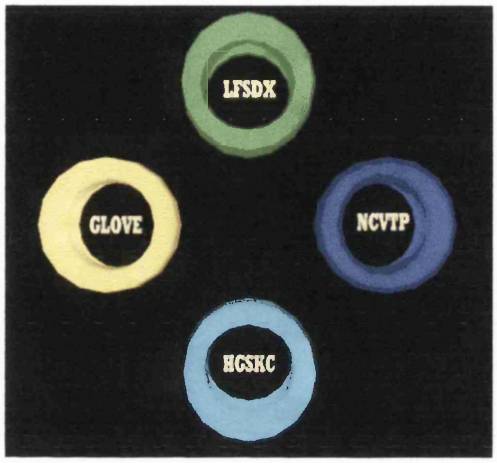
III



Appendix 4

Examples of animated images from word (I) and non-word trials (II & III) at a distance (29th frame) where the verbal content is readable (Experiments 3 and 4). For the generation of motion, see example in Appendix 2.

I



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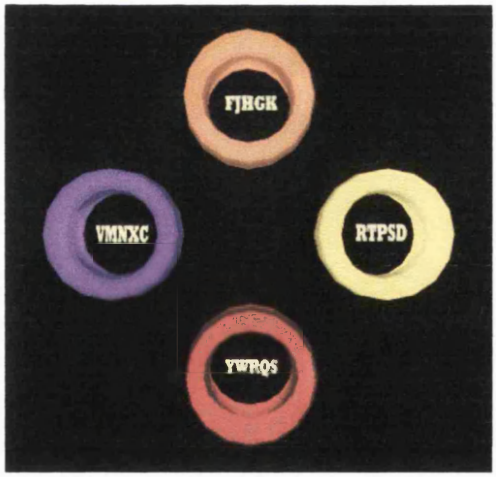
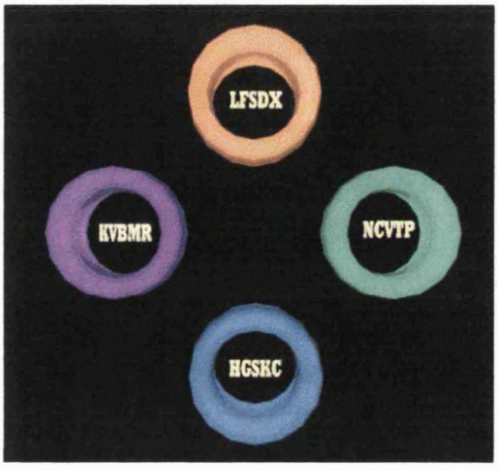


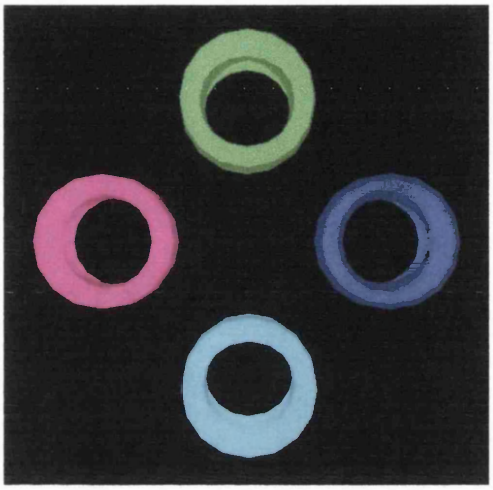
III



Appendix 5

Examples of animated images of empty blocks (I & II) used in the pre-exposure phase, and example of a trial (III) in the testing phase at a distance (29th fame) where the verbal content is readable (Experiments 7 and 9). For the generation of motion, see example in Appendix 2.

I



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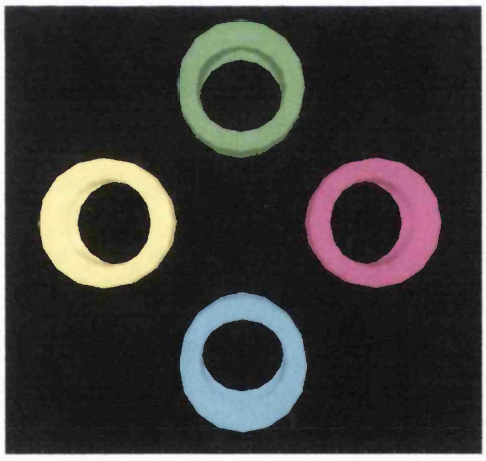
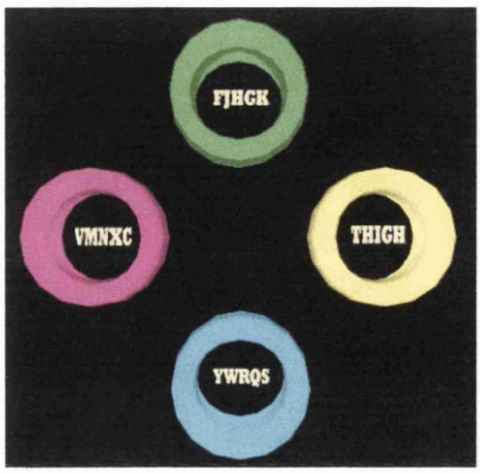


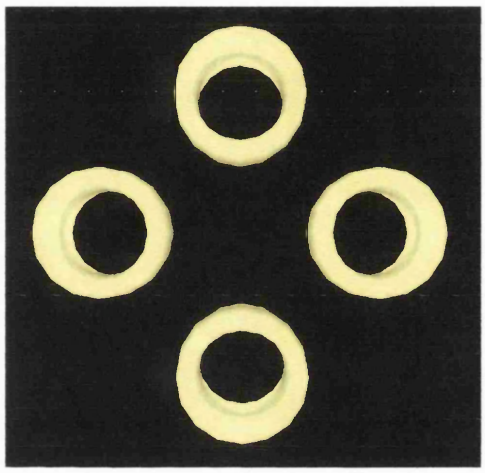
III



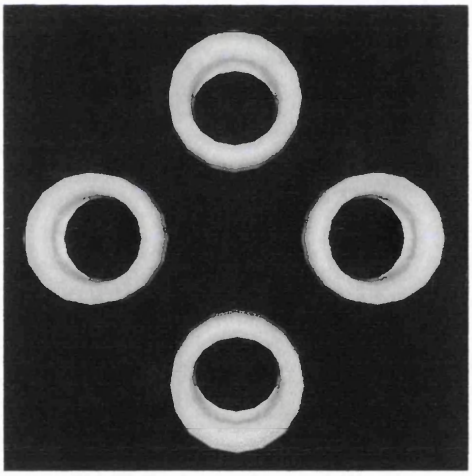
Appendix 6

Experiment 8. Examples of animated images of empty blocks (I & II) used in the first phase, and example of a trial (III) in the testing phase at a distance (29th frame) where the verbal content is readable. For the generation of motion, see example in Appendix 2.

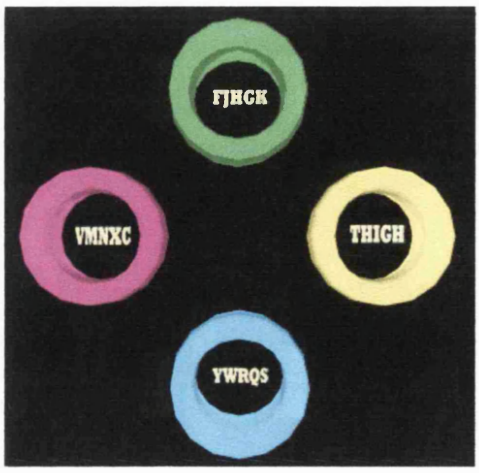
I



II

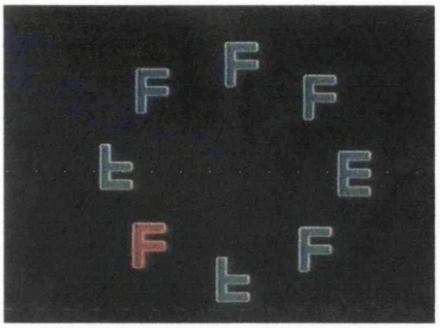


III



Appendix 7

Examples of trials in experiment 10. High level of salience (target salient/ distractor non-salient): images 4 & 7. Medium level of salience (target non-salient/distractor non-salient): images 3 & 8. Low level of salience (target non-salient/distractor salient): images 1 & 5. Examples of non-target trials: images 2 & 6.



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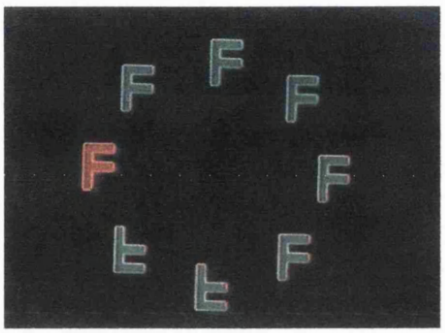

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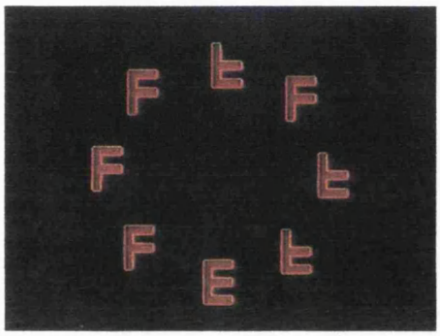

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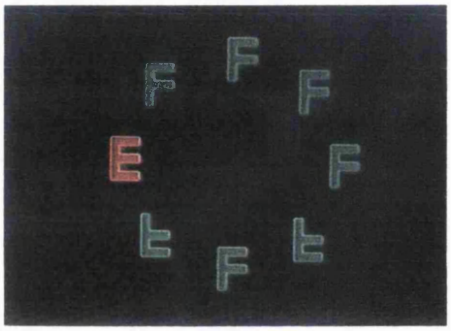

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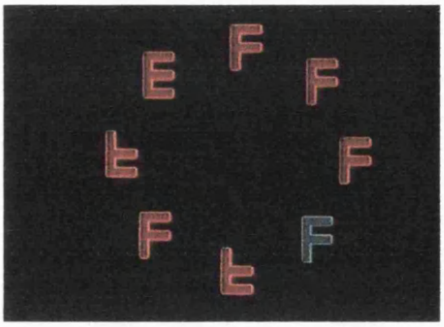

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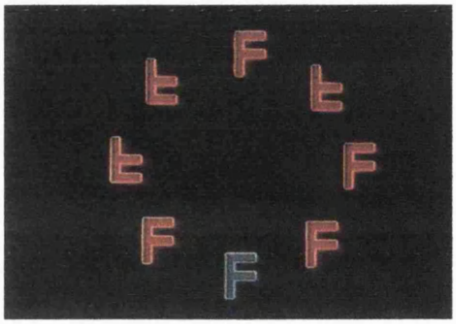

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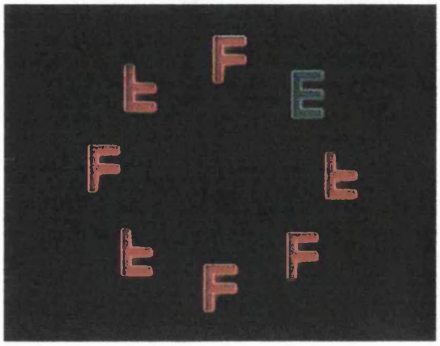
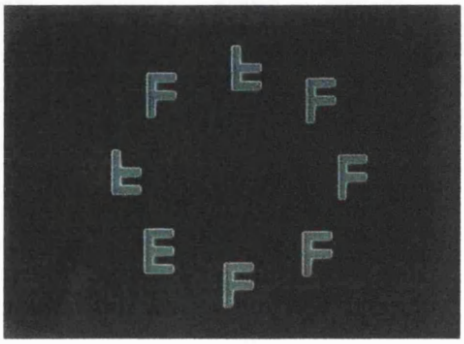


7



8