An Investigation into Illusory Conjunctions and Context-Processing in Schizophrenia: Differential Relationships Between Symptoms

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ABSTRACT

The context processing theory of schizophrenia proposes that when processing information, there is a dedicated mechanism used to select task appropriate responses over task irrelevant ones. It is suggested that in schizophrenia there is a weakening of context processing mechanisms, which causes irrelevant information to be attended to and given greater significance than is required. An illusory conjunction task was designed to test the hypothesis that people with schizophrenia perform differently on context-sensitive tasks to non-psychiatric controls. As it has been suggested that context processing is more deficient in certain sub-types of schizophrenia it was further hypothesised that patients categorised into 'poverty', 'reality distortion' and 'disorganised' symptoms would have significant differences in their performance and that acute symptoms of schizophrenia would see more illusory conjunctions than those with chronic symptoms.

41 patients with schizophrenia and 24 non-psychiatric controls were briefly presented with vertical rows of objects comprised of different coloured squares, circles and triangles and had to indicate if they had seen a red triangle amongst the objects. Presentation times were brief and additional tasks were included to increase processing demands, thereby increasing the likelihood of an illusory conjunction. Results showed that there were significantly more illusory conjunctions, target errors and total errors overall for the schizophrenic group than for the non-psychiatric controls ($f=25.43$, $df=1,63$, $p<0.04$; $f=5.29$, $df=1,63$, $p<0.02$; $f=9.92$, $df=1,63$, $p<0.00$ respectively). As the attention load increased over the three conditions there were more illusory conjunctions seen for the schizophrenic group than for the non-psychiatric controls

($f=3.37$, $df=2,62$, $p<0.04$). However there were no significant differences between the three symptom sub-groups of schizophrenia and there were no significant differences between acute symptoms and chronic symptoms. Results were further discussed in relation to the context processing theory, and previous research showing similar results in people with acquired brain damage. Questions arose as to whether context processing mechanisms are related to the parietal lobes and its involvement in 'diathesis-stress' models of schizophrenia.

INTRODUCTION

Overview

The presentation of symptoms of schizophrenia can raise a considerable challenge to clinicians working in the field of mental health. They are frequently severe, multidimensional in nature, a range of symptoms can be present at the same time and are quite likely to change over the course and duration of the illness. They can produce debilitating cognitive difficulties that can be very distressing to both the person suffering and to their family and friends. Clinicians have to be skilled in recognising the presentation of psychotic symptoms and to be able to diagnose and treat as quickly as possible to enable the best level of care. Understanding the cognitive disturbances that underlie schizophrenia is useful for clinicians, as it gives added insight into the difficulties that patients might face. It is not surprising therefore that there has been considerable research into the effects of schizophrenia upon cognitive processes and the implications this provides for the classification of different subtypes of the disease.

The following study is an attempt to answer some of the questions that arise when trying to identify the cognitive and perceptual deficits in schizophrenia. Its purpose is to use a visual processing task to uncover some of the perceptual difficulties of people diagnosed with schizophrenia and to see if differences between patients can be related to different subtypes of symptoms. To understand fully the reasons behind such a study it is first important to explain previous theories regarding categorisation and cognitive deficits. This introduction, therefore will first give a brief explanation as to what is schizophrenia and then explain the problems that have occurred when trying to categorise schizophrenia into different sub-types. Following on from this, some of the perceptual problems found in schizophrenia will be discussed, paying particular attention to the theories surrounding context processing and illusory conjunctions, as these are the basis of the following research. Examples of previous research on context processing and illusory conjunctions with regards schizophrenia will be given, including a discussion of their findings and methodological weaknesses. Finally the aims of the present study will be discussed and reasons given for why this piece of research is important to the continuing study of cognitive and perceptual deficits in schizophrenia.

What is Schizophrenia?

The fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, American Psychiatric Association, 1994) explains that to be diagnosed with schizophrenia one must have two of the following; delusions, hallucinations, disorganised speech, disorganised/ catatonic behaviour or a flattening of affect/alogia/avolition (only one is required if the delusions are bizarre or the hallucinations consist of voices giving a running commentary/conversing with each other). These must be present for at least one month, with a continuous disturbance for at least 6 months (although it is not necessary to be actively psychotic all the time). They must show reduced social functioning over this period. There must also be no major changes in mood, such as depression, or evidence of organic factors such as drugs. These symptoms can occur at any stage but usually age of onset for men is mid-20s and for women early-30s. Such symptoms present major changes to a person's mental and social functioning and for many these changes remain persistent throughout their life. Yet these symptoms do not always appear to have the same presentation. For example, Frith (1992) describes several case studies of people diagnosed with schizophrenia, yet all are completely different in their presentation. He described one man as withdrawn, fixated on religious themes, having auditory hallucinations of water pouring and tactile hallucinations of his food tasting wrong. Another man became pre-occupied with odd ideas, such as believing his rent book was falsified and fluctuated between extremes of emotions within minutes. He also described one woman as unable to produce coherent sentences, who would sit in a chair for only a few minutes and then wander around the room picking up articles or sit on the floor. Such examples suggest that there seems to be no one 'true' set of symptoms that can define schizophrenia. Furthermore, it seems to be independent of culture and socio-economic status, its course and duration appear difficult to define and outcome is not predictable. It is not surprising therefore that there is a great deal of controversy as to how schizophrenia should be categorised.

Issues in Categorising the Symptoms of Schizophrenia

Most research is based upon how cognitive psychology can aid in the diagnosis of symptoms for schizophrenia. However this has caused controversy in itself, as researchers have differing views over the placement of symptoms within diagnostic categories. The most well known categorisation of symptoms was attempted by Crow (1980), who believed that there were two types of schizophrenics, namely those with positive (Type I) and those with negative (Type II) symptoms. Positive symptoms were those that showed abnormality through their presence, e.g. delusions, hallucinations and unusual thoughts. These are more likely to be seen in the acute stages of schizophrenia. Negative symptoms were those that showed abnormality though their absence, e.g. a poverty of speech, a flattening of affect and social withdrawal. These are more likely to develop over time and become more chronic in their presentation. Crow believed that these categories were independent entities, reflecting different pathological processes.

The categorisation of schizophrenia into the two distinct sub-types defined by Crow has been used extensively when studying cognitive deficits in schizophrenia. However a literature search on the positive and negative symptoms of schizophrenia has shown that there is still some uncertainty as to whether the symptoms that have been designated to these categories are the correct ones. Nicholson, Chapman & Neufeld (1995) state that there have been at least seven different constructs of the sub-types that make up schizophrenia. For example, Andreasen (1982) included inappropriate affect into the negative schizophrenia group whereas Crow (1980) included it in the positive group. Similarly, Servan-Schreiber, Cohen & Steingard (1996) included conceptual disorganisation into the positive group but Cohen et al. (1999) have used this as a separate category altogether. Factor analytic studies suggest that using two categories does not sufficiently capture the complexities of schizophrenia and some believe that a three-factor model is more appropriate (Liddle, 1987a; Arndt, Alliger & Andreason, 1991; Cohen et al., 1999). Liddle named these factors: Reality Distortion (hallucinations and delusions), Poverty (poverty of speech, motor retardation) and Disorganisation (incoherent speech, inappropriate effect).

Other studies have suggested that each of these symptoms is associated with different patterns of brain malfunction. For example, neuroimaging research has suggested that negative symptoms are associated with deficits within the frontal cortex (Andreasen et al., 1986; Frith et al., 1995) and positive symptoms are associated with deficits within the temporal lobes (Dolan et al., 1995; Fletcher et al., 1996). Frith at al. (1995) used functional imaging during a verbal fluency task on 18 patients with negative-type symptoms and six 'normal' controls. They found that there was reduced activity in the prefrontal region for the schizophrenia group, which was not found in the control group. Dolan et al. (1995) used functional imaging on a verbal fluency task on 12 patients with positive-type symptoms and 12 healthy controls. They found that the schizophrenia group had a failure of deactivation in the temporal region, which was not present in the control group.

Neuropsychological tests have also indicated that patients with negative symptoms perform poorly on frontal lobe tests such as verbal fluency and patients with positive symptoms perform poorly on temporal lobe tests such as figure-ground perception (Liddle, 1987b; Liddle et al., 1989). Studies have also shown that the disorganisation syndrome has specific deficits of its own. For example, using the Stroop Task, Cohen et al. (1999) found that people with disorganised-type symptoms of schizophrenia were slower at naming the ink colour of a colour word than other symptom sub-groups and normal controls. Jensterle et al. (2000) found that on the Hayling Sentence Completion Task, patients with disorganised symptoms had more difficulty in fitting the correct word to the context than normal controls and would produce unusual words.

It would seem that there is a general consensus that there are three distinct categories of symptoms within schizophrenia (Liddle, 1987a; Liddle & Barnes, 1990; Cohen et al., 1999, Jensterle et al., 2000). It has also been shown that the disorganisation syndrome, whose symptoms were originally assigned to both positive and negative groups, is now seen as a separate sub-group. The majority of symptoms for the disorganisation group relate to a disorder in form of thought, which has in the past been seen as central to schizophrenia (Bleuler, 1911; Harrow, Silverstein & Marengo, 1983; Liddle, 1987a, 1987b). Johnstone & Frith (1996) have produced further evidence that the groups known as 'poverty' 'reality distortion' and 'disorganisation' are separate dimensions of schizophrenia. They used a sample of 329 unselected patients diagnosed with schizophrenia and found that the categories differed significantly in relation to mental state variables, physical treatments administered, movement disorder, demographic and historical features and cognitive function. Cognitive function is of particular importance, as the ability to indicate differences in cognitive deficits between schizophrenic symptoms should lead to an increase in understanding its aetiology. As Berrios states, 'the reliability and validity of schizophrenia depends upon the 'coherence, stability and clarity of the symptom cluster' (Berrios, 1995, p12).

Cognitive Deficits in Schizophrenia

Although there is an extensive amount of literature regarding cognitive deficits and schizophrenia, it has been suggested that perceptual and attentional disturbances are primary to its aetiology (Maher, McKean & McLaughlin, 1966; Steronko & Woods, 1978; Cadenhead & Braff, 1995). Both perception and attention are used during information processing. There is a general consensus that information processing is comprised of two interactive processes namely 'top-down' and bottom-up'. Bottom-up processing refers to events that are directly affected by stimulus input. For example, fragments of information are joined together without the aid of a former model. It is suggested that people with positive symptoms of schizophrenia, may have more difficulty in carrying out bottom-up processing. For example, Carr, Dewis & Lewin (1998a) found that patients with the hallucination symptoms from the positive sub-group were more likely to have longer reaction times when searching for a target letter amongst a range of letters than other sub-groups of schizophrenia. They also found that patients with delusional symptoms required longer exposure times when searching for an arrow amongst line distractors than other sub-groups of schizophrenia (Carr, Dewis & Lewin 1998b). This suggests that people with positive symptoms of schizophrenia may have a reduced information processing capacity, which means that they are more likely to make errors of object recognition when attention becomes focused.

However, research by Verbraak, Hoogduin & Schaap (1993) has found that people with both the positive and negative symptom categories have difficulties in bottom-up processing tasks. They used six different tasks that measured pre-attentional, attentional, psychomotor and conceptual levels of information processing. They found that both positive and negative groups performed significantly different than healthy controls on concept processing, vigilance in high and low demand and apprehension in backward masking conditions. However the negative group also performed significantly different to normal controls on reaction time, and false alarm rates. They concluded that both groups had information processing deficits but the negative symptom group had a greater severity than the positive symptom group. Therefore it would seem that there is a continuing difficulty in the attempt to define the cognitive deficits that influence the categorisation of symptoms in schizophrenia.

Top-down processing refers to the use of prior experiences and the context of the situation to guide interpretation of incoming stimulus. People with negative symptoms may be more likely to have difficulty carrying out top-down processing as it has been suggested that they have deficits within the frontal cortex (Andreasen et al., 1986; Frith et al., 1995) which is linked to the processing of contextual information (Cohen & Servan-Schreiber, 1992). One theory that has tried to identify particular cognitive deficits between symptoms during top-down processing is the *context processing theory*. This has been researched extensively by Cohen and Servan-Schreiber (Cohen & Servan-Schreiber, 1992; Cohen et al., 1994; Servan-Schreiber & Blackburn, 1995; Servan-Schreiber, Cohen & Steingard, 1996; Cohen et al., 1999), who believe that several of the deficits observed in people with schizophrenia can be related to the processing of contextual information. Context processing involves using pre-defined, related, information to help in the processing of new information. Servan-Schreiber, Cohen & Steingard (1996) propose that contextual information is '*information that has to be actively held in mind in such a form that it can be used to mediate an appropriate behavioural response*' (p1105). Contextual information can be task instructions, the processing of a sequence of prior stimuli, or specific prior stimuli that have been learnt over time. The latter are also known as schemata, which are '*stored traces of earlier experiences that allow for rapid unconscious processing of redundant information*' (Van den Bosch, 1995, p344). This allows us to see regularities in our environment and makes it easier to rule out task-irrelevant information.

A reduction in the ability to use contextual information causes difficulty in suppressing strong, inappropriate responses when carrying out a task. In normal information processing, when a dominant response is irrelevant to the task in hand, context is important to select the weaker appropriate response. Therefore context processing is more than just the ability to select the appropriate behavioural response, it also involves selecting material from previously held schemas about the world to aid in the selection of the correct response. Gray et al. (1991) state that during normal automatic processing, information that is not required for the task is inhibited to reduce processing demands. Prior experiences are also involved to help reduce processing demands and must be limited to that which is relevant to the situation. In schizophrenia there is a weakening of inhibitory processes and the ability to select past experiences to aid in current perception. A lack of inhibitory processes causes irrelevant information to be attended to and given greater significance than is required. Therefore '*a patient's thoughts may be imbued with a significance that is out of proportion to their real importance simply because they happen to capture the attentional focus*' (Gray et al., 1991, p3).

Both attention and inhibition are used to select task-relevant information over other competing sources of information, whilst active memory is useful to hold the relevant information in mind until the response is required. As Braver et al. (2001) state,

> '*Because context representations are maintained on-line, in an active state, they are continually accessible and available to influence processing. Consequently, context can be thought of as one component*

> *of working memory. Specifically, context can be viewed as the subset of representations within working memory that govern how other representations are used. In this manner, context representations simultaneously subserve both mnemonic and control functions'* (p748).

Previously, these various cognitive functions that have been found to be deficient in schizophrenia, namely 'attention', 'active memory' and 'inhibition', have been seen as independent entities. However, Cohen et al. (1999) and Braver et al. (2001) believe that context processing incorporates all three into one single mechanism, which performs all three functions depending on the task in hand. They believe that there is no 'dedicated mechanism' for attention, working memory and inhibition. Instead contextual representations are used as 'top-down' support to maintain task relevant information over competing responses. They replicated previous studies using the Stroop Task and the Continuous Performance Test (CPT) to test their context processing theory. The Stroop Task (Stroop, 1935) looks at selective attention and inhibition as it involves responding to one set of stimuli whilst ignoring a more compelling set of stimuli. For example, colour words are written in different coloured inks to the word. Participants have to name the colour of the ink whilst ignoring the word. By using the 'Stroop effect' it has been shown that word reading is faster than colour naming and so it is harder to name an ink colour when the word is a different colour (Stroop, 1935). In relation to the context processing theory, if one is presented with the word 'blue' in red ink the dominant, task-inappropriate response is the word, and the weaker, task-appropriate response is the colour. The context processing mechanism is utilized to support weaker responses when in competition with stronger ones and so the inhibitory mechanism is used to ignore the dominant response and attention is used to select the weaker, appropriate response.

Cohen et al. (1999) found that people with disorganised-type symptoms of schizophrenia were slower at naming the ink colour than normal controls due to an inability to use contextual information. Making the word a different colour to the ink colour caused the task-irrelevant information to become dominant. This dominant, but irrelevant, information became harder to inhibit and so patients took longer to give a correct answer than normal controls. People with reality distortion and poverty symptoms of schizophrenia did not show this effect. However the Stroop task only utilises the suppression of task irrelevant information and does not include a delay between a contextual cue (i.e. task instructions) and the appropriate response, which Cohen et al. indicate, is fundamental when making tasks sensitive to disturbances in context processing. Cohen et al. tried to remedy this situation by incorporating either a one-second or five-second delay between the task instructions and the response. However, it is questionable as to whether this delay was sensitive enough to create an effect for all schizophrenic sub-types.

Studies by Laplante, Everett & Thomas (1992) have also modified the Stroop task to reveal context processing deficits in people with schizophrenia. They have shown that schizophrenic participants do not show a difference in their reaction times when comparing a negatively primed Stroop task to a normal Stroop task, yet normal controls do. In a negatively primed Stroop task the participants must respond to a stimuli that was inhibited on the previous trial. For example, the first word, 'red' is written in blue ink, the second word, 'green' is written in red ink and the third word, 'yellow' is written in green ink. The participant must ignore the word and name the ink colour. With 'healthy controls' it should take longer to say the ink colour on each subsequent trial, due to the previous inhibition.

Laplante, Everett & Thomas (1992) used four groups of participants for their study, namely positive and negative-type schizophrenics, healthy controls and depressed psychiatric patients. Each group performed a normal Stroop task and negatively primed Stroop task. They found that there was no significant difference between the four groups on the normal Stroop task. This differs to Cohen et al.'s study (1999), who found a difference between healthy controls and patients with schizophrenia. As suggested earlier, it is possible that the normal Stroop task may not be sensitive enough to produce reliable context processing effects. However, during the negatively primed Stroop task schizophrenics performed better than controls, as they were less likely to be distracted by the negatively primed word. This effect was stronger in people with negative-type symptoms of schizophrenia. According to the context processing theory, this would indicate that people with schizophrenia have difficulty in mediating the contextual cues provided by task instructions. Therefore they are less likely to be influenced by prior cues and more likely to give the correct response when context becomes a distractor. It is also suggested that context processing mechanisms (especially the inhibition function) may be more deficient in negative-type symptoms rather than positive and disorganised ones.

The CPT task (Rosvold et al., 1956), which has also been used to test the context processing theory, looks at active memory processes. It is suggested that in order to respond to information there must be some form of instructions or prior experience actively held in mind. To test this theory, participants were asked to push a button when they detected a pre-arranged target letter in a series of briefly exposed letters. It has been shown that people with schizophrenia spot fewer targets and have more false hits than normal controls (Neuchterlein, 1983, 1984; Cornblatt et al., 1989). It has also been shown that people with schizophrenia respond slower to the correct stimuli than healthy controls (Nestor et al., 1990; Van den Bosch, 1995). Van den Bosch suggests that in healthy controls context processing mechanisms allow for rapid and flexible use of pre-arranged, contextual information. The slower performance by schizophrenics on the CPT indicates that there is a slowing down of their use of schemata during information processing.

Although the CPT task has revealed deficits in schizophrenic participants, like the Stoop task it does not use all of the elements of context processing at once. The CPT only utilises the working memory elements of context processing. Cohen, Servan-Schreiber and colleagues, however, have updated the CPT to further explore context processing deficits in schizophrenia (Cohen & Servan-Schreiber, 1992; Servan-Schreiber, Cohen & Steingard, 1996; Cohen et al., 1999). For example, Cohen & Servan-Schreiber (1992) modified the CPT to become the AX-CPT task, so that it incorporated all elements of the context processing theory. The AX-CPT task involves responding to stimuli under specific conditions. Participants were asked to press a button when they had detected a target within a series of stimuli. However this must only be done if information regarding the previous stimuli is held in mind. For example, to press a button when one sees an 'X' but only if it is proceeded by an 'A'. The previous stimulus then provides a context for the task. Cohen & Servan-Schreiber (1992) found that participants with schizophrenia had difficulty in maintaining the internal representation of context (i.e. the task instructions) and gave fewer correct responses than healthy controls.

Stratta et al. (2000) found similar results to the Cohen and colleagues (Cohen & Servan-Schreiber, 1992; Servan-Schreiber, Cohen & Steingard, 1996; Cohen et al., 1999) when they modified the AX-CPT task on patients with schizophrenia and healthy controls. They used differential presentation times to manipulate the delay between the contextual cue and response. In their study patients had both positive and negative symptoms of schizophrenia. Context processing was found to affect both short and long delay times for the schizophrenia group only, with a progressive worsening of performance when there was a long delay. They also found that chronic patients had more errors than acute patients.

The AX-CPT task has been researched extensively by Cohen and colleagues, (Cohen & Servan-Schreiber, 1992; Cohen et al., 1994; Servan-Schreiber & Blackburn, 1995; Servan-Schreiber Cohen & Steingard, 1996; Cohen et al., 1999), and has shown to be a task which people with schizophrenia do not perform as well as healthy controls. Van den Bosch (1995) argues, however that although CPT tasks are supposed to measure the vigilance function in context processing its validity is unclear due to the large amount of mental effort required to perform these tests. Knight and Silverstein (1998) argue that although on CPT tasks one can infer a specific deficit, differential performance on tasks between schizophrenics and normal controls may well be due to the schizophrenic's global performance deficits. This gives little in the way of insight into the difficulties that people with schizophrenia may have. Knight and Silverstein suggest that when comparing different groups, tasks that show similar results on easier levels but differences on harder levels are more likely to discriminate between specific and generalised deficits. Therefore to further research into the context processing theory a task that incorporates all elements of context processing (attention, inhibition and active memory) and one that increases group performance differences over various levels of difficulty may be more reliable than previous tasks.

The present study has taken such issues into consideration and, by using further research as a guide, it would seem that designing a new task that involves *illusory conjunctions* would be more appropriate for testing context processing deficits in schizophrenia.

What are Illusory Conjunctions?

Treisman & Schmidt (1982) have suggested that illusory conjunctions are formed when the attention capacity needed to perceive two objects as separate is divided between the task in hand and another one which is just as demanding. The different features of objects are perceived automatically and in parallel with one another. However, when combining these features to make an object the process is serial which requires attention to be focused. If attention is not focused (due to another demanding task) attention is limited and errors can occur. Therefore, *'features that are correctly* *perceived may be incorrectly combined to form illusory conjunctions'* (Prinzmetal, Henderson & Ivry, 1995, p1363). Treisman & Gelade (1980) give the impression that all features are free floating in space and those within the same area as the spotlight of attention are 'grabbed'. Lack of attention causes the wrong feature to be grabbed. They state that,

> *'Any features which are present in the same central fixation of attention are combined to form a single object....With memory decay or interference the features may disintegrate and float free once more, or perhaps recombine to form illusory conjunctions'* (p98).

An example of illusory conjunctions caused by a lack of attention can be seen in the study by Treisman & Schmidt (1982). They presented three coloured letters with flanking black digits to healthy participants. They had to first report the digits and then the coloured letters. In nearly 40% of trials participants reported illusory conjunctions. For example, when seeing a red T, a blue N and a green X, they would report an illusory conjunction of a green T. It was believed that the reporting of the digits first, had loaded up the attention needed to correctly combine the letters and colours. Therefore less attention was given to the letters and colours, which caused the illusory conjunctions to occur.

Further research on illusory conjunctions has shown that illusory conjunctions can also appear when there is an error in perceiving the location of two or more features (Navon & Ehrlich, 1995; Ashby et al., 1996; Hazeltine, Prinzmetal & Elliott, 1997).

According to Hazeltine, Prinzmetal & Elliott location uncertainty occurs during visual processing. When identifying the shape and colour of an object separate areas of the visual system are used. For example, one area processes form whilst another area processes colour. Each area has a number of 'feature detectors', which are tuned to pick up on a certain feature. Each feature detector has a receptive field so that if the feature falls within this field the feature detector is fired. However, sometimes the feature detector does not fire when the feature is in the receptive field, or fires when the feature is not there. One possible reason may be that the receptive fields overlap slightly and so firing from a neighbouring receptive field may cause the feature detector to fire by mistake. Therefore the wrong colour may be connected to the wrong form to give a location uncertainty. For example, Ashby et al., (1996) presented healthy participants with a brief display of coloured letters from which they had to indicate when the target letter appeared. They found that illusory conjunctions occurred when the target and non-target letters were sufficiently close to each other and when no attention-demanding task was given (17% illusory conjunctions when letters were 1.6mm apart and 7% when 19.8mm apart).

As the above experiments suggest, it would seem that ones attention is never always totally focused on one object. Therefore, it could be argued that there should be more illusions occurring in everyday life than Triesman and colleagues suggest. In real life situations, however, we already have a frame of reference about certain objects, for example, 'the sky is blue and grass is green', and so we select the conjunction that makes sense (Treisman & Schmidt, 1982). To do this we use top-down processing to help construct objects from features. We allow our previous experiences to guide us into what we have seen during the pre-attentive stage of visual processing. During normal visual processing, the visual fields that hold task-relevant stimuli are more likely to be attended to. Task instructions therefore, provide the necessary context to choose the correct visual stimuli. If there is an error in the pre-attentive binding stage of visual processing due to a high attention load or a misperception of location, the context will override the weaker, correct response and an illusion may occur. For example, given the instructions to look for red triangles among a range of objects, the contextual information will be 'red triangle'. Once the task instructions have been provided contextual processing mechanisms will *attend* to the information required (anything coloured red and any triangle), *inhibit* any information that is not required (ignoring the colour blue and any square shapes) and use *active memory* to hold the task instructions in mind whilst the task is being carried out. However, in normal visual processing there is a limit to how much a person can attend to at any one time. When attention is focused upon more than one task at the same time, thereby causing an overload to the attention capacity, the pathways for 'blue triangle' and 'red square' may be close enough together for a location uncertainty to occur. Context processing mechanisms are dominant over weaker responses even when the weaker response is correct. Therefore the dominant task instructions ('look for red triangles') inhibit the correct response and the triangle and the red colour from the two different objects may be erroneously selected and an illusory conjunction of a red triangle is seen.

Illusory Conjunctions and Context Processing in Schizophrenia

The evidence suggests that if previous experiences are required to help construct objects from features, then illusory conjunctions may not occur so readily when context processing mechanisms are deficient. If this is the case then the evidence so far suggests that people with schizophrenia may be less likely to be 'fooled' by context. A comprehensive literature search was therefore undertaken to try to provide evidence for this hypothesis. It would seem that there are very few research studies looking at the phenomenon of context processing mechanisms within illusory conjunctions using schizophrenic groups. Those that have been found are described below.

Silverstein et al. (2000) have suggested that context processing is impaired in schizophrenia due to abnormal perceptual organisation during the binding of object features. They explain that visual processing involves binding stimuli into a '*context-appropriate coherent whole*' (p12), much the same as words or concepts are bound into coherent thoughts. They suggest that studies of parietal lobe damage in individuals has shown that both linguistic and visual representations are impaired and that these impairments have also been shown to be impaired in people with schizophrenia. Their study consisted of people with chronic schizophrenia who had symptoms pertaining to the disorganisation sub-type, non-schizophrenic psychiatric controls and staff controls. Participants had to identify shape contours among an array of Gabor elements on a card, which was presented to them on a table, one at a time. Gabor elements are, '*gaussian-modulated sinusoid luminance distributions which model the known receptive field properties of neurons in the primary visual cortex*' (Silverstein et al., 2000, p14). They found that patients with high scores on the disorganisation factors derived from the Positive and Negative Syndrome Scale (PANSS; Kay, Opler & Fiszbein, 1987) were significantly less likely to identify the contours than both the psychiatric and staff control groups. They suggest that this reveals a dysfunction of integration abilities, which causes an inability to detect groupings among a range of visual stimuli. Silverstein et al. (2000) state that schizophrenic patients with disorganised symptoms would be less susceptible to visual illusions '*due to poor spatial integration capacities and therefore reduced contextual effects*' (p17). However, in relation to the context processing theory, some of the criteria required to produce a context-sensitive task was not included in Silverstein et al.'s study. For example, participant's working memory was not being manipulated, as they were only required to trace a contour on a card rather than remember task instructions. There was also no delay between instructions and a response. Furthermore, Silverstein et al. found a significant difference in education ability between the schizophrenia and control groups and a significant correlation between task score and education level. This suggests that the results may only indicate a generalised educational difficulty rather than a specific deficit in people with schizophrenia.

An experiment by Carr, Dewis & Lewin (1998b) used an illusory conjunction task on patients with schizophrenia and healthy controls to determine if people with schizophrenia would perform differently. This comprised of an arrow detection task, whereby participants had to push a button if they saw an arrow within a display of lines and right-angled shapes. An illusory conjunction would be seen if they erroneously combined a diagonal line with a right-angled shape believing they had seen an arrow. It was hypothesised that the smaller the exposure time, the more illusory conjunctions would be seen by people with schizophrenia than the control group. However they found that people with schizophrenia saw fewer illusory conjunctions than normal controls. Carr, Dewis & Lewin suggest that this shows that people with schizophrenia do not have perceptual grouping deficits. However, using the context processing theory as a guide, it could also be suggested that the schizophrenic group were unable to use top-down processing mechanisms to aid in the selection of the correct stimuli and so were not 'fooled' by the task instructions as shown in the control group. Also, by taking into consideration the above experiment by Silverstein et al. (2000), perceptual grouping deficits may only occur in schizophrenics with the disorganisation sub-type. As it would seem that Carr, Dewis & Lewin used an undisclosed homogenous group of patients with schizophrenia it may be possible that those with the disorganisation sub-type were not represented in their study.

Brennan & Hemsley (1984) also used an illusory conjunction task to show how people with schizophrenia have difficulties in using top-down processes to guide information processing. They presented participants with ambiguous word pairs with some having associative connections such as 'bacon – eggs'. Under normal processing conditions, when word pairs are presented repeatedly and randomly, an illusory conjunction can occur. This means that associative word pairs are reported even when one of these words is presented with a non-associative word such as 'bacon – tiger'. Participants were shown the word pairs and then asked to rate the percentage of frequency for each word pair. They found that participants with paranoid symptoms of schizophrenia were more likely to over-estimate the number of times they saw associative word pairs, thereby indicating that they had seen more illusory conjunctions than non-paranoid schizophrenics and normal controls. Non-paranoid schizophrenics however, were less likely to make illusory conjunctions than normal controls.

Brennan & Hemsley suggest that this difference is due to a deficit of attentional processes for participants with paranoid symptoms and difficulties in accessing contextual information for participants with non-paranoid symptoms. They state that amongst the paranoid group;

> '...*having established schemata with which to organise incoming stimuli, they moved to automatic processing whereby they assigned most stimuli to these categories without much attention to the stimulus field*' (Brennan & Hemsley, 1984, p226).

Unlike the non-paranoid group, the paranoid group were using context processing mechanisms to categorise the stimuli into pre-formed groups, as were the normal controls. Yet they saw more illusory correlations than the control group because they had either quickly established a context for the task or already held strong schemata to categorise the stimuli and were not attending to new incoming stimuli. As paranoid schizophrenia is associated with positive symptoms and non-paranoid schizophrenia more negative symptoms, it is possible that the specific deficits that Brennan & Hemsley have assigned to their groups are similar to the deficits discussed in previous studies mentioned above for positive-type and negative-type symptoms of schizophrenia. However it should also be noted that Brennan and Hemsley only used a small sample size of patients with schizophrenia (11 paranoid, 8 non-paranoid) and so these results should be treated with caution if trying to generalise to the population as a whole.

The above examples help to show how context processing deficits will affect the different symptoms of schizophrenia during an illusory conjunction task. Unfortunately such studies seem to be limited within the growing body of knowledge regarding schizophrenia. As these studies have produced some evidence for the context processing theory, it would seem appropriate to pursue further research into how illusory conjunctions can help to explain context processing and also help define sub-types of schizophrenia. The present study, described below, is proposed to help explain these issues.

The Present Study

The following experiment used an illusory conjunction task to explore context processing deficits in schizophrenia. This task was originally developed by the experimenter to test visual processing deficits in people with acquired brain damage and so has not been used to test people with schizophrenia before. Therefore it should be considered a pilot study, which will hopefully provide new insights into some of the cognitive deficits seen in schizophrenia. The study used a computerised task, which presented a series of four randomised shapes onto a screen. Participants were required to search for a red triangle (target object) amongst the four shapes and verbally indicate if a red triangle was present during the trial. An illusory conjunction would be identified if the participants indicated that a red triangle had been seen when there was none, but instead another red shape and a different coloured triangle were amongst the four shapes presented. There were three separate conditions, which used additional tasks to load the attention level needed to complete the task. These were: 'searching for the target only', 'naming a letter and then searching for the target' and 'naming a letter, naming a sound and then searching for the object'. Patients were categorised into three separate groups depending upon their symptom sub-types, namely, 'poverty', 'reality distortion' and 'disorganisation'. These groups were chosen from evidence by Liddle (1987a, 1987b) and Silverstein et al. (2000) that the disorganisation group is a separate category with its own distinct features that will perform differently during cognitive tasks to other symptom sub-types of schizophrenia.

Evidence suggests that an illusory conjunction task is one that patients with certain sub-types of schizophrenia will perform better than normal controls (Brennan & Hemsley, 1984; Carr, Dewis & Lewin, 1998b; Silverstein et al., 2000). Therefore using an illusory conjunction task will present a double dissociation with the other cognitive tasks used to test the context processing theory, such as the Stroop and CPT. Also an illusory conjunction task incorporates into one test all the elements of the theory that are tested separately in the Stroop and CPT tasks. For example, the present study produces information that can be ambiguous, as the shapes are presented close enough together and at a short enough duration to produce a location uncertainty. It causes interference, as contextual cues (instructions to find a red triangle) are dominant and will override any weaker, correct response. Finally, the two additional tasks involved, such as naming a letter and a sound before searching for a red triangle, provide a delay between contextual cues and the appropriate response. Cohen et al. (1999) suggest that a task that increases the delay between context and response will be more sensitive to context processing mechanisms. However, to reduce the likelihood of memory decay causing incorrect responses (as recalling three sets of information may well cause memory decay), the two additional tasks have been designed to use both the iconic and echoic memory processes, which are hypothesised to be two separate areas within the sensory store (Sperling, 1960; Treisman, 1964). It is believed that iconic memory is used when brief visual stimuli are presented to a person (Coltheart, 1983). Therefore, recalling a target letter will activate the iconic memory in the sensory store. Echoic memory is used when auditory stimuli are presented to a person. Recalling a sound will activate the echoic memory in the sensory store. Therefore, if two attention-demanding tasks come from different parts of the sensory store there will be less of an overload of the memory capacity for each sensory store and so any illusions seen will be less likely due to memory decay. Furthermore Cohen et al. (1999) explain that memory for context (instructions) is different to short-term memory. They define short-term memory as the, '*temporary storage of recently presented information which may or may not have relevance for later behaviour*' (p121). Memory for context, however, is part of the working memory structure which provides an, '*on-line maintenance and manipulation of information necessary to perform a cognitive task*' (p121).

As the present study was designed to show how context processing could have different effects upon different symptom sub-types of schizophrenia, it is important to identify how each sub-type will be affected by the illusory conjunction task. For the present study the patients have been grouped into the sub-types known as 'poverty', 'reality distortion' and 'disorganised' and so are described as such, rather than the usual positive and negative distinctions. To help clarify this information it is useful to know that poverty symptoms are similar to the negative sub-type and reality distortion symptoms are similar to the positive sub-type.

Patients with poverty symptoms of schizophrenia have been described as having a deficit in top-down processing and so contextual information is less likely to aid the binding of objects together during visual processing. Van den Bosch (1995) explains that many patients with negative-type symptoms of schizophrenia describe a fragmentation of their environment. It is as if they can no longer see the whole picture, but only small, detailed fragments of it. He believes that this is caused by a deficit in the ability to hold onto contextual information within the working memory during feature binding. Other researchers have suggested that 'withdrawal', a symptom of the poverty sub-type, is a protective mechanism to cope with the increasing overload of sensory input (Venables & Wing, 1962; Liddle, 1987a; Van den Bosch, 1995). As it seems that contextual information cannot be maintained, these patients are more likely to say what is really there during the illusory conjunction task, rather than be 'fooled' by the task instructions. For example, during the condition which gives the highest processing demands (name a letter and a sound and then search for the red triangle), if a red square and a blue triangle are close enough together in the presentation of shapes, there may be an uncertainty as to whether a red triangle has been seen. In normal controls the context of the task instructions, 'find a red triangle', will be strong enough to override the true answer and a red triangle may be seen. For patients with poverty symptoms, they cannot access this contextual information and so are more likely to say that there is no red triangle (the correct response). It is predicted, therefore, that illusory conjunctions will be less likely to occur.

People with reality distortion symptoms have been shown to be able to access contextual information and so under normal processing they should perform the same as people without schizophrenia on the illusory conjunction task. However reality distortion symptoms have also been associated with attentional difficulties due to a reduced processing capacity (Brennan & Hemsley, 1984). It has been suggested that people with reality distortion symptoms have difficulty in inhibiting information that is not appropriate to the task in hand (Gray et al., 1991). This would mean that they are more likely to attend to irrelevant information within the environment thereby increasing information processing demands on a limited processing capacity system. This lack of inhibition causes the person to see significance in irrelevant material and to see illusions when they are not really there. In the present study, when attention is diverted away from the task, as in the letter and sound naming conditions, there will be even less processing capacity to conjoin the correct features of objects than for the controls. It is predicted that for these patients there will be more errors in binding objects and illusory conjunctions will increase.

Evidence from research described above suggests that patients with disorganised symptoms produce the greatest disturbance in the processing of context (Johnstone & Frith, 1996; Cohen et al., 1999). Hemsley (1994) proposes that positive symptoms seem to become less severe over time, negative symptoms increase and then become stable over time, but disorganised symptoms become progressively worse. He argues that the central difficulty with the disorganisation sub-type is the persistent inability to make sense of the world and see it as normal and predictable. The more events are seen as novel, the less possible it is to gain a sense of self and hence the inevitable slowing down of normal mental functions. As Hemsley (1994) states,

> *'An accumulation of 'non-fortuitous coincidences'... would, over time make it less and less possible to integrate normal and abnormal precepts within the subjects mental model of the world'* (p83).

If the above statement is true then participants with disorganised symptoms should perform much worse than any other group overall in the present illusory conjunction task.

As the disorganisation sub-type has elements of both positive and negative symptoms (Silverstein et al., 2000), this may suggest an attention deficit plus poor contextual coordination and visual integration abilities, which affect contextual processing. In the present study, this will serve to increase interference between the visual pathways and feature binding is less likely to occur. This means that when attention is focused only on the task in hand as in the easiest condition (e.g. searching for red triangles with no additional task) people with disorganised symptoms may perform worse than other groups, as they are more likely to produce inappropriate responses. As the attention load increases in the following two conditions (letter naming and sound naming), object binding reduces to a greater extent than other groups and so true targets may also be missed. This means that patients with disorganised symptoms would be more likely to see red triangles when there is no 'red' or 'triangle' object and to say there are no red triangles when there actually are.

Unfortunately experience has shown that the symptoms of schizophrenia are never as clearly defined as research would suggest. It is more likely for a patient to have a number of symptoms relating to all three sub-types at the same time. If, as suggested above, different sub-types of schizophrenia perform differently on cognitive tasks, then the question arises how can one tell what is really being tested? Can one be specific, or should schizophrenia be defined as a generalised deficit? Johnstone & Frith (1996) however, suggest that the cognitive deficits within symptom sub-groups are completely independent of each other. They tested 329 patients with schizophrenia on various cognitive tests and found that patients did not have to have purely one symptom sub-type to produce cognitive deficits. This would suggest that a patient could have, for example, both positive and negative symptoms but still produce similar cognitive deficits for each sub-group as someone with purely positive or negative symptoms. Therefore in the present study each patient will be categorised into all three dimensions (poverty, reality distortion and disorganisation) if appropriate.

The rationale described above has given rise to a number of hypotheses relating to the following illusory conjunction task. These are:

Hypothesis 1 - Patients with schizophrenia will perform differently on an illusory conjunction task than non-psychiatric controls.

Hypothesis 2 - Patients with 'poverty' symptoms of schizophrenia will see fewer illusory conjunctions than any other symptom group.

Hypothesis 3 - As the attention load increases, more illusory conjunctions will be seen between the three conditions ('target only', 'letter naming and target', 'letter naming, sound naming and target') for patients with 'reality distortion' symptoms of schizophrenia than any other symptom group.

Hypothesis 4 - There will be more errors overall (illusory conjunctions, target errors, feature errors, and colour errors) for patients with 'disorganised' symptoms of schizophrenia than any other symptom group.

In addition to the above hypotheses, the present study will also look at the relationship between acute and chronic symptoms of schizophrenia. It has been suggested that patients with acute symptoms of schizophrenia are more likely to have attention deficits than chronic symptoms. These patients are more likely to process irrelevant information, which intensifies subjective experience and trivial information becomes significant. This causes less attention to be focused on the task in hand. Van Den Bosch (1995) calls this, 'a *hyperconscious relationship with the world'* and believes that having such a relationship, '*provokes unjustified experiences of significance'* (p355). Having a hyperconscious frame of mind means that the attentional capacity is strained and any attempt to perform higher cognitive activities will overload the working memory causing more illusions to be seen. To test this hypothesis a separate analysis of participants grouped into 'duration of illness' categories will be included. These categories will be divided according to the studies by Kay (1990) and Brown (1960) into three stages of illness namely, 'up to 2 years' (acute), 'between 3-10 years' (chronic) and 'over 10 years' (long-term chronic). Liddle & Barnes (1990) see negative symptoms as more likely to be chronic and positive symptoms as more likely to be acute. They explain that patients are able to have both positive and negative symptoms at the same time, but as the duration of the illness increases, the negative symptoms become stronger. Therefore those patients that are within the 'less than 2-years' category should see more illusory conjunctions than other categories, as they are more likely to have positive symptoms.

Hypothesis 5 - Acute patients will see more illusory conjunctions than chronic and long-term chronic patients.

The Effects of Medication During Cognitive Testing

Cohen et al. (1999) stressed the importance that medication might play in detecting differences between patients. They suggest that with negative symptoms, antipsychotic medication may ameliorate context processing deficits. Choosing patients that are not on any medication, however, would only include those with mild schizophrenia. This would be a disadvantage to the following study as the stronger the illness the more likely there is to be an effect. However, previous research has not shown any such difficulties with task performance and medication. Liddle & Barnes (1990) showed an insignificant correlation between patients with schizophrenia and antipsychotic medication. They suggested that medication does not affect the sub-types of schizophrenia in such a way as to modify their performance in relation to other sub-types. For example, patients with poverty symptoms are usually given lower doses of antipsychotic medication, but this does not mean that they would perform differently than participants with reality distortion symptoms (who are given higher doses), solely on the basis of medication. Stratta et al. (1998) used the AX-CPT test to further investigate the context processing theory and medication. They found that their medicated patients gained similar significant results to the original paper by Servan-Schreiber, Cohen & Steingard (1996), who used un-medicated patients. This would suggest that medication might not affect context processing deficits in some patients with schizophrenia.

A further study by Doniger et al. (2001) found no correlation between neuroleptic dose and performance. They quote a paper by Harris, Gelbtuch & Phillipson (1986) who found that visual acuity was not affected by haloperidol and explain how patients with Parkinson's disease, who have a deficiency in dopamine, do not show deficiencies in visual acuity. This suggests that the effect of dopamine-blocking medication on patients with schizophrenia may also not influence visual acuity.

Previous research also suggests that the influence of anticholinergic medication can have an effect upon memory performance. Anticholinergic medication is given to patients to counteract the side effects of antipsychotic drugs such as tremor, abnormal movements and restlessness. Strauss et al. (1990) compared verbal memory and reaction time in seven schizophrenic outpatients over two different dosages of anticholinergic medication. They found that verbal recall became much worse the higher the dosage, but reaction time improved. Mori et al. (2002) found that schizophrenic patients using anticholinergic medication had a reduced cerebral blood flow which is linked to memory performance. When patients were withdrawn from anticholinergic medication they found an improvement in working memory and an increase in cerebral blood flow. However, Cohen et al. (1999) did not find any correlation between anticholinergic medication and performance on their context processing tasks when using the Stroop test and AX-CPT.

As the consensus on medication is not clear then it is important to note that this might raise questions of validity in the following study. Therefore the details of both antipsychotic and anticholinergic medication will be noted for each patient and analysed in relation to performance on the illusory conjunction task.

METHOD

Overview

The present pilot study used a computerised test to investigate visual processing in patients diagnosed with schizophrenia. Participants were presented with different coloured shapes, and then had to indicate if they had seen a red triangle. There were three separate tasks (described below) designed to increase the attention load and thereby increase the error rate. The number of illusory conjunctions seen, number of target errors made, and number of errors overall were recorded.

Participants

The participants were in-patients from a mental health unit of a suburban London hospital. Participants were included if they had a current diagnosis of schizophrenia as diagnosed by one of the unit's Psychiatrists. Participants were excluded if they suffered from a visual field deficit (such as hemianopia), their diagnosis was uncertain, they had a schizo-affective disorder, or were deemed to be suffering at the time of the testing from an acute psychotic episode that might hinder their co-operation. A control group was also recruited which was comprised of staff from the mental health unit and people known to the experimenter. It was decided that a psychiatric control group would not be required as the intention of the study was to measure differences between different categories of schizophrenia and 'healthy' controls.

As the task used has only ever been tested on people with acquired brain damage there was no previous data to calculate group numbers for optimum effect size. The original study, from which the computer program was replicated, showed that results could produce a large effect size even when using only three participants per brain-damaged group (Brown & Wright, 1998). However, this does not mean that the same effect size will appear for the schizophrenic patients. It was therefore decided to include as many in-patients as possible that matched the inclusion criteria. Sixty-three in-patients were approached to take part, of which 12 refused. A further 10 agreed but were unable to complete the test. Of these 10, three wanted to stop the test after the second trial, as they believed they could no longer concentrate properly. For the remaining seven the researcher abandoned the test as four had difficulty in understanding what they had to do when the tests became harder and three could not distinguish a red triangle from the other shapes during the easiest task. In total there were 41 patients with schizophrenia and 24 non-psychiatric controls. The demographic data can be seen in Tables 1 and 2 below.

Table 1. Sex, ethnicity and education data for the schizophrenia group and controls.

	Schizophrenia N (%)	**Control N (%)**	**X^2 (df)**	**sig**
Sex	**n=41**	**n=24**	2.79 (1)	0.09
Male	29 (70.70)	12 (50.00)		
Female	12 (29.30)	12 (50.00)		
Age	**n=41**	**n=24**	29.58 (32)	0.59
18 – 24	3 (7.20)	2 (8.40)		
25 – 34	10 (24.20)	6 (25.60)		
35 – 44	19 (46.40)	5 (21.00)		
45 - 54	7 (17.00)	9 (37.60)		
55 and over	2 (4.80)	2 (8.40)		
Ethnicity	**n=41**	**n=24**	3.56 (2)	0.17
Asian	9 (22.00)	7 (29.20)		
Black	16 (39.00)	4 (16.70)		
White	16 (39.00)	13 (54.20)		
Education	**n=33**	**n=18**	6.09 (3)	0.11
No qualifications	14 (42.40)	3 (16.70)		
O levels or equivalent	11 (33.30)	10 (55.60)		
A levels or equivalent	5 (15.20)	1 (5.60)		
Higher education	3 (9.10)	4 (22.20)		

The mean age for the schizophrenia group was 38 (sd=9.97) and for the control group 41 (sd=11.20).

Table 1 shows that in the schizophrenia group there were 41.4% more males than females, the majority of patients were in the age range 25-44, there were 17% less Asians than any other ethnic group and 57.6% achieved some form of educational qualifications. In comparison to the control group, there were 20.7% more males in the schizophrenia group, with the same number of females participating. The majority of patients in the control group were white with 15.2% more than the schizophrenia group. The Asian population were similar with only 7.2% more in the control group. The main difference was with the black population as the schizophrenia group had 22.3% more than the control group. The schizophrenic group had 25.7% more participants with no qualifications, although the groups were similar in education at A Level or above, with the schizophrenia group having 24.3% of the population compared with 27.8% of the control group. Data concerning educational qualifications could not be obtained for eight of the schizophrenic participants and six of the control participants. This was due to the information not being present in the files for the schizophrenia group or withheld by participants in the control group.

Although there seemed to be quite a few differences in the demographic data between both groups, statistical analysis using Pearson's Chi-square (see Table 1) showed that none of these differences were significant.

Table 2. Age differences between the schizophrenia group and controls

	Schizophrenia N (%)	**Control N (%)**	**t (df)**	**sig**
Age	**n=41**	**n=24**	1.07 (63)	0.29
18 – 24	3 (7.20)	2 (8.40)		
25 – 34	10 (24.20)	6 (25.60)		
35 – 44	19 (46.40)	5 (21.00)		
45 - 54	7 (17.00)	9 (37.60)		
55 and over	2 (4.80)	2 (8.40)		

The mean age for the schizophrenia group was 38 (sd=9.97) and for the control group 41 (sd=11.20).

Table 2 shows that the majority of patients were younger in the schizophrenia group with 21.8% being over the age of 44 compared with 46% of the control group. However, the T-test (see Table 2) showed that the differences between the two groups were not significant.

Allocation of the Schizophrenia Participants to the Symptom Groups

Senior House Officers and Ward Managers were asked to complete the Brief Psychiatric Rating Scale (BPRS – Lukoff, Nuecheterlein & Ventura, 1986) for each patient that took part in the study so that they could be allocated to a symptom group.

The BPRS is an 18-item questionnaire, which has a 7-point rating scale. The ratings can be seen below:

- 1 = not present
- 2 = very mild
- 3 = mild
- 4 = moderate
- 5 = moderately severe
- 6 = severe
- 7 = extremely severe.

The BPRS was originally designed to measure symptom change in patients with psychotic illness. The items measure; *somatic concern, anxiety, emotional withdrawal, conceptual disorganisation, guilt feelings, tension, mannerisms and posturing, grandiosity, depressive mood, hostility, suspiciousness, hallucinatory behaviours, motor retardation, uncooperativeness, unusual thought content, blunted affect, excitement* and *disorientation*. The BPRS can also be used as a tool to distinguish certain sub-groups of schizophrenia (Overall & Gorham, 1988). To do this, some of the items are excluded from the categorisation procedure as they are designed to distinguish mood disorders rather than sub-classes of schizophrenia.

For the purpose of the present study the BPRS was used to categorise the patients into three symptom groups as suggested by Cohen et al. (1999). These are known as 'poverty', 'disorganised' and 'reality distortion' symptoms of schizophrenia. The items used to categorise the 'poverty' group were *motor retardation, blunted affect* and *emotional withdrawal*. The items used to categorise the 'disorganised' group were *conceptual disorganisation* and *mannerisms and posturing*. The items used to categorise the 'reality distortion' group were *hallucinatory behaviours, suspiciousness* and *unusual thought content*. A patient was placed into a symptom group if they scored 4 or more on the 7-point rating scale on any one of the items that related to the symptom group. For example, if a patient scored 4 or more on the item, *blunted affect*, they would be placed into the 'poverty' symptom group. If a patent scored 4 or more on the item, *unusual thought content*, they would be placed into the 'reality distortion' symptom group. The rating of 4 became a cut-off point as Lukoff et al. (1986) suggest that a rating below 4 does not indicate a pathological entity of that symptom.

The majority of patient's scores, however, were not exclusive to just one symptom group. For example one patient was rated as 4 for *conceptual disorganisation*, 4 for *suspiciousness*, 4 for *hallucinatory behaviour*, 5 for *unusual thought content* and 5 for *blunted affect*. This meant that the patient had symptoms of a pathological entity for all three of the symptom sub-groups. If this occurred patients were placed into all three symptom groups. The data showing the allocation of each patient's symptoms to the symptom groups can be seen in Table 3 below.

Table 3. Number of patients with each symptom rated at 4 or above on the BPRS

Patient's Symptoms rated at 4 or above	**Number of patients**
Poverty only	8
Reality distortion only	6
Disorganised only	1
Poverty and reality distortion	5
Poverty and disorganised	2
Reality distortion and disorganised	4
Poverty, reality distortion and disorganised	15

Table 3 shows that only 15 in-patients were put into just one symptom group. The rest had a mixture of two or three categories of symptoms. This meant that the groups were not mutually exclusive and so a multiple regression analysis would need to be used to calculate the results. As most patients were placed into more than one group it meant that in total there were 30 patients in the 'poverty' symptom group, 22 patients in the 'disorganisation' symptom group and 30 patients in the 'reality distortion' symptom group.

Allocation of the Schizophrenia Participants to the 'Duration of Illness' Groups

Data was gathered from the patient's files as to when they were first diagnosed with schizophrenia. From this date it was calculated how long each participant had been identified as schizophrenic and they were then allocated to one of three groups as suggested by Kay (1990) and Brown (1960). These groups were labelled 'acute', 'chronic' and 'long-term chronic'. Patients that had been diagnosed for up to 2 years were placed into the acute group. Patients that had been diagnosed for between 3 and10 years were placed into the chronic group. Patients that had been diagnosed for over 10 years were placed into the long-term chronic group. There were 4 patients in the acute group, 13 patients in the chronic group and 20 patients in the long-term chronic group. The remaining three patients were excluded from this analysis, as data could not be obtained concerning when they were first diagnosed with schizophrenia.

Allocation of the Schizophrenia Participants to the Medication Groups

Data was gathered from the patient's files regarding their medication and dosages. As patients were on different types of antipsychotic medication, the dosages were transformed into chlorpromazine daily equivalents as indicated by the British National Formulary (British Medical Association, September 2000). The mean daily dosage in chlorpromazine equivalents was 572.05mg (sd=541.94). Patients were then placed into three categories, namely 'small', 'medium' and 'high' dosages as indicated by previous research by Johnstone et al. (1991). If patients were taking less than 400mg of chlorpromazine equivalents they were placed into the 'small dosage' group. If patients were taking between 401mg and 800mg of chlorpromazine equivalents they were placed into the 'medium dosage' group. If patients were taking over 800mg of chlorpromazine equivalents they were placed into the 'high dosage' group. There were 20 patients in the small dosage group, 10 patients in the medium dosage group and nine patients in the high dosage group. For the remaining two patients, there was no mention in their file that they were on any antipsychotic medication at the time of the study.

Patients were also placed into a further category for anticholinergic medication. Patients were divided into those that were taking anticholinergic medication and those that were not, as indicated by the patient's file. The mean daily dosage was 15.71mg (sd=15.66). There were seven patients placed into the anticholinergic group and 34 patients placed into the no anticholinergics group.

Ethics

Before the study began the West London Mental Health Trust was approached for ethical approval. A copy of the approval letter can be seen at appendix A. Once approval was obtained the Consultants from the mental health unit were notified of the study and asked to give their consent for the research to be carried out on their wards (appendix B). A Consultant's information sheet was sent out to explain the study in more detail (appendix C).

Materials

The experiment was carried out on a Packard Bell EasyNote VX laptop computer. It was decided by the experimenter and the field supervisor that a laptop computer was more appropriate as patients who were on locked wards could also take part. It also meant that the experiment could be carried out as soon as the patient agreed, rather than having to wait for a member of staff to escort the patient to the research building.

The software package used to create the computer program was Action! version 3.0. As the experiment was designed by the experimenter it is important to describe how the computer program was designed. It was decided that the experiment would have 32 test trials, which would be repeated over three separate presentations (conditions) but in a different order. There was one example trial at the beginning of each of the three conditions. Previous research has shown that 32 trials are short enough to keep concentration levels maintained, but long enough to produce significant results (Brown & Wright, 1998). At the beginning of each trail there was a central fixation cross which appeared for 1.5 seconds. This was designed to enable the participant to focus on the centre of the screen. The cross then changed to a letter, which was an N, E, H or Z. The letter was also in the centre of the screen so that on conditions 2 and 3 it was ensured that the participant's attention was focused in the same position at the start of each trial. At the same time as the letter was presented, four objects were presented on either the left or right side of the central letter. The objects were a circle, triangle or square with a colour blue, yellow, or red attributed to it. Above and below the objects were two digits randomly picked from the numbers 3, 5, 7 and 9, which appeared for the same amount of time as the objects. The objects were presented vertically on the computer screen in either the participant's peripheral or foveal visual field. Examples can be seen in figures 1 and 2 below. For a description of the presentation of objects for all 32 trials see appendix D.

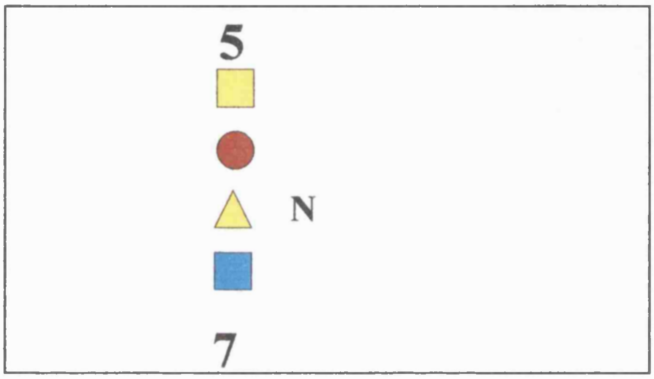

Figure 1. Example of a trial with objects presented to the left foveal field. This shows a possible illusory conjunction as the features 'red' and 'triangle' may erroneously combine.

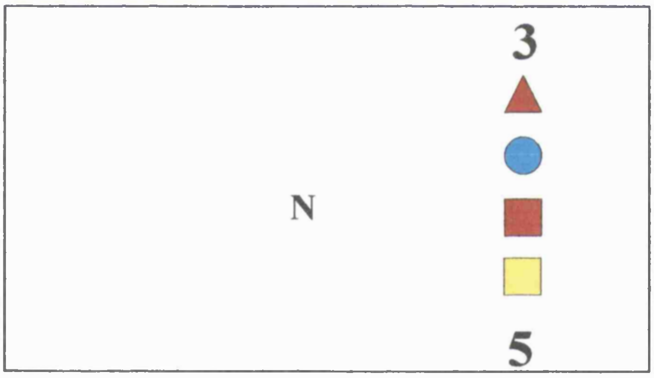

Figure 2. Example of a trial with objects in the peripheral field. This shows a 'target' trial as it has a red triangle.

Of the 32 trials, eight were target trials. This meant that the presentation contained a red triangle and three other different shapes coloured blue, red or yellow. Four were feature only trials in which they did not contain a target object, or any red object, but did include a triangle of a different colour. Four were colour only trials in which there was no target object, (i.e. no triangle), but did include a different red square or circle. The remaining 16 were illusory conjunctions. They contained either a red circle or square and a blue or yellow triangle amongst the four objects (see fig. 1 above). There were eight illusory conjunctions with the target features next to each other, and eight with the target features separated by another object. Each of the three conditions used the same trials but the presentation order was different (see appendix E).

The objects were 5cm in height for the foveal presentations and 8cm high for the peripheral presentations. The objects shown in the participant's peripheral field were larger as previous research had found that small objects are only seen distinctly when they are near the fovea, and so larger objects should be used in the periphery (Harrington & Drake, 1990; Petersen et al., 1994). The presentations of objects in the peripheral field were 6° from the central fixation cross and 1.5 $^{\circ}$ for the foveal presentation.

The exposure duration of the objects was based on studies by Ashby et al. (1996), Hazeltine, Prinzmetal & Elliott (1997), Treisman & Schmidt (1982) and Brown & Wright (1998) who obtained significant results using a similar method. The duration was different depending on the condition being tested. For condition 1, foveal presentation time was 300ms and peripheral 500ms. For conditions 2 & 3, foveal presentation time was 300ms and peripheral presentation was reduced to 400ms in order to increase the attention load.

After the presentation of each trial, a black and white mask appeared on the screen to remove any phosphor traces of the stimuli. Knight & Silverstein (1998) believe that the duration between the mask and following stimuli should be no less than 300ms otherwise the mask may cause interference in attending to the following trial. In this experiment the researcher controlled the presentation of each trail by using a mouse, which allowed time for participants to respond before the next trial was given. This meant that the duration between mask and following stimuli was no less than one second, which should not cause any interference in attending to following trials.

Scorecards were also designed to write down the participant's responses (see Appendix F), which were checked for errors against the data showing the sequence of trials (appendix E).

Procedure

The ward staff were first consulted as to which patients were suitable for the test. Staff then introduced the researcher to each patient who asked if they wanted to volunteer to take part in a study that looked at how people saw objects. They were assured that it would only take about 20 minutes to complete and they would be paid for taking part. If they agreed, participants were taken to the designated test room. This was a quiet room away from the other patients and ward staff. Only the researcher and the participant were present in the room. The patients were given an information sheet explaining the reasons for the study and what they would have to do (see appendix G). The information sheet explained that they would be asked to look at a computer screen and a series of different coloured shapes would appear, on different sides, for a very brief time. The aim of the test was to say 'yes' every time they saw a red triangle.

The members of staff that made up part of the control group were tested in the same environment as the in-patients that belonged to their ward. The rest of the control group were tested in their own home, in a quiet room, away from others. The control group were given a slightly different information sheet from the in-patients (see appendix H). This only differed in its reference to the participants in their group and details about patient care.

If participants agreed to take part they were asked to sign a consent form (appendix I). Both the information sheet and consent form were read by the researcher to all participants so that those with reading difficulties could understand the intentions of the study. All participants were given time to ask questions before the consent form was signed. Once signed, the test instructions were explained to the participant (see appendix J). As shown in appendix J there were three conditions to the test and the instructions were slightly different depending on which condition was being presented. However, the instructions for the second and third conditions were not read out until the participant had completed the previous part.

In condition 1 participants were asked to look at a fixation cross in the centre of the screen. When it changed to a letter they had to verbalise 'yes' or 'no' if they saw a red triangle within the objects presented. In condition 2 participants were asked to look at the fixation cross and when it changed to a letter, say what the letter was. They then had to verbalise 'yes' or 'no' if they saw a red triangle. For the third condition a low or high sound was presented at the same time and for the same exposure duration as the objects[1]. Participants were asked to look at the fixation cross and when it changed to a letter say what the letter was. They then had to verbalise 'high' or 'low' in response to the sound and then say 'yes' or 'no' if they saw a red triangle. During the testing participants were allowed as much time as needed to give a response. The experimenter controlled the presentation of the objects on the screen so that each following trial was not presented until a response had been given and the participant was ready to proceed. The whole process took between 15 minutes and half an hour, depending on how many questions were asked prior to the test and the length of time it took for each participant to respond to each trial.

As all participants were tested in a place that was convenient for them, measures were taken to make the test conditions as similar as possible. A portable, wooden screen was placed behind and around the sides of the computer to reduce external distractions. The screen was 60cm in height, 120cm wide and painted black. The height of the laptop was measured so that the participant's eye level was always in the centre of the screen. Participants were always seated 59cm away from the computer screen to give maximum visual effect[2].

[1]The low tone was taken from the Action! file; MEDIA\ SOUNDEFX\ EDUCATE\ NOTE_D1.WAV. The high tone was taken from the Action! file; MEDIA\ SOUNDEFX\ EDUCATE\ NOTE_C3.WAV.

[2]Professor Michael Wright of Brunel University, who specialises in visual processing, kindly calculated this distance.

Design

The experiment followed a repeated measures design as participants had to complete three trials of the same design, which were manipulated to increase the level of difficulty. There were three between-subject, independent variables, which were 'participant group', 'duration of illness' and 'medication'. The 'participant group' independent variable was comprised of a schizophrenia group and a non-psychiatric control group. The schizophrenia group was further divided into three sub-groups: 'poverty', 'reality distortion' and 'disorganised'. The 'duration of illness' independent variable was comprised of three factors: 'acute', 'chronic' and 'long-term chronic'. The 'medication' independent variable was comprised of two groups of medication: 'antipsychotic' and 'anticholiergic'. There was one main, within-subject independent variable, which was 'attention'. This comprised of three conditions manipulated to increase attention. These were 'target only', 'letter name and target' and 'letter name, sound name and target'.

The dependent variable was named 'errors' which was sub-divided into three factors. These were, 'illusory conjunctions', 'target errors' and 'total errors overall'. Illusory conjunctions occur when a participant says that they have seen a red triangle but two other objects were presented that could cause an illusion. For example, a red circle and yellow triangle are presented but mistaken as a red triangle. Target errors occur when a participant says they have not seen a red triangle when one has been presented. Total errors overall were defined as the total number of errors made by a participant. These could be illusory conjunctions, target errors, colour errors and feature errors. Colour errors occur when a participant says they have seen a red triangle but no red object has been presented and feature errors occur when a red triangle is reported but no triangle has been presented.

Reliability

As this is a pilot study there are no previous measures to indicate its reliability. Reliability assesses whether the test gains similar results on subsequent occasions. Due to time restrictions participants were not re-tested at a later time in order to measure test-retest reliability. However, the participants were given the task three times during testing. Each time the test was re-administered it had an additional task to load the level of attention being used and so should be harder. If participants increased the number of illusory conjunctions over the three tests it would indicate that it is a good measure of reliability.

Validity

Validity asks the question, does the test measure what it is supposed to measure? As this test has not been used before on people with schizophrenia it would be difficult to answer this. However this design has been used in a previous study by the experimenter, to test whether people with acquired brain damage with attention deficits would see more illusory conjunctions than people with acquired brain damage without attention deficits and 'healthy' controls (Brown & Wright, 1998). Results showed that the people with attention deficits were significantly more likely to see illusory conjunctions than any other group and that significantly more illusory conjunctions were seen for this group in the condition that made the highest demands on attention processing capacity. As people with acquired brain damage and attention deficits performed the worst this indicates that the design does indeed measure attentional processes.

The design was also carefully considered as to whether it would be measuring context processing mechanisms (attention, active memory and inhibition). Particular attention was paid to using similar properties to other tests that show deficits in context processing mechanisms such as the Stroop task and the AX-CPT task. For example, active memory was manipulated by producing a delay between the contextual cue and response (used in the AX-CPT task). Attention was manipulated by the need to actively select an object from a range of objects (used in the AX-CPT task). Inhibition was manipulated by having to ignore the contextual cues when an uncertainty occurs during feature binding (used in the Stroop task).

Utility

Utility assesses whether the experiment has practical value such as ease of administration and scoring. The present experiment seemed to have good utility as participants only have to say what they see, rather than push certain buttons for answers, or carry out a complex form of instructions. This reduces the amount of error that could be made by wrong button pushes or misunderstanding of instructions. Also each trial did not begin until the experimenter was certain that the participant was ready, thereby reducing any error made by performance anxiety. The scoring system was also very straightforward in that the numbers of errors made on each trial were added together. This reduces any chance of errors from ambiguity over what is to be scored.

Planned Statistics

As this experiment is a mixed design a number of different statistics were used. The comparison of differences in errors between the patients with schizophrenia and the controls were analysed using a repeated measures ANOVA. A multiple regression analysis was then used to compare the error differences between the sub-groups of schizophrenia for total number of illusory conjunctions seen and total errors made overall. Next, a repeated measures ANOVA was used to compare the differences between the sub-groups of schizophrenia over the three conditions. ANOVAs were also used to compare the differences in errors for the length of time participants had been diagnosed with schizophrenia and to compare any performance differences for dosages of antipsychotic medication. Finally, a t-test was used to compare differences in performance for those using anticholonergic medication and those that were not.

RESULTS

The results section will analyse each hypothesis in turn as stated in the introduction. Firstly an analysis will be made between the schizophrenic group as a whole and the non-psychiatric control group. This will determine if people with schizophrenia perform differently to the control group. Next, the three sub-groups of schizophrenia, as defined in the methodology section will be analysed to determine if there are any symptom differences. Finally the effects of medication will be analysed to see if the amount of medication taken by the patients has had any effect upon the performance of the schizophrenic group.

Before analysis could take place the participants were scored on how many errors they made. These were categorised into three error types: illusory conjunctions, target errors, and total errors overall. The group, 'total errors overall', included illusory conjunctions, target errors, colour errors, and feature errors. The raw scores can be seen at appendix K.

Hypothesis One

The first hypothesis stated that people with schizophrenia would perform differently on an illusory conjunction task than normal controls. This hypothesis was tested by dividing the participants into two groups namely, schizophrenic and controls and then using repeated measures ANOVAs to see if people with schizophrenia perform differently to non-psychiatric controls. Three repeated measures ANOVAs were used to test the difference between the two groups for illusory conjunctions, target errors and total errors overall. The results can be seen in Table 4 below.

Table 4. ANOVAs for the schizophrenia group versus the non-psychiatric control group for number of illusory conjunctions, target errors and total errors seen.

	Schizophrenia n=41 Mean (sd)	Control n=24 Mean (sd)	Group F (df) sig	Condition F (df) sig	Group x Condition F (df) sig
Illusory Conjunction			25.43 (1,63) 0.04	15.44 (2,62) 0.00	3.37 (2,62) 0.04
Condition 1	0.44 (1.12)	0.17 (0.56)			
Condition 2	1.87 (2.18)	0.79 (1.53)			
Condition 3	1.21 (1.90)	0.33 (0.64)			
Target Errors			5.29 (1,63) 0.02	18.01 (2,62) 0.00	3.13 (2,62) 0.05
Condition 1	0.07 (0.26)	0.04 (0.20)			
Condition 2	1.54 (1.82)	0.58 (0.78)			
Condition 3	1.37 (2.05)	0.71 (1.00)			
Total Errors Overall			9.92 (1,63) 0.00	37.98 (2,62) 0.00	6.41 (2,62) 0.00
Condition 1	0.71 (1.36)	0.25 (0.90)			
Condition 2	3.85 (3.18)	1.62 (2.16)			
Condition 3	3.05 (2.85)	1.17 (1.20)			

The first two columns from Table 4 show the means and standard deviations for the schizophrenia and control groups. The third column shows the main effect for group. This indicates that the people with schizophrenia saw significantly more illusory conjunctions and made significantly more target errors and total errors overall than the non-psychiatric controls. The fourth column shows the main effect for condition. This indicates that as the attention load increased over the three conditions people with schizophrenia made more illusory conjunctions, target errors and total errors overall than non-psychiatric controls. The fifth column shows the interaction between group and condition. This indicates that the main effect was qualified by the significant results shown in the interaction between group and condition for illusory conjunctions and total errors overall. The interaction between group and condition, however, only showed a trend for target errors. The graphs below illustrate the differences between the two groups as attention load increased for the three types of errors.

Average Number of Illusory Conjunctions Seen for People With Schizophrenia versus Controls

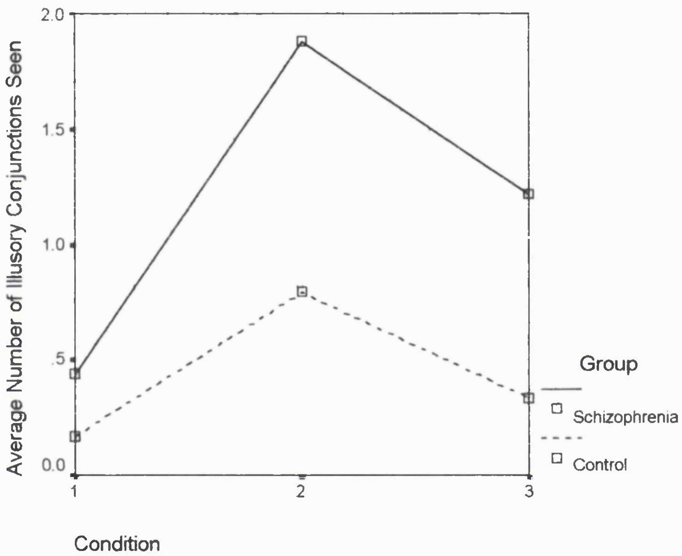

Figure 3. Graph to illustrate the number of illusory conjunctions seen as the attention load increased over the three conditions for schizophrenics and controls.

Figure 3 shows that the two groups were quite similar in the number of illusory conjunctions seen in the first condition. This condition had no additional task to complete and so there was nothing to overload the attention. In conditions 2 and 3 the schizophrenia group increased the number of illusory conjunctions, whereas the control group remained roughly the same. For condition 2 there was one additional task to complete before the target response was made and for condition 3 there were two additional tasks to complete. These two conditions also had their presentation time reduced from 500ms (as shown in condition 1) to 400ms. It is interesting to note that the third condition, although harder, did not on average cause more illusory conjunctions than condition 2. This will be discussed further in the discussion below.

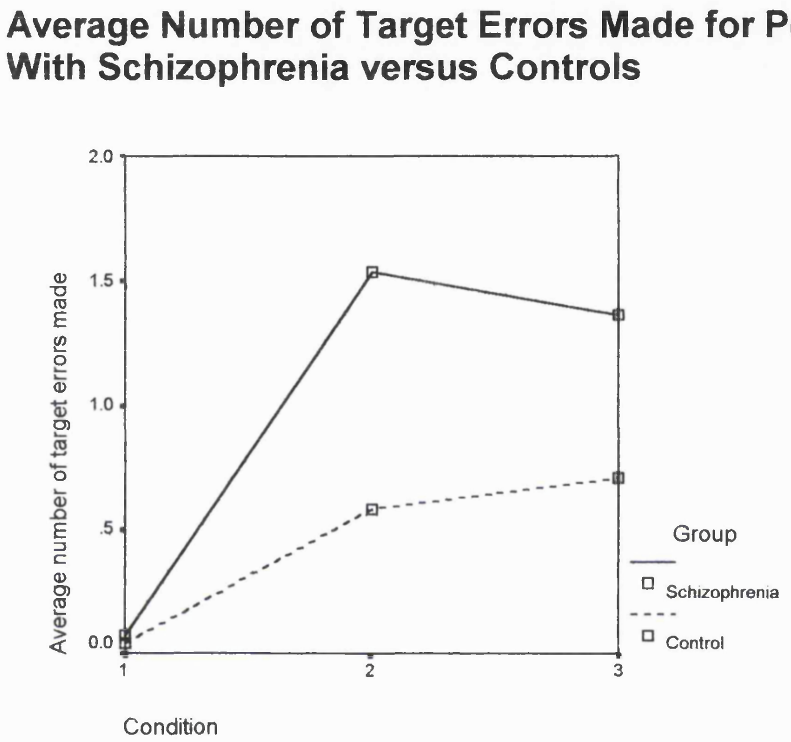

Figure 4. Graph to illustrate the number of target errors made as the attention load increased over the three conditions for schizophrenics and controls.

Figure 4 shows that the two groups on average made the same number of target errors in the first condition. In conditions 2 and 3 the schizophrenia group increased the number of illusory conjunctions from condition 1, to a greater extent than the control group. For condition 3, the schizophrenia group reduced the average number of target errors made, whereas the control group made more errors.

Average Total Number of Errors Made for People with Schizophrenia versus Controls

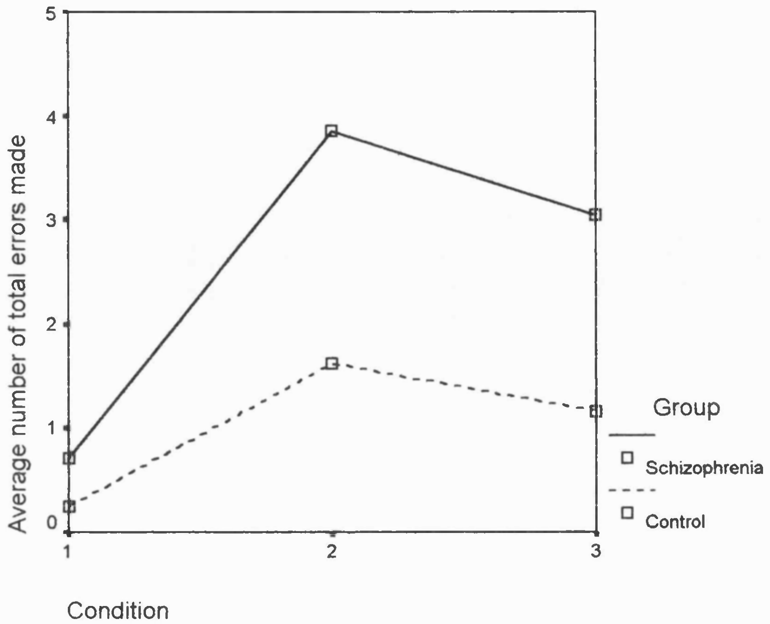

Figure 5. Graph to illustrate the number of total errors seen as the attention load increased over the three conditions for schizophrenics and controls.

Figure 5 is also very similar in its presentation to figures 3 and 4. The two groups were very similar in the total amount of errors seen in the first condition. In conditions 2 and 3, however, the schizophrenia group increased in total number of errors overall, whereas the control group remained roughly the same. Again it is shown that the third condition, although harder, did not on average cause more total errors overall than condition 2. This will be discussed further in the discussion.

As the interaction between group and condition was significant a post-hoc comparison was made using Bonferroni pairwise comparisons, which tests for type I error. The results can be seen in Table 5 on the next page.

Table 5. Bonferroni pairwise comparisons showing the mean differences between the schizophrenia group versus the non-psychiatric control group and the mean differences between each condition for number of illusory conjunctions, target errors and total errors seen.

	Schizophrenia Mean (sig)	Control Mean (sig)	Schizophrenia Condition 1 Mean (sig)	Schizophrenia Condition 2 Mean (sig)	Schizophrenia Condition 3 Mean (sig)	Control Condition 1 Mean (sig)	Control Condition 2 Mean (sig)	Control Condition 3 Mean (sig)
Illusory Conjunctions								
Condition 1	0.272 (0.271)	-0.272 (0.271)		1.439 (0.000)	0.780 (0.000)		0.625 (0.123)	0.167 (1.000)
Condition 2	1.086 (0.036)	-1.086 (0.036)	-1.439 (0.000)		-0.659 (0.009)	-0.625 (0.123)		-0.458 (0.314)
Condition 3	0.886 (0.031)	-0.886 (0.031)	-0.780 (0.000)	0.659 (0.009)		-0.167 (1.000)	0.458 (0.314)	
Target Errors								
Condition 1	0.03 (0.617)	-0.03 (0.617)		1.463 (0.000)	1.293 (0.000)		0.542 (0.234)	0.667 (0.173)
Condition 2	0.953 (0.018)	-0.953 (0.018)	-1.463 (0.000)		-0.171 (1.000)	-0.542 (0.234)		0.125 (1.000)
Condition 3	0.447 (0.146)	-0.447 (0.146)	-1.293 (0.000)	0.171 (1.000)		-0.667 (0.173)	-0.125 (1.000)	
Total Errors Overall								
Condition 1	0.457 (0.148)	-0.457 (0.148)		3.146 (0.000)	2.341 (0.000)		1.375 (0.012)	0.917 (0.060)
Condition 2	0.733 (0.003)	-0.733 (0.003)	-3.146 (0.000)		-0.805 (0.092)	-1.375 (0.012)		-0.458 (1.000)
Condition 3	1.882 (0.003)	-1.882 (0.003)	-2.341 (0.000)	0.805 (0.092)		-0.917 (0.060)	0.458 (1.000)	

Table 5 shows the pairwise comparisons for the main effect of group and the main effect of condition. The first two columns show the group comparisons. The results indicate that there was no difference between the schizophrenia and control group for condition 1 with regards illusory conjunctions, target errors and total errors overall. As stated earlier condition 1 was the easiest of the tests with no additional task to load the attention before the target response was required. However, there was a significant difference between the two groups for conditions 2 and 3 for total errors overall and illusory conjunctions. This implies that the significant results highlighted in the repeated measures ANOVAs are justified and are not due to a type I error. When comparing the number of target errors made, however, there was a significant difference between the two groups for condition 2 but not for condition 3.

The next three columns show the comparisons between conditions for the schizophrenia group. The results indicate that there was a significant difference in the number of errors made between conditions 1 and 2 and between conditions 1 and 3 for illusory conjunctions, target errors and total errors overall. This implies that the significant results highlighted in the repeated measures ANOVA are justified and are not due to a type I error. However, it is noticeable that the differences between condition 2 and 3 only show significance for the number of illusory conjunctions seen. There is no significant difference between the number of target errors made and total errors made overall.

The last three columns show the comparisons between conditions for the control group. There are no significant differences between any of the conditions for illusory conjunctions and target errors. However there is a significant difference between conditions 1 and 2 (but not between conditions 1 and 3 or 2 and 3) for total errors overall.

It would seem from the results discussed above that the null hypothesis for hypothesis one can be rejected. People with schizophrenia do perform differently on an illusory conjunction task than non-psychiatric controls.

Hypothesis Two

Hypothesis two states that patients with poverty symptoms of schizophrenia will see fewer illusory conjunctions than any other schizophrenic group. To test this hypothesis each participant was allocated to one, two or three symptom groups depending on their scores on the Brief Psychiatric Rating Scale. As patients could be in more than one group the groups were not mutually exclusive. Therefore a multiple regression analysis was used so as to counteract the effects of the other groups. It was found that there was no significant main effect of symptoms for number of illusory conjunctions seen ($F=0.99$, $df=3$, $p<0.41$). The means, standard deviations and coefficients can be seen in Table 6 below.

Table 6. Multiple regression analysis of the number of illusory conjunctions seen for the three schizophrenic symptoms.

	Mean (n=41)	sd	B	β	t	p
Poverty	1.27	0.45	0.87	0.08	0.49	0.42
Reality Distortion	1.27	0.45	-2.36	-0.22	-1.28	0.21
Disorganised	1.46	0.50	1.66	0.18	1.03	0.31

Table 6 shows that there was no significant difference between each symptom group for number of illusory conjunctions seen and so the null hypothesis was not rejected. Patients with poverty symptoms of schizophrenia do not see fewer illusory conjunctions than any other symptom group.

Hypothesis Three

Hypothesis three states that as the attention load increases more illusory conjunctions will be seen between the three conditions (target only, letter naming and target, letter naming, sound naming and target) for patients with reality distortion symptoms of schizophrenia than any other schizophrenic group. It was not possible to test this hypothesis as the groups were not mutually exclusive and so this comparison was not justified.

Hypothesis Four

Hypothesis four states that there will be more errors overall (illusory conjunctions, target errors, feature errors and colour errors) for patients with disorganised symptoms of schizophrenia than any other schizophrenic group. As in hypothesis two, the symptoms are not mutually exclusive groups and so a multiple regression analysis was used to test the above hypothesis. It was found that there was no significant main effect of symptoms ($F=0.36$, $df=3$, $p<0.78$). The coefficients can be seen in Table 7 below.

Table 7. Multiple regression analysis of the total number of errors made for the three schizophrenic symptoms.

	Mean (n=41)	sd	B	β	t	p
Poverty	1.27	0.45	0.46	0.03	0.19	0.85
Reality Distortion	1.27	0.45	-2.29	-0.16	-0.89	0.38
Disorganised	1.46	0.50	1.24	0.10	0.56	0.58

Table 7 shows that there are no significant differences between each symptom group for total errors made and so the null hypothesis was not rejected. Patients with disorganised symptoms of schizophrenia do not make more errors overall than any other schizophrenic group.

Hypothesis Five

Hypothesis five states that acute patients will see more illusory conjunctions than chronic patients. Firstly, the patients were divided into three groups according to the length of time that they had been diagnosed with schizophrenia. Three of the patients were excluded from this analysis, as it was not known when they were first diagnosed with schizophrenia and so their duration of illness could not be determined. An ANOVA was then used to see if there were any differences between the groups with regards illusory conjunctions. The results can be seen in Table 8 below.

Table 8. ANOVA showing the differences between the number of illusory conjunctions seen and the duration of illness.

	Mean (n)	**sd**	**F**	**df**	**sig**
Illusory Conjunctions			2.61	2, 34	0.09
Acute	0.50 (4)	1.00			
Chronic	1.92 (13)	1.55			
Long- term chronic	3.75 (20)	3.89			

Table 8 shows that there was no significant difference between the duration of illness and number of illusory conjunctions seen. However there does seem to be a trend for the long-term chronic patients to perform worse than any other group. Therefore the null hypothesis was not rejected. Acute patients do not see more illusory conjunctions than chronic patients.

Medication

An analysis of the medication taken by patients was made to see if antipsychotic medication would have an effect upon the illusory conjunction task. Firstly, the different types of antipsychotic medication were transformed into chlorpromazine equivalents as indicated by the British National Formulary (British Medical Association, Sept 2000). Patients were then placed into three categories, namely 'small', 'medium' and 'high' dosages as indicated by previous research by Johnstone et al. (1991). ANOVAs were then used to analyse the effects of differences in medication upon errors made. Results can be seen in Table 9 below.

Table 9. ANOVAs showing the differences between the dosages of antipsychotic medication in relation to the number of illusory conjunctions, target errors and total errors made.

	Mean (n)	sd	F	df	sig
Illusory conjunctions			0.28	2, 38	0.76
Low dose	3.48 (21)	5.72			
Medium dose	2.80 (10)	3.01			
High dose	4.40 (10)	4.12			
Target errors			0.70	2, 38	0.50
Low dose	8.00 (21)	7.26			
Medium dose	6.20 (10)	5.14			
High dose	8.20 (10)	6.30			
Total errors overall			0.31	2, 38	0.74
Low dose	3.57 (21)	3.87			
Medium dose	2.40 (10)	2.32			
High dose	2.30 (10)	2.75			

Table 9 shows that there was no significant difference between the medication dosage and number of illusory conjunctions seen, target errors and total errors overall. This suggests that antipsychotic medication does not affect performance on this illusory conjunction task.

The influence of anticholinergic medication was also tested as it is suggested that such medication can have an effect upon memory performance. Patients were divided into two groups namely, those using anticholinergic medication and those that were not. T-tests were then used to analyse the effects of anticholinergics upon errors made. The results can be seen in Table 10 below.

Table 10. T-tests showing the differences between anticholinergic medication and the number of illusory conjunctions, target errors and total errors made.

	Mean (n)	sd	t	df	sig
Illusory conjunctions			0.54	39	0.59
Using anticholinergics	4.43 (7)	4.23			
Not using anticholinergics	3.35 (34)	4.89			
Target errors			0.61	39	0.55
Using anticholinergics	8.71 (7)	6.05			
Not using anticholinergics	7.38 (34)	6.62			
Total errors overall			0.49	39	0.63
Using anticholinergics	2.29 (7)	2.36			
Not using anticholinergics	3.12 (34)	3.45			

Table 10 shows that there was no significant difference between patients on anticholinergics and those that were not in relation to number of illusory conjunctions, target errors and total errors overall. This suggests that anticholinergic medication does not affect performance on this illusory conjunction task.

Summary

The results reveal that only the first hypothesis was accepted. People with schizophrenia do seem to perform differently to non-psychiatric controls. The differences are that patients with schizophrenia see more illusory conjunctions and make more target errors and total errors overall. Post-hoc tests were undertaken to try to identify the source of these differences. It was found that both groups perform similarly on the first condition. This was the easiest task as it had no additional task to load attention and participants just had to say yes or no if they saw a red triangle. Both groups made very few illusory conjunctions, target errors and total errors overall on this task. The groups however differed in their performance on conditions 2 and 3. The control group did not see significantly more illusory conjunctions, target errors and total errors overall for these two conditions in relation to condition 1. This indicates that the tasks designed to load the attention (name a letter for condition 2 and name a letter and a sound for condition 3) did not significantly affect the performance of the control group. However, it was shown that the schizophrenia group did see significantly more illusory conjunctions, target errors and total errors overall when the attention load increased in the 2nd and 3rd conditions. This would indicate that the additional tasks designed to increase the attention load did affect performance for the schizophrenia group. However, it is interesting to note that although the third condition was designed to be harder than the other two conditions both the schizophrenia group and control group did not see significantly more target errors or total errors overall in this condition compared to the second condition.

The other four hypotheses were not shown to be significant. Patients with poverty symptoms did not see fewer illusory conjunctions, patients with reality distortion symptoms did not see more illusory conjunctions as the attention load increased, and patients with disorganised symptoms did not see more total errors overall. It was also found that patients that were classed as acute in their presentation did not see more illusory conjunctions than those that were classed as chronic or long-term chronic. Results suggest that there was a trend for the reverse, as long-term chronic patients saw on average more illusory conjunctions than any other group. Furthermore, the non-significant results from the analyses of medication suggest that antipsychotic and anticholinergic medication did not affect the performance of patients on the illusory conjunction task. Overall the results suggest that the illusory conjunction task cannot distinguish between sub-groups of schizophrenia, but does show that when schizophrenia is classed as one homogeneous group, there are significant differences in performance when compared to a non-psychiatric control group.

DISCUSSION

Overview

The present pilot study used an illusory conjunction task to re-examine the context processing theory. Context processing theory suggests that during information processing a single underlying mechanism *'actively holds information in mind in such a form that it can be used to mediate task appropriate behaviour'* (Cohen et al., 1999, p120). This mechanism is comprised of inhibition, attention and memory. It is suggested that people with schizophrenia have difficulties in using context processing mechanisms to aid in the processing of information. The illusory conjunction task designed for the present study was deemed an appropriate method to test this theory. The illusory conjunction task involved a series of objects being presented briefly onto a computer screen in varying positions. The task instruction was to verbally indicate when a red triangle had been seen. The task had three levels of difficulty designed to increase the participant's attention load. Attention load was manipulated by asking for additional information prior to the target instruction and reducing the presentation times. An illusory conjunction was seen if a participant believed they had seen a red triangle when there was another red shape and a different coloured triangle presented.

As the experimenter had designed the task, it had not been used before to test the context processing theory. Therefore it was important to ensure that such a task would follow the criteria that Cohen et al. (1999) suggested were required for it to be context-sensitive. For example, the presentation of the shapes on the screen was carefully calculated from previous research that showed that these distances and presentation times were close enough together and at a short enough duration to produce a location uncertainty, thereby causing information to be ambiguous (Treisman & Schmidt, 1982; Harrington & Drake, 1990; Petersen et al., 1994; Ashby et al., 1996; Hazeltine, Prinzmetal & Elliott, 1997; Brown & Wright, 1998). The contextual cues (instructions to find a red triangle) were dominant to the task, thereby causing interference when weaker, correct responses were presented (e.g. believing one had seen a red triangle when a different coloured triangle and a different red shape were presented). The two additional tasks involved, such as naming a letter and a sound before searching for a red triangle, provided a delay between contextual cues and the appropriate response. Finally, the strength of competing responses became stronger as the attention needed to perform the task increased. This would cause an increase in information processing demands upon a limited processing capacity system for all participants. However, as it is suggested that patients with schizophrenia have a deficit to areas that underlie attention, their capacity would already be reduced and hence be more influenced by irrelevant stimuli (Brennan & Hemsley, 1984; Gray et al., 1991).

After testing 41 people with schizophrenia and 24 non-psychiatric controls, the first hypothesis was shown to be significant. The patients with schizophrenia did in fact perform differently to the non-psychiatric control group. Results showed that the schizophrenic group saw significantly more illusory conjunctions and had significantly more target errors and total errors overall than non-psychiatric controls. It was found that patients with schizophrenia were significantly more likely to see illusory conjunctions than non-psychiatric controls as the attention load increased. It was also found that patients with schizophrenia were significantly more likely to make errors overall than controls as the attention load increased. The increase in errors as task difficulty increased was shown to be higher in the second condition, which had one additional task, than in the third condition, which had two additional tasks.

Comparisons were also made between the different sub-groups of schizophrenia, namely poverty, reality distortion and disorganised. Patients with poverty symptoms of schizophrenia did not see fewer illusory conjunctions than any other schizophrenic group. Patients with disorganised symptoms of schizophrenia did not make more errors overall than any other schizophrenic group. Acute patients did not see more illusory conjunctions than chronic patients. Thus the initial hypotheses were disconfirmed.

The following discussion will first look at the significant findings with regards schizophrenic and non-psychiatric controls and consider how these findings help to explain the context processing theory in relation to the literature described in the introduction. It will then look at the non-significant findings between the different sub-groups of schizophrenia and try to explain what this means for the context processing theory. Methodological limitations of the present study will then be discussed and suggestions given on how improvements could be made if this experiment was carried out again. Finally there will be a discussion on what implications this study has for clinical work and future research.

Schizophrenia Versus Non-psychiatric Controls

The significant findings with regards performance between people with schizophrenia and non-psychiatric controls seem to corroborate previous predictions concerning schizophrenic performance in context-sensitive tasks. As Cohen et al. (1999) suggest people with schizophrenia show a disturbance in the ability to process context-dependent information, which causes a difficulty in being able to select task-appropriate actions over competing responses. Part of this difficulty seems to stem from an inability to keep in mind a set of task instructions needed to identify the correct stimuli required. Yet at the same time the present study showed that task instructions could also become a distractor for the correct stimuli. In the present study the task instructions, 'look for a red triangle' became a distractor for the correct response when high processing demands caused an uncertainty at the binding stage of visual processing. Patients with schizophrenia were unable to inhibit the dominant contextual cue (red triangle) and saw significantly more red triangles when there were none being presented. As the nature of the illusory conjunction task was to show how a failure in inhibition could give rise to an incorrect response, it would seem that inhibitory mechanisms are crucial to the processing of stimuli. As Servan-Schreiber, Cohen & Steingard (1996) state,

> '*Such tasks require the use of encoding strategies that rely on the representation and maintenance of contextual information rather than simply short-term memory to manage supraspan items or to prevent the influence of intervening distracting items*' (p1110).

Non-psychiatric controls performed as expected. They appeared to use contextual information to influence their responses. When there was a presentation that showed an illusory conjunction they used their prior knowledge (the contextual cue) to select the dominant response (red triangle) rather than the weaker correct response (blue triangle, red square). The control participants were 'fooled' by their contextual processing mechanisms. Many theorists researching illusory conjunctions suggest that this is a normal phenomenon in non-psychiatric, healthy controls (Treisman & Schmidt, 1982; Prinzmetal, Henderson & Ivry, 1995; Hazeltine, Prinzmetal & Elliott, 1997). However, the evidence also indicates that the schizophrenic group were performing in a similar way to the healthy controls, as they saw illusory conjunctions too. This would suggest that people with schizophrenia might have intact context processing mechanisms.

Previous research has also shown that people with schizophrenia have intact context processing mechanisms. For example, Chey & Holzman (1997) have shown that visual perceptual organisation is relatively intact in people with schizophrenia. They used Gestalt principles to examine proximity, collinearity and similarity on patients with schizophrenia, bipolar disorder and healthy controls. Participants had to indicate if the stimulus on the computer screen was part of the pattern presented at the start of the trial. Patients with schizophrenia were as accurate as the other groups in their responses. For Chey & Holzman, however, there was no manipulation of the attention capacity. In the present study, during condition 1, the presentation times are low and no prior demanding task is required. Participants only have to say what they see. During this condition the schizophrenic group seem to hold the context in mind and are able to mediate an appropriate response and so the patients are performing in the same manner as Chey & Holzman suggest. Yet when the attention load increased in conditions 2 and 3, by having to perform additional tasks, the schizophrenic group saw significantly more illusory conjunctions than the control group.

Liu, Hwu & Chen (1997) also state that when patients only need to keep a single set of instructions in mind or a single stimulus this places the least demand on the system and so are less susceptible to degradation. They believe that competing responses are most sensitive to context processing effects and that schizophrenics should show the greatest deficits when a dominant response tendency leads to an inappropriate response. The key element to the illusory conjunctions task in the present study was that a dominant response tendency would lead to an inappropriate response. Therefore the significant differences between the schizophrenic and non-psychiatric control group indicate that increasing the attention processing capacity has an effect on the schizophrenic group only. So what does this mean for the context processing theory?

Cohen et al. (1999) explain that representations of context support task-relevant information during competing processes. By manipulating a delay between contextual support and task-relevant information, errors in context processing will be made for people with schizophrenia. They believe this is caused by a deficit within working memory, which is responsible for on-line maintenance and manipulation of information. They manipulated delay by increasing the presentation time between the contextual cue and target response during cognitive tasks. This manipulation had an effect for both schizophrenic and control groups much the same as it did in the present study. However, in the present study the delay was manipulated between the contextual cue and target response by increasing processing demands upon attention. This was not done by Cohen et al. Manipulating the delay through increasing processing demands was shown to significantly increase errors for the schizophrenic group as a whole but not for any specific sub-type. This additional factor suggests that when attention is over-stimulated it reduces the efficiency of the context processing mechanism in all sub-types of schizophrenia rather than just those with disorganised symptoms as Cohen et al. suggest.

Further analysis has shown that the schizophrenic group as a whole performed as it was predicted that the reality distortion group would perform. It was hypothesised that the patients with reality distortion symptoms would be able to access contextual information (Brennan & Hemsley, 1984) under normal visual processing and so they should perform the same as people without schizophrenia on the first condition of the illusory conjunction task. However, as they are perceived to have difficulties within areas of the brain that underlie attention, people with such symptoms would have difficulty in inhibiting information that is not appropriate to the task in hand (Cohen et al., 1999). This would cause more illusory conjunctions to be seen in conditions 2 & 3 due to the high processing demands. This is what appears to have happened to the schizophrenic group as a whole in the present study.

It would seem, therefore, that it is likely that there is an underlying cognitive deficit found in schizophrenia. Could it be suggested then that all people with schizophrenia have deficits inhibiting irrelevant material and hence use up more of their information processing capacity than normal controls rather than just the reality distortion sub-group as suggested by Cohen and colleagues? To help answer this question, a literature search was made to find studies that may also have drawn similar conclusions.

Research by Verbraak, Hoogduin & Schaap (1993) found that patients with either positive or negative symptoms have difficulties in visual processing tasks. They found that both positive and negative groups performed significantly different than healthy controls on the Wisconsin Card Sorting Test (WCST), which measures concept processing, the CPT, which measures vigilance in inhibiting distractors during high and low demand and a backward masking task which measures apprehension of briefly presented digits. Stratta et al. (2000) describe the WCST as 'crucial' in its ability to detect context processing deficits. It has also been shown above that the CPT tasks produce context processing deficits in patients with schizophrenia. Therefore the research by Verbraak, Hoogduin & Schaap (1993) provides further evidence that context processing deficits are deficient in both positive and negative-type symptoms of schizophrenia, which is similar to the conclusions of the present study.

Serper (1993) used a visual selective attention task with both low and high processing demands on people with schizophrenia, bipolar disorder and healthy controls. Participants had to push a button whenever a histogram touched the outer display on a computer screen. Serper found that people with schizophrenia were more likely to gain errors during high processing demands than the bipolar disorder and healthy controls. He suggested that during visual information processing schizophrenic patients have a limited pool of resources, which is consistent with a generalised deficit in schizophrenia. Such research also seems to be compatible with the present study in that schizophrenics have an underlying deficit of attention that is seen in all symptom sub-groups. It would be unwise to make such a statement without further investigation, and so the results of the separate sub-groups of schizophrenia will now be discussed.

Non-significant Findings Between Symptom Sub-types

In the present study none of the results were significant when looking at the difference between the different symptom sub-groups of schizophrenia. Firstly, patients with poverty symptoms of schizophrenia did not see less illusory conjunctions than any other sub-group. This is contrary to the findings of Silverstein et al. (2000), Laplante, Everett & Thomas (1992) and Brennan & Hemsley (1984), who suggested that patients with negative symptoms would perform better than other sub-groups on cognitive performance tasks that use context processing mechanisms. Secondly, patients with disorganised symptoms of schizophrenia did not see significantly more total errors overall. This is contrary to the findings of Hemsley (1994), Silverstein et al. (2000) and Cohen et al. (1999), who suggested that patients with these types of symptoms should perform significantly worse on context processing tasks than any other symptom sub-group '*due to poor spatial integration capacities and therefore reduced contextual effects*' (Silverstein et al., 2000, p17). Finally, patients with acute symptoms of schizophrenia did not see significantly more illusory conjunctions than chronic or long-term chronic patients. This is contrary to the findings of Van Den Bosch (1995) and Liddle & Barnes (1990) who suggested that acute patients with more positive symptoms have less attentional processing capacity, which should cause more illusory conjunctions to occur.

However, the non-significant finding between deficits in context processing and poverty symptoms has been replicated by Cohen and colleagues (Servan-Schreiber et al., 1996; Cohen et al. 1999). They suggest that possibly patients with negative-type symptoms do not have context processing deficits, which seems to be confirmed in the present study. However it must be taken into consideration that both the present study and the one by Cohen et al. (1999) used a cross-section of patients, which may not provide the most sensitive test of relationships between sub-groups. For example, in the present study, the schizophrenia group as a whole performed as predicted by the reality distortion group. Therefore it could be suggested that the individual reality distortion symptoms were more severe in patients than any other symptom. However, if this were true it does not explain why the reality distortion group, when analysed as a single entity, did not show any significant results. It may have been that the multiple regression analysis was not sensitive enough to filter out all the other sub-group symptoms. Therefore those patients that had a mix between the different sub-types could either be confounding the results, or there is no difference between the sub-types in relation to this particular context processing task. It could also be suggested that the present study did not use enough participants to gain a significant effect for the symptom sub-groups. This will be discussed further when describing the methodological limitations of the study (see below).

Although the present study could not find any differences between sub-types, this is not uncommon. Many studies only test for differences between schizophrenics and non-psychiatric control groups with the schizophrenics comprising one homogeneous group rather than separating them into symptom groups (Posner et al. 1988; John & Hemsley, 1992; Doniger et al., 2001). This would suggest that if it is possible to make a clear distinction between these groups it is more likely that there are some cognitive tasks that people with schizophrenia perform badly on regardless of their sub-type.

Although it may be useful to cluster symptoms into categories, it has been shown in the introduction that there is no real reason to indicate that these categories are homogeneous. Cohen and colleagues have themselves found significant differences in one sub-type, but later found a significant difference in a completely different sub-type when using the same experiment. For example, in 1992, Cohen et al. proposed that context processing deficits were present in patients with negative symptoms of schizophrenia, whereas in 1999 Cohen et al. proposed that these deficits were associated with disorganised symptoms. History suggests that many of the symptom clusters are due to knowledge and fashion of the time and may not really have anything particular in common except the category that they are assigned to (Berrios, 1995). As Liddle (1987a) states,

> '*the syndromes do not represent distinct types of schizophrenia but instead reflect discrete pathological processes occurring within a single disease*' (p150).

Patients are also known to change between symptom sub-types throughout the course of the illness and so it could be suggested that testing patients at a particular time can only give a snapshot of how they are feeling at that moment, rather than give an indication of any specific pathological process. For example, in the present study, some of the BPRS forms showed patients with severe positive symptoms, yet when these patients were with the researcher, before, during and after the test (approximately 30 minutes in total), the researcher did not witness this behaviour at all. Also some patients were described on the BPRS as having severe motor retardation, yet during the time with the researcher they appeared very motivated and spontaneous in their responses.

Neurological Implications for Schizophrenia

The present study has shown that context processing mechanisms are involved during the binding of features to make coherent objects. As Triesman & Schmidt (1982) have shown, top-down processes are required to mediate errors of binding. Silverstein et al. (2000) calls this 'object thinking' as binding requires context-appropriate meaning rather like the binding of words to make a coherent sentence. He quotes evidence for the correlation between perceptual organisation in both linguistic and visual representations and damage to the parietal lobes.

The parietal lobes have been shown to be involved in orientating attention within the visual fields (Posner et al., 1987). Damage to the parietal lobes causes difficulty in disengaging attention from the current focus and shifting attention onto another location. It is interesting to note that in the present study the schizophrenic group performed similarly to the group tested by Brown & Wright (1998), who had brain damage to areas associated with attentional processes, when using the same illusory conjunction task. In the previous study by Brown and Wright, people with brain damage to areas associated with attentional processes made more illusory conjunctions than people with brain damage that was not associated with these areas and normal controls. Also, as the attention load increased more illusory conjunctions were seen for the group with brain damage associated with attentional processes than any other group. These subjects all had damage to their parietal lobes, an area shown to be in use when attention is required (Posner et al., 1987; Silverstein et al., 2000).

Although one must be cautious when trying to generalise results from one population to another, there is evidence from other researchers that people with schizophrenia might have a deficit within the parietal lobes. For example, Posner et al. (1988) presented schizophrenic patients and non-psychiatric controls with a computerised visual attention task. A central fixation cross was flanked on either side of the screen by a square. Participants had to press a button when a star appeared in the centre of one of the squares. In some trials one of the squares would be brightened before the start to act as a cue. In other trials a different square would be brightened from the one that held the star. It was found that the schizophrenic group had longer reaction times than the control group, especially when they had to divert attention away from a cue from the opposite side to the target. Posner et al. explain that this shows an inability to disengage from the cue and shift attention to the contextual target. They state that this abnormality has a '*strong resemblance to those found in patients with left-sided parietal lesions*' (p817). Harvey et al. (1993) was able to compare the MRI scans of 60 people with schizophrenia and 36 healthy controls matched for age, ethnicity and parental social class. They state that,

> '*the volume of the frontal and anterior parietal lobes was significantly reduced in the schizophrenic group as a result of a selective decrease in cortical volume*' (p591).

It could then be suggested that the patients in the present study may also have difficulties processing information within this region of the brain. However it must be taken into consideration that schizophrenia involves a disorganisation of brain function, whereas brain damage is a fixed pathology with an absence of function (Dolan et al., 1999). One probable direction might be to use the present illusory conjunction task with fMRI scans, on people with schizophrenia compared with non-psychiatric controls with parietal lobe damage and on people with schizophrenia compared with healthy controls. This might give further insight into what areas of the brain are involved when performing an illusory conjunction task.

Although the present study has achieved some significant results, there are some methodological limitations that must also be taken into consideration.

Methodological Limitations

Data Collection

The computer test was performed in different environments due to the fact that the schizophrenic groups were residing in different buildings and that some of the control group were not hospital staff. Although steps were taken to ensure that the conditions were the same for each participant (i.e. using a screen to reduce distractions, positioning the laptop 59cm away from the participant, ensuring the participant's eye level was in the centre of the screen), different environments may have had a different impact on the participants. For example, some of the rooms that were used for testing were large and bright with windows, which may have caused a distraction to those participants that had difficulty sustaining attention. Other rooms were very small with no windows, which may have increased anxiety levels for some. It may be more appropriate to test participants in just one designated room, using a computer that could be set up and left in the required position. This would reduce any extraneous variables caused by the different environments.

Another methodological limitation with regards data collection could be due to the completion of the Brief Psychiatric Rating Scales by both Senior House Officers and Ward Managers. As the schizophrenic population were residing in different buildings these were not always the same people. Although one is usually trained before completing this measure, the Brief Psychiatric Rating Scale is rather subjective. It could be that one person was scoring with slightly different criteria than another. Unfortunately, as there were so many different wards within the hospital that had patients with schizophrenia it meant that there was no one person who knew every patient. Consequently if only one Senior House Officer was chosen to carry out this task it would have involved many lengthy interviews with each patient. Time constraints did not allow for this to happen and it would probably have been almost impossible to recruit a willing volunteer to carry out this task! Therefore if the study is replicated, it may be easier for the experimenter to be trained in completing the Brief Psychiatric Rating Scale and carry out this task on every patient to ensure consistency.

Design

As the computer task had not been used on people with schizophrenia before, there are a number of considerations for improvement. Firstly, previous research has concentrated on reaction times to test the context processing theory (Cohen & Servan-

Schreiber, 1992; Cohen et al., 1994; Servan-Schreiber & Blackburn, 1995; Servan-Schreiber, Cohen & Steingard, 1996; Cohen et al., 1999). It may have been useful to include a way of measuring the length of time it took for participants to give a response, thereby enabling the present task to have another variable to compare with previous research. Secondly, the number of trials and presentation times were based on previous research by Brown & Wright (1998) on patients with acquired brain damage. Although the present study showed some significant results it should be taken into consideration that schizophrenia is a different population group. Therefore it may be useful to consider doing further pilot studies on different lengths of presentation times and different numbers of trials to see if such differences have any affect on performance.

One of the more puzzling results shown was that between conditions 2 and 3 less illusory conjunctions and total number of errors were seen for both the schizophrenia and control groups. This is somewhat surprising as condition 3 had two tasks to complete before the target response and condition 2 had only one task. Previous research would suggest that condition 3 would load the attention capacity even more than condition 2 and so produce more errors (Brown & Wright, 1998). As this effect occurred for both groups it would suggest that there was something about condition 3 that made it easier to perform even though it increased the load on attention. As all participants were shown condition 2 before condition 3 it could be that there was a practice effect causing the third condition to be easier. Another reason may be that participants were explained at the start that there were three tasks to complete. After experiencing an increase in difficulty from tasks 1 and 2, they may have pre-empted the third task as being harder and so made a concerted effort to concentrate more on the third condition. In the results of the study by Brown & Wright (1998) the reverse effect was found, as the control group and brain-damaged groups performed significantly worse on condition 3 than on condition 2. The only difference between Brown & Wright's study to the present one was that Brown & Wright had randomly assigned the presentation order of the conditions. This further suggests that a practice effect may well have taken place in the present study. If this study is replicated it would be important to randomly assign the presentation order of the conditions.

Schizophrenia Group

As the present study has only been used on people with acquired brain damage, it was not possible to use power analysis to estimate how many schizophrenic participants were required. A literature search on previous studies that have explored cognitive deficits in schizophrenia showed that between 17 to 53 schizophrenic participants have been used previously. Therefore it would seem probable that the number of patients used in the present study was an adequate sample size to detect an effect between patients with schizophrenia and non-psychiatric controls. However, the sample size between the different symptom groups was smaller and may not have been enough to produce an effect. It may be appropriate to increase the sample size when carrying out future research.

As there was limited time to recruit participants it was decided that every patient with schizophrenia that was willing to take part would be included. This meant that the majority of patients were people that had symptoms relating to all three of the sub-groups that were being tested. There were only eight patients with symptoms purely from the poverty sub-group, six patients with symptoms purely from the reality distortion sub-group, and one patient that had symptoms purely from the disorganisation sub-group. Although previous research has suggested that the different sub-types of schizophrenia are associated with different patterns of cognitive performance, (Johnstone & Frith, 1996; Cohen et al., 1999) this did not seem to be the case for the present study. It may be that the patient groups used in the present study were too similar in their symptomatology. For example, there were 16 patients with aspects of poverty, reality distortion and disorganised symptoms, five patients with poverty and disorganised symptoms, 6 patients with poverty and reality distortion symptoms and four patients with disorganised and reality distortion symptoms.

Further limitations with regards the schizophrenia group were that recruitment was purely voluntary. This meant that the patients that took part might have been those with milder symptoms, or those that were stable on medication. This meant that the schizophrenia group might not have been a representative sample, as those that refused to take part may actually have been more severe in their illness. This may also have been the reason that some participants that volunteered could not perform the task or withdrew half way through testing. However, as there are ethical considerations to be made when recruiting it could be said that this type of difficulty occurs throughout all research on schizophrenia.

Comparison Group

During testing the comparison group were observed to be displaying signs that they may have been more nervous than the schizophrenia patients when completing the experiment. For example, even though the aims of the study were explained before taking part, some participants were making inferences that if they performed badly on the test it might show that they were schizophrenic. It is possible therefore, that anxiety has affected the performance of the control group. It could also be suggested, however, that the schizophrenia group were just as anxious for different reasons, such as the results being used as a measure of their suitability for discharge. As it is generally known that anxiety can affect performance, it might be useful to include an anxiety questionnaire prior to the experiment, which could be correlated with the results. It must also be noted that the comparison group were not screened for Axis I disorder or any first-order family history of schizophrenia and so one cannot be certain that all of the control group were different to the schizophrenia group in this respect. It may be appropriate to use a screening questionnaire if the study is replicated.

Medication

The results suggested that there were no significant interactions between dosages of antipsychotic medication and performance, or the use of anticholinergic medication and performance. This confirms previous results by Liddle & Barnes (1990), Stratta et al. (1998) and Cohen et al. (1999) who found no significant relationship between medication and performance. It still cannot be said for certain, however, that the medication has not affected the patient's performance and so such results should still be treated with caution until further evidence is found for this particular illusory conjunction task. Some of the ways that could help would be to carry out this test using a different population of people. Many studies suggest using drug-naïve patients

(Kay, 1990; Cohen et al., 1999; Peters et al., 2000). This type of group, however, would not be representative of the population, as the majority of patients remain on medication throughout the course of the illness. Furthermore, as Frith (1992) explains, drug-naïve patients are usually in the acute stage of the illness and unlikely to be able to participate in psychological experiments. It may be more appropriate to perform a longitudinal study with people with schizophrenia, so that a patient's progression over the course of the illness would reflect different dosages of medication. With regards anticholinergic medication, it would be possible to use a non-psychiatric control group on the same medication as people with schizophrenia. For example, people with Parkinson's disease are also given anticholinergic medication and so if they perform in a similar way to the non-psychiatric controls in the present study this would give further evidence that anticholinergic medication does not affect performance on this particular task.

Although there have been quite a few areas that could have been improved it must be noted this is a pilot study and should be seen as the preparatory work for much more in-depth research in this area. However, the significant findings in this study should not be ruled out as they suggest some interesting implications for a cognitive model of schizophrenia.

Clinical Implications for a Cognitive Model of Schizophrenia

Impairment in social functioning is one aspect of the diagnostic criteria for schizophrenia (DSM-IV – American Psychiatric Association, 1994). There seems to be a general consensus that cognitive disturbances can affect social functioning (Fowler, Garety & Kuipers, 1995; Fowler, 1999; Garety et al., 2001). Stratta et al. (2000) believe that cognitive disturbances are linked to difficulties in processing context, as normal functioning in social situations requires constant monitoring and use of environmental cues to perform the appropriate behavioural responses. If more compelling, but socially inappropriate behaviour is unable to be inhibited they are more likely to be performed. Inappropriate environmental cues will also be imbued with significance and can lead to delusions and hallucinations.

The 'diathesis-stress' or 'vulnerability' models of schizophrenia have been developed to explain how impairment in social functioning can give rise to environmental stress and lead to schizophrenia. Zubin's theory of vulnerability, states that schizophrenia is seen to arise from the amalgamation of a genetic inheritance, which endures over ones lifetime, and a time-limited, environmental stress (Zubin & Spring, 1977). Vulnerability is related to an inherited deviant personality and structural changes in the brain early on in life, whilst stress is related to unpredictable life events such as sudden unemployment or death of a relative. Eaton, Tein & Poeschla (1995) believe that vulnerability and stress are both needed to produce schizophrenia, but either factor can be dominant in this process. For example, you can have a high amount of stress and a low vulnerability or high vulnerability and a low amount if stress. Research has shown that schizophrenia is more prevalent in people that have a number of stresses prior to the illness (Brown & Birley, 1968; Lukoff, Snyder & Ventura, 1984; Birchwood, Macmillan & Smith, 1994).

It seems that the present study can help to show how the 'diathesis-stress' model can be linked to difficulties in social functioning and that these difficulties may be exacerbated by context processing deficits. The results in the present study suggest that under high processing demands people with schizophrenia show difficulties in processing contextual information. It can therefore be inferred that in everyday situations there is an underlying vulnerability for some people to have context processing deficits. When environmental stressors are low these deficits are not seen to cause any effects. However, when environmental stress develops, it increases the demand on the information processing capacity, as stress can imbue the mind with a multiple of irrelevant thoughts and feelings. As the information processing system is limited, due to context processing deficits, it is harder for irrelevant material to be inhibited and such material is given a delusional importance, which leads to a psychotic state.

Rief (1991) briefly acknowledges this idea as one reason for the performance of her group of schizophrenics on a visual perception task. She found that schizophrenics performed significantly worse than alcoholics and healthy controls when trying to judge the number of lines presented in different groups on a computer screen. Rief suggests that poor performance was due to interference by irrelevant stimuli, which leads to a disruption of cognitive processes of attention, perception and judgement. Such disruptions cause a vulnerability which when linked to environmental stressors exacerbates schizophrenic symptomatology. The present study has shown that these cognitive processes are all involved in context processing. Therefore it is plausible that an increase in stresses may well place higher demands upon a limited processing capacity system and result in clinical problems.

Conclusion

The results from this pilot study suggest that there is a difference between schizophrenic and non-psychiatric controls when performing an illusory conjunction task. As the task was particularly context-sensitive it would suggest that people with schizophrenia have a deficit in the mechanisms that process context during information processing. One of these mechanisms, which is particularly pertinent to illusory conjunctions, is attentional processes. Previous research on acquired brain-damage patients with attention deficits has also shown this to be the case. Attentional processes have been linked to the parietal lobe in acquired brain-damaged participants and there is some suggestion that this could also be affected in schizophrenia. However this deficit does not seem to be related to any particular sub-type, as cross-symptom correlations did not show any significant effect between sub-groups. It is therefore more likely that context processing is a deficit seen in schizophrenia as a whole, rather than one that is specific to any sub-type of schizophrenia. Clinical implications for the present study links the context processing theory to a vulnerability model of schizophrenia and gives further evidence to the formulation of schizophrenia within a cognitive model. As there is limited research into the effects of illusory conjunctions upon schizophrenia the present study has shown new insights into the information processing deficits that underlie schizophrenia and further research into this phenomenon can hopefully enhance future cognitive models.

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APPENDIX A

West London Mental Health NHS
NHS Trust

Ms Tracey Brown,
Trainee Clinical Psychologist,
2 Beech Avenue,
Eastcote,
Middx. HA4 8UQ

Our Ref: SB/01/ **28th September 2001**

Dear Tracey,

Protocol: Illusory conjunctions and context processing in schizophrenia: Differential relationships between symptoms.

Please accept my apologies for the delay in responding to you. Your submission had been circulated to all members of the Ethics Committee on 27th July 2001 and I am pleased to report that no adverse comments were received. I am therefore happy to confirm the Committee's approval for your project to proceed.

May I take this opportunity to remind you of this Committee's Standard Operating Procedures:

- ❑ The need to comply, throughout the conduct of the study, with good clinical research practice standards;
- ❑ To enable the Committee to receive feedback of research approved, you are requested to provide six-monthly reviews. Where this is not provided, the Committee reserve the right to suspend approval of the protocol;
- ❑ The results of the research should be sent to the Chairman of the Committee, if necessary in draft form, pending a copy of the completed final report/publication, which will be made available in the Medical Library;
- ❑ Further research projects submitted to the Ethical Committee by researchers who fail to comply with these conditions will not be approved;
- ❑ If there are any further changes to the Protocol, these must be notified to the Committee for approval.

May I take this opportunity to wish you well in your study.

With kind regards,

Yours Sincerely,

Dr Ian Treasaden,
Ethics Committee Chairman

APPENDIX B

Dear

I have been given ethical approval to conduct a study into disturbances of visual processing in schizophrenia. This study is being supervised by Hamish McLeod at the Academic Centre, St Bernard's Wing, Ealing Hospital and has received ethical and R&D office approval (see attached letter). I would like to recruit in-patients that are currently under your care that have symptoms of schizophrenia.

I would be very grateful if you could sign the attached consent form to state that you are happy for me to conduct this research, and return it to Hamish McLeod. Please find enclosed an information sheet that will give you more details as to what the study is trying to achieve.

I look forward to hearing from you.

Tracey Brown
Trainee Clinical Psychologist

CONSENT FORM

VISUAL PROCESSING IN SCHIZOPHRENIA

Researcher : Miss Tracey Brown
Sub-Department of Clinical Psychology
University College London
Torrington Place
London W1

I agree to give my consent for the above named person to conduct research on visual processing in schizophrenia with in-patients within my care. I have read the attached information and understand that this research will be conducted with full ethical consideration of the participants involved and within the requirements of the South West London Local Research Ethics Committee.

Signature of RMO ....

Name ....

Date ....

Please sign and return to: Hamish McLeod,
Academic Centre,
St Bernard's Wing,
Ealing Hospital

APPENDIX C

CONSULTANT INFORMATION SHEET

VISUAL ILLUSIONS STUDY

My name is Tracey Brown and I am a Trainee Clinical Psychologist at University College London. My research thesis is concerned with illusory conjunctions and context processing in schizophrenia. Illusory conjunctions occur in every day situations and are caused when the brain combines the wrong features to a colour during the visual processing of objects. For example a blue car and a white van may pass each other in the street but it is perceived as a blue van and a white car. There is some evidence that these visual illusions are less frequent in certain types of schizophrenia. I would be grateful if you could help me to find the participants that I require for the research.

Rationale for the study

Schizophrenia has no one characteristic set of symptoms and it is difficult to define exactly its course and duration. Neuropsychological research has tried to provide evidence for deficits within specific neural networks and to help localise the disrupted areas. It is hoped that such evidence will provide a much clearer diagnosis. Servan-Schreiber et al. (1996) propose that a reduction in the ability to use contextual information when carrying out a task causes difficulty in suppressing strong, inappropriate responses. Previously, these various cognitive functions needed for context processing (e.g. attention, active memory and inhibition) have been found to be deficient in schizophrenia. Silverstein et al. (2000) have shown that context processing is impaired in schizophrenia due to a location uncertainty during the binding of object features. Using Gabor elements to define shape contours, they found that patients with high scores on the 'disorganisation' factors derived from PANSS (Kay et al., 1987), were significantly more likely to have poor integration abilities than those with only positive or negative symptoms and normal controls. They believe that schizophrenic patients with these symptoms would be less susceptible to visual illusions '*due to poor spatial integration capacities and therefore reduced contextual effects*' (Silverstein et al., 2000, p17). This study will use visual illusions to expand upon this theory.

What I would like you to do

I will need to test approximately 60 participants with schizophrenia. There will be 20 each with positive, negative and disorganised symptoms. I would like you to carry out a Brief Psychiatric Rating Scale (BPRS) on patients that have been diagnosed with schizophrenia so that they may be categorised into the three groups. Please could you indicate on the attached sheet any patient that you think might be suitable for the study. I may need to ask you at a later stage to carry out this procedure again if I find that more participants are needed to produce an effect.

Task procedure for participants

Participants will be asked to look at a computer screen and a series of different coloured shapes will appear, on different sides, for a very brief time. Participants will be asked to say 'yes' if they have seen a red triangle. To keep motivation at a maximum, each time they guess correctly they will be given 5 pence. There are 98 guesses in total. The whole experiment will only take about 15 minutes to complete.

The task will not be harmful in any way and there will be no side effects from taking part. Participants will be able to withdraw at any point if they wish.

This study is being organised by University College London and is part of my research thesis. Data collection will last for about one year. The WLT has given approval. The study will be completed in June 2002 and the results will be available at the Sub-Department of Clinical Psychology, University College London, 1-19 Torrington Place, London, W1.

Any queries about this study may be directed to myself, Tracey Brown on 07899 794121. If you wish to take part in this study as a control or would just like to see what it is all about please do not hesitate to contact me.

Thank you for taking part in this study. Your help is greatly appreciated.

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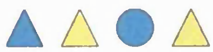
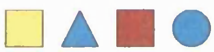
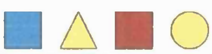
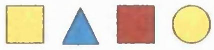
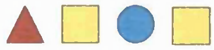
PRESENTATION OF OBJECTS

TRIAL	OBJECT PRESENTATION	LETTER
1	5  9	E
2	3  7	N
3	7  3	H
4	9  7	N
5	7  5	Z
6	9  3	N
7	5  9	Z
8	9  5	N
9	5  9	H
10	3  7	H
11	5  9	E
12	9  3	Z
13	9  7	N
14	5  7	E
15	7  3	H
16	7  5	H

TRIAL	OBJECT PRESENTATION	LETTER
17	9  3	E
18	7  5	E
19	7  5	Z
20	5  9	H
21	7  3	N
22	7  3	Z
23	9  7	E
24	9  7	Z
25	Example Trial 35 79	Z
26	5  9	Z
27	5  9	E
28	3  5	Z
29	3  5	E
30	9  3	E
31	5  7	Z
32	7  9	H
33	3  5	Z

SEQUENCE OF TRIALS FOR EXPERIMENT 1

SEQUENCE NUMBER	TRIAL NUMBER	POSITION ON SCREEN	ERROR STATUS	PROXIMITY OF IC FEATURES
1	6	Far Right	IC	Apart
2	7	Far Right	IC	Close
3	8	Near Right	Colour	
4	1	Near left	Feature	
5	3	Far Left	IC	Apart
6	2	Far Right	Target	
7	4	Near Right	IC	Apart
8	9	Far Left	IC	Close
9	5	Far Left	Feature	
10	10	Near Left	Target	
11	11	Near Left	IC	Close
12	12	Far Left	IC	Apart
13	13	Far Right	Target	
14	14	Near Right	Feature	
15	15	Far Right	Colour	
16	16	Near Right	IC	Close
17	17	Near Left	IC	Close
18	18	Near Left	Target	
19	19	Far Right	IC	Apart
20	20	Near Left	IC	Apart
21	21	Near Right	Target	
22	26	Far Right	Feature	
23	24	Far Left	Colour	
24	22	Far Left	Target	
25	23	Near Right	IC	Close
26	27	Near Right	Target	
27	28	Far Left	IC	Close
28	29	Near Right	IC	Apart
29	30	Near Left	IC	Apart
30	31	Far Left	Target	
31	32	Near Left	Colour	
32	33	Far Right	IC	Close

NB Trial number 25 is an example which is presented before the experiment begins

SEQUENCE OF TRIALS FOR EXPERIMENT 2

SEQUENCE NUMBER	TRIAL NUMBER	POSITION ON SCREEN	ERROR STATUS	PROXIMITY OF IC FEATURES
1	7	Far Right	IC	Close
2	1	Near Left	Feature	
3	28	Far Left	IC	Close
4	2	Far Right	Target	
5	4	Near Right	IC	Apart
6	9	Far Left	IC	Close
7	5	Far left	Feature	
8	33	Far Right	IC	Close
9	10	Near Left	Target	
10	12	Far Left	IC	Apart
11	14	Near Right	Feature	
12	27	Near Right	Target	
13	15	Far Right	Colour	
14	16	Near Right	IC	Close
15	18	Near Left	Target	
16	20	Near Left	IC	Apart
17	21	Near Right	Target	
18	24	Far Left	Colour	
19	30	Near Left	IC	Apart
20	23	Near Right	IC	Close
21	19	Far Right	IC	Apart
22	31	Far Left	Target	
23	13	Far Right	Target	
24	8	Near Right	Colour	
25	17	Near Left	IC	Close
26	3	Far Left	IC	Apart
27	6	Far Right	IC	Apart
28	11	Near Left	IC	Close
29	22	Far Left	Target	
30	26	Far Right	Feature	
31	29	Near Right	IC	Apart
32	32	Near Left	Colour	

NB Trial number 25 is an example which is presented before the experiment begins.

SEQUENCE OF TRIALS FOR EXPERIMENT 3

SEQUENCE NUMBER	TRIAL NUMBER	POSITION ON SCREEN	ERROR STATUS	PROXIMITY OF IC FEATURES
1	14	Near Right	Feature	
2	21	Near Right	Target	
3	17	Near Left	IC	Close
4	4	Near Right	IC	Apart
5	33	Far Right	IC	Close
6	11	Near Left	IC	Close
7	22	Far Left	Target	
8	8	Near Right	Colour	
9	9	Far Left	IC	Close
10	29	Near Right	IC	Apart
11	2	Far Right	Target	
12	7	Far Right	IC	Close
13	16	Near Right	IC	Close
14	12	Far Left	IC	Apart
15	26	Far Right	Feature	
16	18	Near Left	Target	
17	1	Near Left	Feature	
18	32	Near Left	Colour	
19	31	Far Left	Target	
20	24	Far Left	Colour	
21	30	Near Left	IC	Apart
22	6	Far Right	IC	Apart
23	13	Far Right	Target	
24	5	Far Left	Feature	
25	3	Far Left	IC	Apart
26	15	Far Right	Colour	
27	27	Near Right	Target	
28	28	Far Left	IC	Close
29	10	Near Left	Target	
30	20	Near Left	IC	Apart
31	19	Far Right	IC	Apart
32	23	Near Right	IC	Close

NB Trial number 25 is an example which is presented before the experiment begins.

SCORE SHEET FOR EXPERIMENT No __

PARTICIPANT No __

Slide No.	Target Y/N	Correct	IC	C/F/T Error	Slide No.	Target Y/N	Correct	IC	C/F/T Error
1					23				
2					24				
3					25				
4					26				
5					27				
6					28				
7					29				
8					30				
9					31				
10					32				
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22									

PATIENT INFORMATION SHEET

<u>VISUAL ILLUSIONS STUDY</u>

You are being invited to take part in a research study, which is looking at how the brain combines different features, such as colour or shape, into complete objects. The study aims to examine the instances where the brain combines the wrong features together to produce a visual illusion. This is quite common amongst people when they have not really concentrated on what they are looking at. For example if a blue car and a white van speed pass each other in the street, you might think you have seen a blue van and a white car instead. There is some evidence that these everyday visual illusions are less frequent in certain types of schizophrenia

You have been asked to be a volunteer because you have been diagnosed with schizophrenia. There will be 59 other people like you that will be taking part in this study.

This study is being organised by University College London and is part of my research thesis. It will last for about one year. The South West Local Research Ethics Committee has approved this study.

You will be asked to look at a computer screen. A series of different coloured shapes will appear on the screen, on different sides, for a very brief time. You will be asked to say 'yes' if you have seen a red triangle. Each time you guess correctly you will be given 5 pence. If you guess them all correctly you will be given £5. The whole experiment will only take about 15 minutes to complete.

The task will not be harmful to you in any way and there will be no side effects from taking part. However I would like to reassure you that if I feel the tasks are too distressing for you I will withdraw you from the study straight away.

All information that is collected about you during the course of the research will be kept strictly confidential. Any information about you that leaves the hospital will be kept anonymous so that you cannot be recognised from it. You will be asked to sign a consent form to show that you agree to take part. You do not have to take part in the study if you do not want to. If you decide to take part you may withdraw at any time without giving a reason. Your decision whether or not to take part will not affect your care and management in any way.

The study will be completed in June 2002 and the results will be available for anyone to look at in the Sub-Department of Clinical Psychology, University College London, 1-19 Torrington Place, London W1.

Any queries about this study may be directed to myself, Tracey Brown at the above address. If you wish, an independent person can provide you with more advice. Their name is, Hamish McLeod, Academic Unit, St Bernards Wing, Ealing Hospital.

Thank you for taking part in this study. Your help is greatly appreciated.

VOLUNTEER INFORMATION SHEET

VISUAL ILLUSIONS STUDY

You are being invited to take part in a research study, which is looking at how the brain combines different features, such as colour or shape, into complete objects. The study aims to examine the instances where the brain combines the wrong features together to produce a visual illusion. This is quite common amongst people when they have not really concentrated on what they are looking at. For example if a blue car and a white van speed pass each other in the street, you might think you have seen a blue van and a white car instead. There is some evidence that these everyday visual illusions are less frequent in certain types of schizophrenia

I will be testing 60 patients from a local hospital who have been diagnosed with schizophrenia. You have been asked to be a volunteer because I need to include 20 healthy controls to help verify the results

This study is being organised by University College London and is part of my research thesis. It will last for about one year. The South West Local Research Ethics Committee has approved this study.

You will be asked to look at a computer screen. A series of different coloured shapes will appear on the screen, on different sides, for a very brief time. You will be asked to say 'yes' if you have seen a red triangle. Each time you guess correctly you will be given 5 pence. If you guess them all correctly you will be given £5. The whole experiment will only take about 15 minutes to complete.

The task will not be harmful to you in any way and there will be no side effects from taking part. However you may withdraw from the experiment at any time without giving a reason..

All information that is collected about you during the course of the research will be kept strictly confidential. Any information about you that leaves the hospital will be kept anonymous so that you cannot be recognised from it. You will be asked to sign a consent form to show that you agree to take part. You do not have to take part in the study if you do not want to.

The study will be completed in June 2002 and the results will be available for anyone to look at in the Sub-Department of Clinical Psychology, University College London, 1-19 Torrington Place, London W1.

Any queries about this study may be directed to myself, Tracey Brown at the above address. If you wish, an independent person can provide you with more advice. Their name is, Hamish McLeod, Academic Unit, St Bernards Wing, Ealing Hospital.

Thank you for taking part in this study. Your help is greatly appreciated.

APPENDIX I

CONSENT FORM

Visual Illusions study

Researcher : Miss Tracey Brown
Sub-Department of Clinical Psychology
University College London
Torrington Place
London W1

To be completed by the volunteer:	**Delete as Necessary:**
Have you read the information about the study?	Yes/No
Have you had an opportunity to ask questions and discuss the study?	Yes/No
Do you understand that you are free to withdraw from this study at any time, without giving a reason for withdrawing and without affecting your care in any way?	Yes/No
Do you agree to take part in this study?	Yes/No

Signature of volunteer ....

Name ....

Date ....

Signature of researcher ....

Name ....

Date ....

INSTRUCTIONS FOR EXPERIMENT 1

- The experiment starts with trial 25, which is an example of the test.

This test comes in three parts and this is the first part. Can you see the cross in the centre of the screen? If you look at this you will see that it changes to a letter. I want you to keep looking at the letter all the time. As the letter appears you will also see some objects out of the corner of your eye on different sides of the screen. All you have to do is to say yes or no if you see a red triangle amongst the objects. Can you see a red triangle here? Good, so all you need to say is 'no'. Can you see a red triangle here? Good, so all you need to say is 'yes'. Don't forget to look at the centre of the screen all the time and say yes or no if you see a red triangle. The objects will flash up on the screen very quickly. Are you ready?

INSTRUCTIONS FOR EXPERIMENT 2

- The experiment starts with trial 25, which is an example of the test.

This is the second part of the test. It is very similar to the one that you have just done. Again you will see a cross in the centre of the screen, which changes to a letter. I want you to keep looking at the letter all the time. As the letter appears you will also see some objects out of the corner of your eye on different sides of the screen just as you did for the first part. This time I want you to first tell me the letter that you see and then tell me if you have seen a red triangle. As you can see from this example the letter is 'z' and there is no red triangle, and so you will say, 'z, no'. In this example the letter is 'z' and there is a red triangle, and so your answer will be, 'z, yes'. Don't forget to look at the centre of the screen all the time. Tell me the letter first and then say yes or no if you have seen a red triangle. The objects will flash up on the screen very quickly. Are you ready?

INSTRUCTIONS FOR EXPERIMENT 3

- The experiment starts with trial 25, which is an example of the test.

This is the third part of the test. It is very similar to the last two parts but this time you will have three things to do. Again you will see the cross in the centre of the screen, which will change to a letter. But this time when the objects appear you will also hear a sound. It will either be a high sound or a low sound. Here is the high sound. Did you hear that? Good. So this time you have three things to do. First tell me the letter in the centre of the screen as before. Then I want you to tell me if you hear a high or low sound and then tell me if you have seen a red triangle. So for this example you would say 'z, high, no'. Now here is the low sound. Did you hear that. Good. For this example you would say 'z, low, yes'. Do you understand what you have to do? Can you repeat back to me what you have to do. Good. I will go through the tones with you again. This is high, this is low. Can you hear the difference in the sounds? Good. Again, this is high and this is low. Don't forget to look at the centre of the screen all the time. Tell me the letter first, then say high or low for the sound and then say yes or no if you have seen a red triangle. The objects will flash up on the screen very quickly. Are you ready?

APPENDIX K

RESULTS FOR CONDITION 1

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
1	C	32	0	0	0	0	0
2	S	32	0	0	0	0	0
3	S	32	0	0	0	0	0
4	S	31	0	1	0	0	0
5	S	32	0	0	0	0	0
6	C	32	0	0	0	0	0
7	C	30	2	0	0	0	0
8	C	32	0	0	0	0	0
9	C	32	0	0	0	0	0
10	C	32	0	0	0	0	0
11	C	32	0	0	0	0	0
12	S	32	0	0	0	0	0
13	S	32	0	0	0	0	0
14	S	32	0	0	0	0	0
15	C	32	0	0	0	0	0
16	S	31	1	0	0	0	0
17	S	32	0	0	0	0	0
18	S	32	0	0	0	0	0
19	S	30	2	0	0	0	0
20	S	32	0	0	0	0	0
21	C	32	0	0	0	0	0
22	C	32	0	0	0	0	0
23	C	28	2	1	0	1	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 1

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
24	S	32	0	0	0	0	0
25	C	32	0	0	0	0	0
26	S	28	3	1	0	0	0
27	S	28	2	1	0	1	0
28	C	32	0	0	0	0	0
29	S	29	1	1	0	1	0
30	S	32	0	0	0	0	0
31	C	32	0	0	0	0	0
32	C	32	0	0	0	0	0
33	C	32	0	0	0	0	0
34	S	32	0	0	0	0	0
35	S	26	6	0	0	0	0
36	S	32	0	0	0	0	0
37	S	32	0	0	0	0	0
38	S	32	0	0	0	0	0
39	S	32	0	0	0	0	0
40	S	31	0	0	0	0	1
41	S	30	0	1	0	0	1
42	S	28	1	0	0	1	2
43	S	32	0	0	0	0	0
44	S	32	0	0	0	0	0
45	S	31	1	0	0	0	0
46	S	32	0	0	0	0	0
47	C	32	0	0	0	0	0
48	S	31	1	0	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 1

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
49	C	32	0	0	0	0	0
50	C	32	0	0	0	0	0
51	C	32	0	0	0	0	0
52	C	32	0	0	0	0	0
53	C	32	0	0	0	0	0
54	C	32	0	0	0	0	0
55	S	32	0	0	0	0	0
56	S	31	0	1	0	0	0
57	S	32	0	0	0	0	0
58	S	32	0	0	0	0	0
59	S	32	0	0	0	0	0
60	S	28	0	2	0	0	2
61	S	32	0	0	0	0	0
62	S	32	0	0	0	0	0
63	S	32	0	0	0	0	0
64	S	32	0	0	0	0	0
65	S	32	0	0	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 2

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
1	C	32	0	0	0	0	0
2	S	26	0	0	0	6	0
3	S	31	0	0	0	1	0
4	S	31	0	0	0	1	0
5	S	30	0	0	0	2	0
6	C	31	1	0	0	0	0
7	C	28	3	0	0	0	1
8	C	29	1	0	0	2	0
9	C	29	0	0	0	1	2
10	C	27	2	1	1	1	0
11	C	31	1	0	0	0	0
12	S	31	1	0	0	0	0
13	S	30	0	0	1	0	1
14	S	29	3	0	0	0	0
15	C	31	1	0	0	0	0
16	S	28	2	1	0	1	0
17	S	32	0	0	0	0	0
18	S	29	2	0	0	1	0
19	S	23	6	0	0	3	0
20	S	29	1	0	0	2	0
21	C	31	0	0	0	1	0
22	C	31	0	0	0	1	0
23	C	24	7	1	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 2

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
24	S	30	1	0	0	0	1
25	C	26	1	3	0	2	0
26	S	20	7	3	0	2	0
27	S	24	1	1	0	6	0
28	C	32	0	0	0	0	0
29	S	24	4	0	1	3	0
30	S	28	2	0	0	2	0
31	C	32	0	0	0	0	0
32	C	31	1	0	0	0	0
33	C	32	0	0	0	0	0
34	S	30	0	0	0	2	0
35	S	22	9	0	0	1	0
36	S	30	1	0	0	0	1
37	S	30	2	0	0	0	0
38	S	30	0	0	0	1	1
39	S	26	0	0	0	4	2
40	S	22	6	2	1	0	1
41	S	21	3	1	0	4	3
42	S	26	1	0	0	2	3
43	S	29	0	0	0	2	1
44	S	29	2	1	0	0	0
45	S	26	0	0	0	3	3
46	S	32	0	0	0	0	0
47	C	28	1	0	0	2	1
48	S	25	3	1	0	2	1

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 2

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
49	C	32	0	0	0	0	0
50	C	32	0	0	0	0	0
51	C	32	0	0	0	0	0
52	C	32	0	0	0	0	0
53	C	30	1	0	0	0	1
54	C	30	0	0	0	2	0
55	S	28	2	1	0	1	0
56	S	26	3	3	0	0	0
57	S	23	2	0	0	7	0
58	S	23	5	1	0	1	2
59	S	28	3	0	0	0	1
60	S	25	0	0	0	3	4
61	S	31	1	0	0	0	0
62	S	30	2	0	0	0	0
63	S	31	1	0	0	0	0
64	S	32	0	0	0	0	0
65	S	32	0	0	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 3

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
1	C	32	0	0	0	0	0
2	S	29	0	0	0	3	0
3	S	32	0	0	0	0	0
4	S	30	0	1	0	0	1
5	S	32	0	0	0	0	0
6	C	32	0	0	0	0	0
7	C	30	1	0	0	1	0
8	C	28	0	0	0	2	2
9	C	30	1	0	0	1	0
10	C	29	2	1	0	0	0
11	C	31	0	0	0	1	0
12	S	29	0	0	0	3	0
13	S	27	2	0	0	2	1
14	S	26	0	0	0	6	0
15	C	30	0	0	1	1	0
16	S	28	3	1	0	0	0
17	S	32	0	0	0	0	0
18	S	32	0	0	0	0	0
19	S	28	3	0	0	1	0
20	S	29	2	0	0	1	0
21	C	30	0	0	0	2	0
22	C	30	0	1	0	1	0
23	C	29	2	1	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 3

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
24	S	26	2	0	0	4	0
25	C	27	0	0	0	4	1
26	S	26	4	2	0	0	0
27	S	21	3	0	1	6	1
28	C	30	0	0	0	2	0
29	S	29	0	1	0	2	0
30	S	31	1	0	0	0	0
31	C	31	1	0	0	0	0
32	C	31	0	0	0	1	0
33	C	32	0	0	0	0	0
34	S	28	1	0	0	1	2
35	S	21	10	1	0	0	0
36	S	30	2	0	0	0	0
37	S	30	1	1	0	0	0
38	S	30	0	1	0	1	0
39	S	31	0	0	0	1	0
40	S	26	4	2	0	0	0
41	S	26	2	2	0	1	1
42	S	25	1	0	0	4	2
43	S	30	0	0	0	1	1
44	S	30	0	0	0	1	1
45	S	24	0	0	0	2	6
46	S	32	0	0	0	0	0
47	C	30	1	0	0	1	0
48	S	24	1	0	0	6	1

NB – C=CONTROL, S=SCHIZOPHRENIA

RESULTS FOR CONDITION 3

No	Status	Correct	IC	Colour Error	Feature Error	Target Error	Did Not See
49	C	32	0	0	0	0	0
50	C	30	0	0	0	0	2
51	C	32	0	0	0	0	0
52	C	32	0	0	0	0	0
53	C	32	0	0	0	0	0
54	C	32	0	0	0	0	0
55	S	31	1	0	0	0	0
56	S	28	1	3	0	0	0
57	S	28	2	0	0	1	1
58	S	25	4	1	0	1	1
59	S	32	0	0	0	0	0
60	S	23	0	1	0	8	0
61	S	31	0	1	0	0	0
62	S	32	0	0	0	0	0
63	S	30	0	1	0	0	1
64	S	32	0	0	0	0	0
65	S	32	0	0	0	0	0

NB – C=CONTROL, S=SCHIZOPHRENIA