

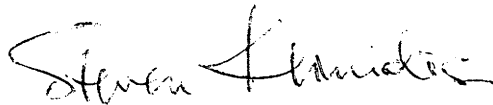
VISUAL-INFORMATION PROCESSING DEFICIT IN SCHIZOPHRENIA

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**Submitted in partial fulfilment of the requirements for the
degree of Doctor of Philosophy (Clinical Psychology), in The
Department of Psychology, The Australian National University,
February 1988.**

Declaration

I declare that this thesis reports my original work, that no part of it has been previously accepted or presented for the award of any degree or diploma by any university, and to the best of my knowledge no material previously published by another person is included, except where due acknowledgement is given.

A handwritten signature in cursive script, reading "Steven Hendrick".

This thesis describes original research carried out by the author in the Department of Psychology at the Australian National University during the period 1982-1987.

PREFACE

Disordered information processing has been suggested to underly various 'aspects' of schizophrenic illness (e.g., George & Neufeld, 1985; Hemsley, 1977). At times the concept has been recruited to explain cognitive activity during the state of psychosis (e.g., Chapman, 1966; Frith, 1979; Hemsley, 1977; McGhie & Chapman, 1961) while at other times the concept has gained the status of a trait variable or a marker of the vulnerability to schizophrenic illness (e.g., Asarnow & MacCrimmon, 1981; Braff, 1981; Meehl, 1962; Nuechterlein & Dawson, 1984; Sterenko & Woods, 1978). However, there is no clear evidence which links the laboratory findings of attenuated performances with the signs and symptoms of schizophrenia (George & Neufeld, 1985). Moreover, there has been little success in identifying the particular cognitive processes or levels of processing that are disordered in schizophrenia.

The present work investigates visual information processing and is concerned with the ability of subjects who are labelled 'schizophrenic' to perform a number of tasks which probe specific visual processing functions. Possible factors contributing to the disorder in visual processing are derived from a model of perception which follows Neisser's (1967) theory of the interplay between preattentive and attentional processes. The second aim of the research is to identify clinical variables that are associated with the processing disorder.

The concept of schizophrenia is described in Chapter 1, preliminary to the presentation of the experimental research. Chapter 2 presents the evidence that visual perception in

schizophrenia is abnormal and worthy of further investigation. The results of three kinds of studies are presented which suggest that visual distortions, an inability to assimilate size and distance cues, and an impairment in smooth-pursuit eye movements may all have a common cause - a poor ability of schizophrenics to synthesise the visual scene efficiently relative to controls.

In Chapter 3 the notion of disordered figural synthesis is developed further with a review of studies that have attempted to isolate the earliest level of visual-information processing that might be 'impaired' in schizophrenia. It will become apparent from the review that there is evidence for an early processing deficit, but the evidence does not establish clearly which processes are disordered. Specifically, views of the disorder have included disabilities within automatic, preattentive organization of the visual object and/or a disability in attentional processing. In non-visual processing studies the evidence from auditory studies (e.g., Hemsley & Zawada, 1976; Oltmans, 1978; Oltmans & Neale, 1975, but see, Berg & Leventhal, 1977; Lerner, Nachshon & Carmon, 1977; Rund, 1983; Schneider, 1976; Straube & Germer, 1979), psychophysiological studies (e.g., Callaway & Naghi, 1982; but see, Baribeau-Braun, Picton & Gosselin, 1983) and general literature surveys (e.g., Chapman & Chapman, 1973; Silverman, 1964; Lang & Buss, 1965), is suggestive of a deficit in the processes subsumed under the rubric 'attention'. On the other hand, it is possible that attentional processing is limited because of a more fundamental disorder within preattentive processing (Cox & Leventhal, 1978; Nuercherlein, 1982; Place &

Gilmore, 1980; Wells & Leventhal, 1984).

Chapter 4 presents an overview of the data collection method along with a description of clinical measures and the subject selection procedure. Chapter 4 also introduces the model of processing which has guided the present studies. Chapters 5, 6, and 7 present a series of Experiments which collectively investigate the processing functions of stimulus identification, selective attention, perceptual organization of the stimulus representation and the effects of stimulus familiarity on information processing. In Experiment 1, an analysis of the types of report errors made during tachistoscopic 'identification' was conducted to test whether the processing deficit in schizophrenia is at the preattentive or the attentional processing level. In Experiment 2, perceptual segregation by colour was investigated in a visual search task to test the hypothesis that schizophrenics do not conduct preattentive analysis (Cox & Leventhal, 1978; Place & Gilmore, 1980; Wells & Leventhal, 1984). In Experiment 3, target-noise discriminability was varied to further test the preattentive-deficit hypothesis. Experiment 4 re-assessed the two processing levels concentrating its inquiry on whether there is an attentional deficit in schizophrenics. The task, in this case, was to judge whether two simultaneously presented objects were the 'same' or 'different' under conditions which stressed the different levels of processing. In addition to investigating the processing levels, Experiment 4 inquired into whether schizophrenics can utilise stimulus familiarity to facilitate processing, as normal controls have been found to do (e.g., LaBerge, 1973). Experiment 5 followed up the issue of stimulus familiarity using a distraction

paradigm. In this case it was thought that familiar or 'organized' distractors would interfere with the performance of controls more severely than schizophrenics if schizophrenics did not process the distractors normally.

By and large, the present Experiments have found little evidence that any specific level of visual-information processing is abnormal in schizophrenia. The results were not fully consistent with either the preattentive or attentional deficit hypotheses. There was some suggestion that preattentive processing was impaired (esp. in Experiments 1, 2 & 5) but this hypothesis could not explain other results in the study. With regard to the attentional-deficit hypothesis, the bulk of the present results suggested that processing by focal attention was normal in the present sample of schizophrenics. In view of these results the main evidence for the preattentive- and attentional- deficit hypotheses is re-evaluated in Chapter 8. It was concluded that the case for the attentional-deficit hypothesis is not supported by the literature and by the present findings in general. However, although most of the evidence for the preattentive-deficit hypothesis could be re-interpreted to support the attentional-deficit hypothesis, the results of the Place and Gilmore (1980) study remained relatively unique evidence for a preattentive-processing deficit in schizophrenia.

Chapter 8 also reviews the findings with respect to the correlation analysis carried out between the processing variables and the clinical variables, concluding that, in general, small sample studies like the present are incapable of answering the complex question of whether any particular

symptom and sign or dimension of schizophrenia is related to poor performance in information-processing tasks. The analysis also indicated that some of the performance deficits demonstrated in the present series of Experiments could well have been due to the effects of medication on information-processing. (On the other hand, performance was found to be positively correlated with medication level in Experiment 1).

Chapter 8 also makes recommendations for future experimentation in visual perception in schizophrenia, pointing out the need to make the logical 'link' between the phenomenology of visual perception in schizophrenia and information-processing variables. This approach can lead to the selection of relevant control groups based on the phenomenon under investigation and this can have the added advantage of reducing the uncontrolled variables which are abundant in typical schizophrenia research. Other directions for further research are also discussed in the Chapter.

Acknowledgements

I would like to thank my supervisors, Drs. D.G. Byrne and M. Cook for their encouragement, support and critical comments on the work. I thank Mr. R. Fleming and the staff of Kenmore and Young District hospitals for their hospitality during the course of the data-collection. I am also grateful to the staff and the clinical and research students for their moral support throughout the period of the work. Warm thanks to Ms. G. Keismith for her hours spent in proof-reading and compiling the final draft. Finally, I thank my parents for their encouragement.

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CHAPTER 1. AN OVERVIEW OF SCHIZOPHRENIA

1.1 The diagnostic concept of schizophrenia

From its inception, the concept of schizophrenia has referred to a number of apparently different psychiatric disturbances that were grouped together on the basis of an early onset and poor outcome or deteriorating course. Kraepelin's concept of 'dementia praecox' included previously defined conditions of 'hebephrenia' and 'catatonia' along with two newly defined syndromes - 'paranoid disorder' and 'dementia simplex' (Braceland, 1956; Jablensky, 1986; Klein, Gittelman, Quitkin & Riffkin, 1980; Stromgren, 1982). Kraepelin's description of symptoms associated with these conditions is summarised in Figure 1.1.

Bleuler's (1950; Freyhan, 1958; Raskin, 1975) concept of schizophrenia also included a number of disorders whose aetiology was thought to be variable:

"Under the term dementia praecox or schizophrenia we thus subsume a group of diseases which can be clearly distinguished from all other types of diseases in Kraepelin's system. They have many common symptoms and similar prognoses. Nevertheless, their clinical pictures may be extremely varied. " (Bleuler, 1950, p. 4).

Bleuler distinguished between fundamental symptoms and accessory symptoms of schizophrenia. Fundamental symptoms were expected in every case of schizophrenia and included: The loss of associative connectivity; affective disorder (loss of affective depth, presence of moodiness or inappropriate affect); ambivalence (of affect, will, and intellect); autism (e.g. a preoccupation with phantasy to the exclusion of reality). Accessory symptoms, which included hallucinations,

FIGURE 1.1: Kraepelin's description of symptoms for 'dementia praecox' (compiled from Braceland, 1956; Klein et al., 1980; Kraepelin 1920; Manschreck, 1983).

PRESENT IN DEMENTIA PRAECOX

lack of insight and judgement
hallucinations
incoherent thinking and speech
incoherent affect and actions
misinterpretations of sensation
attachment of peculiar meanings to sensations
inappropriate mood
poor concentration
decrease in attention to the external world
a reduction in volition and goal directedness
motor disturbances (e.g. catatonic excitement)

ABSENT IN DEMENTIA PRAECOX

impaired perception and memory
clouded consciousness

delusions, lapses in memory, poverty of ideas, and language disturbances ('word salad', neologisms, agrammatisms and the condensation of words), were regarded as common in conditions other than schizophrenia and were of lesser diagnostic value. Additionally, accessory symptoms, in contrast to the fundamental symptoms, were thought to be present periodically or not at all once the disorder had developed.

Bleuler brought to the concept a further distinction, that of primary and secondary symptoms. This distinction referred to the aetiology of symptoms while by comparison, the fundamental-accessory distinction referred to the description of the disorder. Primary symptoms were regarded as expressions of a disease process while secondary symptoms were thought to reflect behavioural adaptations to the primary symptoms (Berner, 1980; Raskin, 1975).

Schneider (1957) posed two main criticisms of Bleuler's classification. First, fundamental symptoms which were regarded as central to diagnostic decisions were not necessarily present in the condition:

"... in order to be recognized with confidence, they [fundamental symptoms] must 'have attained a certain degree of severity'. This means, however, that they are not 'present at all times and in every case', as Bleuler himself expressly concedes." (Schneider, 1957, p. 41).

Secondly, Schneider criticised Bleuler on the grounds that there was no correspondence between fundamental symptoms and primary symptoms on the one hand, and, accessory and secondary symptoms on the other. That is, fundamental symptoms were not, as Schneider expected, more or less the same as primary symptoms:

"Of the basic symptoms, only disturbed association counts as primary, and even then there are reservations: disturbed affect, ambivalence, autism are not primary but secondary symptoms, disturbed affect being listed as provisional. This and much more is inconsistent, illogical, and unsystematic." (Schneider, 1957, p. 42).

Schneider's rejection of Bleuler's classification led him to adopt an approach which relied solely on the description of the most common symptoms of the disorder; he avoided theoretical inferences between the symptoms and aetiology (Deutsch & Davis, 1983; Hoenig, 1982). Schneider identified 'first rank' symptoms as those that were the most diagnostically conclusive of schizophrenia in the absence of evidence of any organic impairment. 'Second rank' symptoms were regarded as merely suggestive of schizophrenia (Berner, 1980; Deutsch & Davis, 1983; Mellor, 1970). 'First rank' symptoms included: the patient hears his thoughts aloud; the voices comment on the patient's actions; the voices are arguing or discussing the patient; the hallucination of influences on the body ('somatic passivity'); delusional interpretation of information; the experience that one's thoughts are interfered with or withdrawn by external influences; the experience that thoughts are inserted by external forces; the experience that one's thoughts are transmitted to others and can influence others' behaviour; and experiences that affect, impulses, and motor activity are 'made' for the patient by external forces (Deutsch & Davis, 1983; Fenton, Mosher & Matthews, 1981; Hoenig, 1982; Klein et al., 1980; Mellor, 1970).

More recently diagnostic criteria for schizophrenia have reflected a trend towards increasing the reliability of the

diagnosis (although whether the signs and symptoms validly refer to a single disease process remains an issue). In this respect the World Health Organization (1973) sponsored the International Pilot Study of Schizophrenia. A sample total of 1,121 psychiatric patients was interviewed using the Present State Examination (Wing, Cooper & Sartorius, 1974). Patients were interviewed in nine different countries by local psychiatrists and were assigned clinical diagnoses based on the International Classification of Diseases. Using half of the initial cohort data, twelve symptoms were found to identify the patients who were diagnosed schizophrenic (Bartko, Carpenter & Strauss, 1981; Carpenter, Strauss & Bartko, 1973, 1974). These 'flexible' symptoms were: restricted affect, poor insight, hearing thoughts aloud, poor rapport with the interviewer, widespread delusions, incoherent speech, unreliable information during the interview, bizarre delusions, nihilistic delusions, absence of early waking, absence of depressed appearance, absence of elation.

The 'flexible' symptoms were applied to the rest of the cohort and the results indicated that 91 percent of clinically diagnosed schizophrenics exhibited four or more symptoms but so did 38 percent of other diagnoses. When the cut-off was specified at eight or more symptoms, 20 percent of clinically diagnosed schizophrenics were selected but no other diagnoses could be confused with schizophrenia. Generally a cut-off of six or more 'flexible' symptoms is acceptable as this includes 63 percent of clinically diagnosed schizophrenics and six percent of other disorders.

Fenton et al. (1981) pointed out, most of the classification systems have concentrated on a cross-sectional

FIGURE 1.2: DSM III criteria for the diagnosis of schizophrenia (adapted from the DSM III, American Psychiatric Association, 1980).

DIAGNOSTIC CRITERIA FOR A SCHIZOPHRENIC DISORDER

- A. At least one of the following during a phase of the illness:
1. bizarre delusions, such as delusions of being controlled, thought withdrawal, thought insertion, thought broadcasting
 2. somatic, grandiose, religious, nihilistic, or other delusions without persecutory or jealous ideation
 3. delusions with persecutory or jealous content if accompanied by hallucinations of any type
 4. auditory hallucinations in which either a voice keeps up a running commentary on the individual's behaviour or thoughts, or two or more voices converse with each other
 5. auditory hallucinations on several occasions with content of more than one or two words, having no apparent relation to depression or elation
 6. incoherence, marked loosening of associations, markedly illogical thinking, or marked poverty of content of speech if associated with at least one of the following:
 - a. blunted, flat, or inappropriate affect
 - b. delusions or hallucinations
 - c. catatonic or other grossly disorganised behaviour
- B. Deterioration from a previous level of functioning in work, social relations and self-care.
- C. Duration: Continuous signs of the illness for 6 months with a period which includes symptoms from A (above), with or without a prodromal or residual phase (see below)
- D. Absence of the full depressive or manic syndrome or this developed after the other psychotic symptoms, or was relatively brief in comparison to the other psychotic symptoms
- E. Onset before the age of 45
- F. No evidence of Organic Mental Disorder or Mental Retardation

PRODROMAL AND RESIDUAL SYMPTOMS

1. social isolation or withdrawal
 2. impairment in vocational functioning
 3. peculiar behaviour (e.g. collecting garbage)
 4. reduced personal hygiene and grooming
 5. blunted, flat, inappropriate affect
 6. digressive, vague, circumstantial
 7. bizarre ideation, overvalued ideas, ideas of reference
 8. unusual perceptual experiences (e.g. recurrent illusions)
-

rather than longitudinal description of the disorder. However, the third edition of the Diagnostic and Statistical Manual (DSM III) for the classification of mental disorders has adopted a longitudinal criterion. The DSM III criteria are presented in Figure 1.2. These criteria were largely derived from the Feighner Criteria (Feighner, Robins, Guze, Woodruff, Winokur & Munoz, 1972) which take the theoretical view that good- and poor-prognosis schizophrenias are two distinct disease entities (Robins & Guze, 1970) and that the poor prognosis group is, supposedly, the 'true' schizophrenia. For this group, the disorder develops insidiously, it is present for at least six months and includes individuals with a poor psychosocial adjustment prior to the 'onset' of the illness (Spitzer, Andreasen & Endicott, 1978).

However, according to Fenton et al. (1981) validation of these criteria has been somewhat tautological since the most popular validation measure used was the prediction of outcome. As Fenton et al. pointed out, a good association can be expected between established chronicity and future chronicity in any psychiatric disorder. Moreover, in Klein's (1982) assessment, he indicated that the Feighner Criteria and the DSM III criteria showed only low correlations with broad measures of premorbid psychosocial adjustment. Interestingly, the Flexible-Symptoms system, which does not include a duration-of-illness requirement, tended to select more chronic cases (even when a cut-off of only 5 symptoms was used).

Klein (1982) compared the following systems for diagnosing schizophrenia: Feighner Criteria; Taylor and Abrams Criteria; DSM III; Research Diagnostic Criteria; Flexible

Symptoms; and, Schneider's First Rank Symptoms. These systems were compared in terms of the degree to which they included patients who were chronic, were poorly adjusted premorbidly, or exhibited paranoid symptomatology. The results indicated no major differences between the systems in selecting patients on these systems on the three indices. It seems that these systems, regardless of their inclusion of chronicity criteria, are equivalent in their ability to select chronic, poor psychosocially-adjusted, or paranoid patients.

1.2 Age of onset

The onset of schizophrenia ranges between 16 and 25 years of age (for 75 percent of diagnoses), the number of new cases becoming rare after the age of 40 (Torrey, 1983). Age of onset appears to differ for the sexes. Below the age of 34, more men are diagnosed than women, while this pattern is reversed beyond the age of 35 (Wing, 1982). This may be a reflection of different social and vocational pressures, and the different opportunities for the recognition of the disorder in the sexes. On the other hand, it has been suggested that hormone-dopamine interactions in women may reduce their early predisposition to the illness (Loranger, 1984) or in men these may "trigger" (Lewine, 1981, p. 440) the early onset of the disorder.

1.3 The incidence of schizophrenia

The most common measure of incidence is the number of new cases of schizophrenia detected by a psychiatric service within a period of time (usually one year and usually expressed per 1,000 of the population). Recent reviews of such incidence figures reveal an average rate of 0.31 per 1000 with

a range of 0.17 to 0.52 (Jablensky, 1986). These figures reflect diagnoses from seven European countries. Haffner & ander Heiden (1986) found an average rate of 0.30 with a range of 0.08 to 0.69 representing figures from nine countries including the Victorian Register in Australia (incidence of 0.16, Krupinski, 1984 personal communication to Haffner & ander Heiden, 1986).

Data published by Krupinski, Alexander and Carson (1982) from the Victorian registry for the years 1961 to 1973 showed a mean rate of 0.26 with a range of 0.20 to 0.31. It is interesting that the data indicated a reduction in the incidence rate over this period from 0.27 to 0.20 since a similar reduction was found in the Danish National Registry for the years 1957 to 1972 (Weeke & Stromgren, 1978). The reason for this effect is not clear, but may reflect an increase in the utilization of facilities outside of psychiatric services (Jablensky, 1986). This is indeed suggested by the data from the Victorian Registry which shows a tendency for greater use of out-patient facilities and an emphasis on less hospitalization over this period (Krupinski, Alexander & Carson, 1982).

1.4 Long-term outcome

Comparison of outcome studies is difficult. Among other sources of variability, studies show heterogeneity in samples with respect to symptoms, variable outcome criteria, variable length of follow-up, and varying treatment environments. Ciompi (1984) noted that a number of factors have been found that influence illness duration, including: personality factors (e.g., habitual coping styles to stress); social

influences (e.g., social stimulation, familial environment, life events); treatment or institution related factors (e.g., institutional infra-structure, the system of care, treatment expectations of those concerned); and, cultural and economic status. These influences suggest that the traditional association of chronicity with schizophrenia might be misleading (see also, Barham, 1984).

Nevertheless, generalizations about outcome have been made in the literature (e.g., Stephens, 1978; Tsuang, 1982). Generally, 25 percent of cases can be expected to recover from psychosis without residual defect, 40 percent can be expected to suffer from recurrent psychotic episodes with residual disabilities in social and vocational spheres, and the rest can be expected to remain psychotic indefinitely (Quality Assurance Project, 1984).

1.5 The diathesis-stress model

The data concerning schizophrenic illness are best accommodated by the diathesis-stress model of psychopathology (e.g. Ciompi, 1984; Davison & Neale, 1978; Nuercherlein, 1986; Nuercherlein & Dawson, 1984). According to this view, schizophrenics exhibit a predisposition to psychosis but its development is influenced by a stressful environment. There is substantial support for the notion of a genetic predisposition to the disorder although mechanisms of inheritance are as yet obscure (e.g. Baron, 1986; Gottesman & Shields, 1982; McGue, Gottesman, & Rao, 1986; Rainer, 1982). On the 'environment' side of the diathesis-stress equation, the work on the expression of emotion in families of schizophrenics (Tarrier, Vaughn, Lader, & Leff, 1979; Vaughn & Leff, 1976) suggests an

FIGURE 1.3: Stages in the development of psychosis (adapted from, Docherty et al., 1978).

STAGE 0	<u>HOMEOSTASIS</u> normal adaptation
STAGE I	<u>OVEREXTENSION</u> experience of being overwhelmed, experience of the need think faster to keep up with events, feelings of overstimulation, persistent decreasing efficiency and distractability
STAGE II	<u>RESTRICTED CONCIOUSNESS</u> limitation in scope of thought, boredom, apathy, listlessness, social withdrawal, reduced activity, obsessional, phobic symptoms, somatic complaints, feelings of hopelessness, dissatisfaction, loneliness and dependency
STAGE III	<u>DISINHIBITION</u> impulsive actions, uncharacteristic, risk taking, sexual promiscuity, rage attacks, unrestricted spending, dissociative phenomena, mood elevation, ideas of reference, repressed material becomes conscious
STAGE IV	<u>PSYCHOTIC DISORGANIZATION</u> <u>PART i. Destructuring of the</u> <u>external environment</u> loss of figure/ground relationships, percepts assembled with concious effort, ideas of reference now prevalent, speech disorganization, comprehension of external stimulation is difficult <u>PART ii. Destructuring of the self</u> loss of self identity, loss of sense of self connectedness, actions are disconnected, intrusions of 'primitive' sexual and aggressive images into conciousness severe anxiety, panic, hallucinations <u>PART iii. Total fragmentation</u> complete loss of self control, catatonia may appear
STAGE V	<u>PSYCHOTIC RESOLUTION</u> decreased anxiety, increased organization, development of delusional belief system, denial of unpleasant affect, denial of responsibility

effect of 'specific' stressors. On the other hand, as suggested by Ciompi (1984, see also, Frith, 1979), non-specific stressors may have an adverse influence on schizophrenics because of their generalised intolerance to high levels of stimulation.

For Ciompi the concept of diasthesis included more than genetic constitution. He summarised much of the evidence on the aetiology of the disorder by stating that genetically determined constitutional abnormalities, prenatal and perinatal cerebral damage, early disturbance of the mother-child relationship, ambiguous and contradictory familial patterns of communication and situational social and cultural influences, all play a role in shaping a person toward vulnerability. Ciompi identified this vulnerability as a "deficiency in information processing" and particularly, as an "abnormally low 'channel-capacity'...[in the].. information processing system" (1984, p. 638). These ideas have been expressed previously by others (e.g. Gjerde, 1983; Knight & Russell, 1978; Yates, 1966). Accordingly, psychotic symptoms can be seen as an overwhelming of a vulnerable information-processing system (Ciompi, 1984).

1.6 The development of psychosis

The course of psychosis was summarised from the literature into a five-stage model by Docherty, Kammen, Siris and Marder (1978). Their summary is presented in Figure 1.3. In agreement with Ciompi (1984) Docherty et al. speculated that the "progressive disturbance of psychotic decompensation reflects the levels of breakdown seen with progressive information overload" (Docherty et al., 1978, p. 425).

1.7 Chapter Summary

Schizophrenia is a concept that refers to a number of diverse disorders in behaviour having in common a severe deterioration of personality. It is characterised by periods of psychosis with experiences of hallucinations, delusions, thought disorder, and emotional disorganization. The course of schizophrenia is variable but not uncommonly it is characterised by long-term psychosocial disability. Schizophrenia is best described by the general model of the interaction between two factors: vulnerability to psychosis and stressful environment. Vulnerability may have both psychosocial and biological aetiologies, and while there is some evidence for the action of specific stressors in the expression of psychotic behaviour, the more common opinion in the literature (e.g. Callaway & Naghi, 1982; Frith, 1979; Ciompi, 1984; Gjerde, 1983; Knight & Russell, 1978) is that schizophrenics are vulnerable to information 'overload'. Information 'overload' seems to be linked to psychosis by some theorists (e.g., Docherty, et al., 1978) while others (e.g., Ciompi, 1984) regard it as an endurable characteristic of schizophrenics.

CHAPTER 2. VISUAL PROCESSING DISORDER IN SCHIZOPHRENIA

2.1 Historical note

The present work is concerned with visual perception in schizophrenia and with the question as to whether specific processes within perception are abnormal. Contrary to this view, the various disturbances in perception, which will be reported below, were not featured in the diagnostic descriptions of schizophrenia by Kraepelin and Bleuler. According to Weckowycz and Blewett (1959) Kraepelin's conclusions that there are no perceptual disturbances in 'dementia praecox' were based on Wundt's concept of perception which considered the study of perception to be concerned, essentially, with the study of sensory phenomena and with the measurement of thresholds.

In Wundt's system phenomena involving complex interpretation of stimulation and those to do with the processing of meaning, were classified as "apperception". Following the measurement of sensory thresholds in 'dementia praecox' by Wundt's methods, Kraepelin concluded that perceptual processes were preserved in the disorder. Bleuler reinforced this view by providing among the descriptors of schizophrenia the term 'clear sensorium'. Accordingly, research interest in perceptual phenomena waned, and attention was turned to emotional factors associated with schizophrenia. Interest in perception was rekindled, however, by the advent of the Gestalt school which conceived perception as integrated with other aspects of human behaviour (e.g. needs, drives, emotions, etc.).

2.2 Visual distortions in schizophrenia

Disordered processing of visual information is suggested by the experiential reports of schizophrenic patients. For example, McGhie and Chapman (1961) noted disturbances of the ability to limit attention to a subset of the stimulus field, in the reports of schizophrenics. These patients experienced an interruption in the stream of thought as a result of detecting irrelevant environmental events:

"If I am talking to someone they only need to cross their legs or scratch their heads and I am distracted and forget what I am saying"
(McGhie & Chapman, 1961, p. 104);

and,

"I can't concentrate on television because I can't watch the screen and listen to what is being said at the same time. I can't seem to take in two things like this at the same time especially when one of them means watching and the other listening. On the other hand I seem to be always taking in too much at the one time and then I can't handle it and can't make sense of it."

(McGhie & Chapman, 1961, p. 105).

Other patients reported more severe problems such as the need to concentrate in order to visualise the stimulus field coherently:

"Everything is in bits. You put the picture up bit by bit into your head. It's like a photograph that's torn in bits and put together again. You have to absorb it again. If you move it's frightening. The picture you had in your head is still there but it's broken up. If I move there's a new picture that I have to put together again."

(McGhie & Chapman, 1961, p.106).

Chapman (1966) reported similar experiences:

"I have to put things together in my head. If I look at my watch I see the watch, watchstrap, face, hands and so on. I have to put them together to get it into one piece." (p. 229)

As early as 1941 Arieti noted similar problems in the 'severely regressed' patients (Arieti, 1974). He reported that the perceptual fragmentation of objects to their parts, which he termed "primary awholism" (1974, p. 283), becomes more prominent as the severity of psychosis increases. As an explanation Arieti presented the following account. First, he distinguished between primary and secondary perceptual processes, suggesting that primary processes are rapid and usually outside the observer's consciousness while secondary processes are conscious. Primary processes are involved in deriving the perceptual representation of parts of objects which are then integrated by the secondary process. He went on to state that,

"what appears to us to be normal perception, involving wholes, is only the ultimate stage of a complicated mechanism. This microgenic mechanism occurs in the normal subject in a fraction of a second, and the subject is aware only of the terminal stage, that is, when he perceives wholes as wholes...[In schizophrenia] perception becomes arrested at one of the pregestaltic stages."

(Arieti, 1974, p. 283).

Apart from these reports, which seem to suggest failures to select and integrate information into meaningful events, Freedman (1974) reported changes in the sensitivity to sensory input. There are, for example, accounts of enhanced sensitivity:

"...my eyes became markedly oversensitive to light. Ordinary colors appeared to be much too bright and sunlight appeared dazzling in intensity. When this happened ordinary reading became impossible."

(Freedman, 1974, p. 101).

On the other hand, Chapman (1966; also, Freedman, 1974)

recorded experiences of muted sensory awareness - an experience that all sensation is dimmed or dulled. Other patients reported that background stimuli became as perceptually salient as foreground stimuli - figure and ground resolution was diminished. Reports in Chapman's paper alluded to visual distortions involving shape and depth information:

"I was sitting listening to another person and suddenly the other person became smaller and then larger and then he seemed to get smaller again...Last week I was with a girl and suddenly she seemed to get bigger, and bigger, like a monster coming nearer and nearer. The situation becomes threatening and I shrink back and back."

(Chapman, 1966, p. 229);

and,

"I see things flat. Whenever there is a sudden change I see things flat. That's why I'm reluctant to go forward...There is no depth, but if I take time to look at things I can pick out the pieces like a jigsaw puzzle. Moving is like a motion picture. If you move the picture in front of you changes. The rate of change in the picture depends on the speed of walking. If you run you receive signals at a faster rate. The picture I see is literally made up of hundreds of pieces. Until I see into things I don't know what distance they are away."

(Chapman, 1966, p. 230).

In addition to recording such experiences early in the course of the disorder, Chapman noted the association of 'visual disturbances' with poor clinical outcome.

More recently, Phillipson and Harris (1985), using survey methodology, investigated the frequency of various visual illusions and distortions in schizophrenics. These visual disturbances included changes in the perception of colour, motion, brightness contrast, depth, size, shape and tilt. Data from schizophrenics were compared with non-psychiatric, non-neurological patients who attended accident

and emergency wards. As expected, schizophrenics reported more visual distortions than controls and, whereas controls tended to report singular kinds of distortions, schizophrenics reported multiple types of disturbances (e.g. brightness and colour and tilt disturbances). Among the various distortions investigated, disturbances in brightness contrast were most often reported by schizophrenics.

Within the schizophrenic group, 52 percent of patients reported that visual disturbances occurred prior to their seeing a doctor about their psychosis, supporting Chapman's observations. Noteworthy is the finding that the majority of patients reporting disturbances concerning colour, motion and brightness also reported that these were reduced by medication. Curiously, this was not the case for disturbances of depth, size, and tilt perception. Finally, visual hallucinations were reported more often by schizophrenics who reported other visual disturbances, compared with those who did not, suggesting a common process for the two symptoms. However, 40 percent of patients who reported visual hallucinations did not report visual distortions. Phillipson and Harris speculated that the discrepancy among the patients might be due to the less observant patients reporting hallucinations and ignoring visual distortions.

In summary, the literature on the experiences of schizophrenics indicates that these patients are susceptible to disturbances in the coding of visual information. The visual disturbances can appear early in the course of the disorder and seem to be most prominent among those patients who tend to have deteriorating clinical courses. According to the patients' reports these experiences are summarised as an

inability to select a subset of the total stimulus field, an inability to integrate the objects of perception into meaningful events, a breakdown in the rules for the resolution of figure and ground, an oversensitivity or a heightened awareness of sensory input, a dulling of sensory input, a failure to appreciate depth, shape, tilt, and motion correctly, and a disorder in the perception of brightness contrast.

2.3 Experimental evidence for visual-processing disturbance: Experiments using general measures of processing

Two types of experimental study will be reviewed in this section whose results are consistent with the phenomenological descriptions mentioned above. Findings in these studies, however, are inconclusive regarding what information-processing mechanisms are responsible for the deficient performances of schizophrenics. (The survey of studies more pertinent to this issue is deferred to the next Chapter.) The first group of studies to be reviewed are those investigating size and distance constancies in schizophrenics suggesting that schizophrenics fail to appreciate the relevant cues for conducting normal judgements of size and distance. Second, are the studies showing a number of disorders in voluntary eye-movements, although other measures of oculomotor function seem to be normal. Disorders of voluntary eye-movements might also be due to less efficient stimulus processing (Cegalis & Sweeney, 1981).

2.31 The impairment of perceptual constancies

The results of studies investigating perceptual

constancies are consistent with the phenomenological reports of distorted depth and size perception presented earlier. Weckowycz (1957) for example, showed that chronic schizophrenics tended to make 'underconstancy' judgements when they were asked to match the height of a 'proximal' rod to a 'distal' rod as the experimenter manipulated the distance of the distal rod. ('Underconstancy' is a consistent error of underestimating the size of the distal rod.) 'Underconstancy' judgements were then shown to be related to reduced ability for abstract conceptualization (Weckowycz & Blewett, 1959) as is common among psychotic schizophrenics (Payne, 1960).

Previously, Holway and Boring (1941) had shown that size 'underconstancy' in normal subjects is eliminated by cues for distance. The judgement of size requires the availability of cues for distance which include, linear and texture perspective, convergence, accommodation, binocular disparity and head-movement parallax (for summaries see, Kaufman, 1974; Kaufman & Rock, 1962; Neisser, 1968). Consonant with the size-distance relation Weckowycz, Sommer and Hall (1958) demonstrated that chronic schizophrenics made abnormal judgements of the distance between two objects as these receded from the observer. Judgements of schizophrenics again tended to underestimate the actual distance between the two objects. Weckowycz et al. (1958) concluded from this that schizophrenics "live in a flatter world" (p. 1180) than comparative groups and that the relative absence of depth perception might underly some of the phenomenological reports of schizophrenics (such as those mentioned above).

A spate of studies followed these early investigations. Price and Eriksen (1966), in reviewing the literature, noted

that studies comparing schizophrenics to normals can be about equally divided amongst the three possible findings: schizophrenics make 'underconstancy' judgements; they make 'overconstancy' judgements; they are no different to controls in their judgements. However, studies investigating subgroups of schizophrenics and normal controls indicated a more consistent pattern - paranoid schizophrenics tended to make 'overconstancy' judgements while non-paranoid schizophrenics made 'underconstancy' judgements (Price & Eriksen, 1966).

Price and Eriksen partially confirmed this pattern of results. Furthermore, they attempted to discover whether the reported differences between schizophrenic subgroups and normal controls were due to changes in the actual sensitivity to visual cues or whether these were due to response bias (i.e., differences in criteria for responding in a particular direction). They found that only non-paranoid schizophrenics had diminished sensitivity to perceptual cues, compared with controls. Moreover, a measure of response variability, despite equal sensitivity between normals and paranoids, showed a tendency for the latter group to make ratings of greater confidence about size judgements.

Overall, the constancy literature suggests that chronic non-paranoid schizophrenics are insensitive to the available visual cues whereas paranoid schizophrenics show normal sensitivity. Paranoid schizophrenics, are occasionally shown to make 'overconstancy' judgements which, other than an exaggeration of the normal tendency for such judgements, might also suggest a 'miscalculation' of the size-distance relation.

2.32 Comments on the explanation of constancies impairment

Early explanations of underconstancy provided by Weckowycz and Blewett (1959) seem to be at variance with their data. They suggested that schizophrenics are unable to select the relevant information from the visual scene in order to maintain normal constancy judgements. Weckowycz and Blewett stated that for schizophrenics,

"perception is more influenced by the here and now factors of the immediate situation and less by the experience of the past and the anticipation of the future...there is some change in filtering the stimulation...The gates are wide open, the cortex is flooded with irrelevant information so that maintenance of set becomes difficult. The subject cannot attend selectively to certain cues and he interpretes all the stimulation patterns literally because he attends to all cues at the same time."

(Weckowycz & Blewett, 1959, pp. 930-931).

The failure to use cues provided by the visual scene is a possibility, particularly in view of the Holway and Boring (1941) demonstrations, but that these cues become available through the kind of active selection process suggested by Weckowycz and Blewett is not necessarily indicated by the data. Indeed the kind of 'filter' breakdown they suggest is consistent with the findings of 'overconstancy', where the subject appears to be 'hyper-sensitive' to distance cues. Notably, Holway and Boring (1941) found 'overconstancy' in normal subjects in unrestricted viewing conditions (e.g., binocular viewing, bright illumination, etc.).

The Weckowycz and Blewett explanation fits better some of the distractibility phenomena reported earlier, as well as the results of other early experiments which showed in schizophrenics: an excessive susceptibility to the Muller-Lyer illusion (Weckowycz & Witney, 1960); a relative inability to

perceive objects that are embedded as 'hidden figures' (Weckowycz, 1960). In both of these examples schizophrenics were susceptible to the effects of cues which can mislead the subject from the correct response. In this case, schizophrenics seemed unable to utilise the selective mechanism which mediates, first, the breakdown of initially formed gestalts, and second, the subsequent perceptual reconstitution of the stimulus based on the subject's expectancies (Weckowycz & Blewett, 1959). (Notably, according to this explanation preattentive processing is assumed to be normal in schizophrenia.) In the constancy task however, chronic non-paranoid schizophrenics appeared not to be sensitive to any cues. Alternatively they may have been sensitive to them but the integration of size-distance information led to a consistent miscalculation toward underestimation. In either case, the data do not necessitate that the 'calculation' occurs by the active selection process suggested by Weckowycz and Blewett. Alternatively, the calculation may involve 'hard-wired' processes as is suggested, for example, by developmental data showing the size-distance constancy in six to eight month old infants (Bower, 1966).

It is worthwhile noting that a number of other criticisms have been leveled at the literature on constancies (e.g. Chapman & Chapman, 1973; Neale & Cromwell, 1970). Neale and Cromwell pointed out that schizophrenics might have consistently misunderstood task instructions. It is possible that schizophrenics who made underconstancy judgements, contrary to controls, made their judgments based on the

retinal size of the stimulus rather than its distal size. Indeed, normal college students change their criteria and show similar reduced constancy judgements as a function of experimental instructions (for summary see, Kaufman, 1974). Neale and Cromwell pointed out that if task instructions are disambiguated as when task practice is allowed there are no constancy differences between schizophrenics and controls. These criticisms suggest the possibility that the above findings are an artifact of the subjects using different criteria for their judgements. It is not clear, however, that this is the case for all the studies mentioned.

2.33 Eye-movement disorder in schizophrenia

Between 65 and 80 percent of schizophrenics exhibit disordered voluntary eye movements compared with six percent in normal populations (Holzman, 1978; Lindsey, Holzman, Haberman & Yasillo, 1978). The disorder is found in about 45 percent of first-degree relatives of schizophrenics and consequently it has been suggested as a vulnerability marker. The data reviewed by Lindsey et al. suggest that the disorder in smooth pursuit tracking is not an artefact of the measurement technique or of phenothiazine medication. Nor does it appear to be due to dysfunction at the neuromuscular level (Holzman, 1975). Mather (1986), for example, noted that other oculomotor responses are normal. These responses include: oculomotor reaction time; main sequence programming for single saccade eye-movement; reflexive eye movements as shown by optokinetic nystagmus (even when abnormal voluntary pursuit movement is present); saccadic velocity; inter-saccadic interval; and, as to be expected, patients showed normal

increase in double jump saccades as the targets became more peripheral. Tracking disturbances might underly the distractibility and poor coding phenomena reported by schizophrenics (Levin, 1984a; 1984b). On the other hand, they may be secondary to the poor ability of schizophrenics to appreciate or utilise the cues from the visual scene (Cegalis & Sweeney, 1981).

The ability to track a moving pendulum appears to be influenced by cognitive factors. For example, Acker and Toone (1978) showed that normals who are given a competing task of counting backwards from 1000 exhibited disordered pursuit movements. Deviant eye-tracking was shown to become more pronounced as the difficulty of the counting task was increased. These authors demonstrated the same effect in schizophrenics, but they cautioned that in this group the observed deficit may have been an artifact of general inattentiveness to the task. This was supported by the observations that the deficit was not continuously present in the same patient, and secondly, global behavioural measures of restlessness were correlated with degree of tracking impairment.

The demonstration that improvement in eye-tracking performance of schizophrenics is rendered by increasing the task complexity is also consistent with the involvement of cognitive factors. Shagass, Roemer and Amadeo (1976) improved eye-tracking performance of schizophrenics by increasing the attentional demands of the tracking task. They did this by requiring subjects to determine whether an oscillating target (on a cathode ray tube) was the number six or the number three. An improved performance was observed on this task

compared with one where the discrimination judgement was not required. Similarly, Iacono and Koenig (1983, see also, Holzman, Levy & Proctor, 1978) asked subjects to monitor the presence (or absence) of a dot within an oscillating circle. Performance of both schizophrenics and controls (normals, bipolar and unipolar affective illness patients) improved in this task over the less demanding task.

Iacono and Koenig (1983) also noted that pursuit performance of schizophrenics was characterised by a greater phase lag than that of the other groups. (Phase lag refers to the average number of degrees of visual angle that the eye lags behind the target position.) The greater lag for schizophrenics was most evident during the task that did not require dot monitoring. Moreover, composite measures of tracking and phase lag showed different patterns of correlations with dot-discrimination performance for the schizophrenic and control groups. For the control groups, these correlations were negative (see also, Iacono and Lykken (1979) whereas they were positive for schizophrenics. According to Iacono and Koenig, this indicates that some lag is essential for accurate tracking but schizophrenics tend to lag too far behind the target, compared with controls. Iacono and Koenig suggested that the improvement in performance in the dot-monitoring task is due to the greater 'attentional' requirement of this task. By implication, attention and the processing subsumed under this label must be lacking when the disordered tracking is present (consistent with Acker & Toone's analysis).

Mather and Putschat (1983) investigated a number of

aspects of saccadic movements in schizophrenics and found that the main differences between schizophrenics and controls were obtained in measures which might be expected to tap the processing of input to the oculomotor system. These measures which were, the overshooting the target position and the number of corrective double-jump saccades, are both sensitive to 'certainty' in stimulus position information - i.e., during stimulus-position uncertainty there is more overshooting and more double-jump saccades. Mather and Putchat presented the tracking task either in the presence or in the absence of stimulus background information. In contrast to controls, the second saccade of schizophrenics was found to be much bigger in the absence of background than in its presence. This suggested a greater reliance on background information by the schizophrenic group for predicting target position (Mather & Putchat, 1983). Moreover, in the background-absent condition, the first saccade of double saccadic movement showed much larger variations in schizophrenics than in normals. This was less the case for the second saccade, suggesting that schizophrenics were compensating for an initial deficit in target position information by updating this during the first saccadic movement (Mather & Putchat, 1983).

The hypothesis that poor coding of the stimulus might underly eye-movement disorder is further supported by the studies of Cegalis and associates. Cegalis, Leen and Solomon (1977) measured eye-movement latency and made concurrent measurements of stimulus discrimination as the stimuli were presented to the periphery of the visual field. Subjects were asked to report whether displays contained 4 or 5 dots. Multiple dots were presented at a variety of angles from

the central fixation, either to its left or to its right while report order remained constant from left to right. Acute and chronic schizophrenics were compared with normal controls. The results showed that, as stimulus eccentricity was increased, acute schizophrenics remained accurate in discrimination up to an eccentricity of 47 degrees. Performance of normals deteriorated well before this value; they were accurate only up to 25 degrees. Chronic schizophrenics had an even more limited field of discrimination since their performance fell away after only 12 degrees of eccentricity.

In the analysis of eye-movement latency Cegalis et al. expected that those who were capable of the broadest apprehension of the display would not need to shift their eyes as rapidly as the other subjects, since they would already have processed a substantial portion of the second stimulus. That is, if the breadth of scanning is wide enough to encompass the right-sided stimulus during the processing of the left-sided stimulus, then the latency of eye movements to the right stimulus would be prolonged. The assumption leads to the expectation that as the stimuli are shown more peripherally the latency of eye movements for all groups ought to decrease. Indeed this was found for normal subjects but this was not the case in the schizophrenic groups. In contrast to controls both schizophrenic groups showed fast left to right eye movements which did not relate to the eccentricity of the stimuli. Such decreased scanning latency would be expected for the chronic group but it is difficult to see why acute schizophrenics, who were capable of detecting

information better than normals, persisted in short-latency eye movements. One explanation, suggested by Cegalis et al., is that the mechanisms which regulate the allocation of attention have, in schizophrenia, become 'desynchronised' with those mechanisms which function to select and encode stimuli.

The study of Cegalis and Tegmeyer (1980) further suggests stimulus encoding deficiency in chronic schizophrenics. Cegalis and Tegmeyer varied the discrimination difficulty of stimuli: low confusion stimuli consisted of two columns of two or three dots while high confusion stimuli contained four or five dots. The results indicated that with low-confusion stimuli dot discrimination of the acute schizophrenics was evident at eccentricities of up to 25 degrees. No other group could match this performance. When high-confusion stimuli were used, chronic schizophrenics were unable to perform accurately beyond only two degrees. The performance of 'neurotics' remained accurate at 12 degrees of eccentricity. Notably, both groups of schizophrenics narrowed their field of selection and encoding as a function of discrimination difficulty.

Together, these two experiments suggest that the voluntary tracking behaviour of schizophrenics, and particularly of chronics, might be abnormal due to underlying problems in stimulus encoding. Chronic schizophrenics, who are incapable of accurate discrimination, tend to limit their field of encoding to small visual angles in comparison with other groups. Recently, Kojima et al., (1986) reported reduced breadth of scanning and longer fixation times in chronic schizophrenics viewing a 'static' display suggesting that the scanning abnormality is not necessarily due to pursuit itself.

Most of their measures also indicated similar scanning between chronic schizophrenics and amphetamine psychotics but the latter group was able to alter scanning strategy (toward normal 'broad' scanning) as a function of task instructions. Chronic schizophrenics were less flexible.

Returning to the Cegalis et al. studies, acute schizophrenics seemed insensitive to the variations in eccentricity and their better ability to discriminate in the periphery did not seem to modify their scanning latency. They were, however, sensitive to the manipulation in discrimination difficulty as can be seen in the narrowing of their field of scanning. This does not support the notion that attentional scanning is unresponsive to stimulus encoding, as suggested by Cegalis et al., (1977), but it does suggest that eye-movement control itself is disordered in acute schizophrenics.

In summary, the finding that schizophrenics show abnormalities in visual tracking behaviour seems to be robust and does not appear to be due to neuromuscular level dysfunction. In acute schizophrenics there appears to be a dissociation of encoding and eye-movement control, while in chronic schizophrenics object position information appears to be encoded poorly. The latter deficit may be a more general one of reduced figural synthesis. Consistent with this view, Cegalis and Sweeney (1981) noted that the addition of the attention-demanding task to the simple tracking task might reduce eye-movement disturbance by improving figural synthesis:

"... it is reasonable to assume that processing movements is preattentive and global with minimal call for conscious activity and focal attention. However, the introduction of pattern

information may require the allocation of resources for focal attention and pattern recognition operations. Assuming that subjects fixated and tracked the intermittent or continuous presence of alphanumeric patterns, greater allocation of focal attention and an emphasis on processing figural information may have heightened sensitivity to the target, thereby enhancing the detection of velocity differences and/or providing feedback for finer control of eye movements." (1981, p. 158).

However, their account leaves open two possible interpretations. It is unclear whether non-schizophrenics outperform schizophrenics because they are able to carry out figural synthesis to the appropriate extent through preattentive analysis, or, whether non-schizophrenics tend to allocate focal attention in the 'simple' tracking task more often than schizophrenics.

2.4 Chapter summary

In this chapter three kinds of research have been described which compared certain general visual behaviours of schizophrenics and controls. Phenomenological reports suggested that there is a diversity of perceptual distortions in schizophrenia. Reports have alluded to the notion of disordered information processing at the level requiring attention (e.g., reports of distractibility and the requirement of conscious effort to overcome 'awholism'). Similar views of the disorder were expressed by Weckowycz and Blewett (1959) although not all the data fitted their explanation of a breakdown in the mechanism of active selective attention. In their view, and in Arieti's (1974), schizophrenics process information adequately by the early segregative processes of grouping by similarity, proximity and good continuation - the Gestalt processes (see, Wertheimer,

1923) but, they are unable to extract and integrate information by means of the expectancy-based system which uses attentional selection and integration of information.

Contrary to this description, some schizophrenics, notably chronic, non-paranoid schizophrenics, seem to perform as if they did not code the information available to them. It was suggested that, in the constancy task, it is possible that such coding may occur outside the realm of active selection. In the pursuit eye-movement literature it was again suggested that the reliable tracking deficit observed in chronic schizophrenics is due to an underlying disorder of figural synthesis as it is carried out by attentional processes. The allocation of attention, elicited by increasing processing demands in the task, was shown to normalise eye-tracking in schizophrenia. However, it remains uncertain whether normals track moving pendulums by using attentional processing more often than schizophrenics, or, whether the information of velocity is available to the motor system of normals at a level outside of attentional processing but this is not the case in schizophrenics.

CHAPTER 3. LEVELS OF VISUAL-INFORMATION PROCESSING IN SCHIZOPHRENIA

As suggested in the previous Chapters, the abnormal visual phenomena associated with schizophrenia might be explained by the concept of disordered figural synthesis. However, from the studies surveyed it was unclear whether this was a disorder at the level of attentional processing or a disorder at the preattentive level. This Chapter will survey studies bearing on this issue. To preempt the discussion that follows, studies can be divided broadly into those that : have found no differences between schizophrenics and controls (e.g., Schwartz & Winstead, 1985; Spaulding, Rosenzweig, Huntzinger, Cromwell, Briggs & Hayes, 1980); found differences between groups at the preattentive-processing level (e.g., Cox & Leventhal, 1978; Place & Gilmore, 1980); and, those that found differences between groups but the two processing levels, preattentive and attentional, were confounded in their measurement (e.g., Broga & Neufeld, 1981; Neale, 1971).

The general pattern of results arising from these studies is as follows. Stimulus energy variations, as in the measurement of sensory thresholds, indicate that schizophrenics perform detection tasks normally (e.g., Schwartz & Winstead, 1982; Stilton & Koppel, 1964). These conditions, where the stimulus is presented in the absence of information that is irrelevant to the response (i.e., 'noise') will be termed here 'simple threshold' conditions. 'Complex thresholds' will refer to conditions where the stimulus is presented together with visual noise. Stilton and Koppel (1964; also, Pharr & Connor, 1977) showed that schizophrenics performed more poorly than controls only in 'complex threshold'

tasks. Consonant with the phenomenological reports, a failure in these conditions suggests that those processes responsible for figure-ground and texture resolution are disordered in schizophrenia.

Support for this comes from demonstrations that schizophrenics, in performing visual search, are insensitive to the properties of the display which normally lead to perceptual grouping and organization (Cox & Leventhal, 1978; Frith, Stephens, Johnstone, Owens & Crow, 1983; Place and Gilmore, 1980; Wells & Leventhal, 1984; c.f. Arieti, 1974; Weckowycz & Blewett, 1959). Indeed, when preattentive grouping is arranged to interfere with visual search and when the display contains organization which elicits grouping automatically, schizophrenics can perform visual search better than controls (Place & Gilmore, 1980). Furthermore, the results of some masking experiments can be explained by a deficit in preattentive processing (e.g. Knight, Elliot, & Freedman, 1985). However, not all 'preattentive' tasks have shown performance deficit in schizophrenics (Davidson & Neale, 1974; Russell & Knight, 1977). For example, both the Davidson and Neale and the Russell and Knight studies indicated that visual search rate varied equally, for schizophrenics and controls, as a function of target-noise discriminability. A more detailed analysis of these studies will be conducted below.

Most of the studies that have confounded the measurement of the preattentive and attentional processing stages have been guided by Sperling's (1960) and Neisser's (1967) conceptions of the 'iconic storage' and 'post-iconic' attentional selection. These studies can be subdivided into:

those that have assumed that the icon of schizophrenics is as equally developed as that of controls and accordingly the processing disorder is assumed to be at the level of attentional selection (e.g. Asarnow, Steffy, MacCrimmon & Cleghorn, 1978; Neale, 1971); and, those studies that have attempted to remove any inequalities between groups in the 'quality' of the icon (e.g., Saccuzzo & Braff, 1981; Saccuzzo, Hirt, & Spencer, 1974) before concluding, once again, that there is a post-iconic selection deficit.

In the first kind of study, evidence for 'attentional' processing disorder is to be found in the effects of display-size on visual search (Butler, 1980, 1981; Treisman & Gelade, 1980). Consonant with the attentional deficit hypothesis, some studies have found that perceptual deficit is observed only in multi-item displays (e.g. Asarnow et al., 1978; Neale, 1971) while other, similar visual search studies have failed to replicate this result (e.g. Davis, Glaros & Davidson 1981; Place & Gilmore, 1980). Using the whole-report procedure, Knight, Sherer & Shapiro (1977) found significant but unsystematic effects of display load while display load effects in the opposite direction were reported by Davidson and Neale (1974). In the second kind of study, it is arguable that the attempts to 'equalise' the quality of the icon between groups have been successful. This will be discussed in the latter portion of this Chapter.

Before embarking on the analysis of the above literature it is necessary to digress to a pertinent issue. The iconic model has given rise to a different kind of explanation of perceptual disorder in schizophrenia than the above. It has

been suggested that the length of iconic decay might differ in schizophrenia resulting in poor performance either through 'too rapid' decay or by 'too slow' decay. The first hypothesis is that the icon decays abnormally rapidly in schizophrenia, before any permanent coding of the information has taken place. The second hypothesis is that the persistence of the icon is abnormally long so that the persisting icon interferes with the registration of new information. Whether there is an icon processing disorder as opposed to a disorder in the decay of the icon has not been tested adequately. Since it has been suggested that iconic persistence depends on processing variables (Dick, 1974; Spaulding et al., 1980) it might be that the evidence for abnormal decay reflects poor icon formation. This argument will be taken up in the first section of the review of studies. Following the discussion on iconic decay there will be a more detailed account of the rest of the studies. In this account, emphasis is given to parametric variations and to the variations in the stimulus materials used in the studies since these are likely to indicate the function of the processing stages.

3.1 Abnormal icon decay in schizophrenia

In this section, it is suggested that abnormal icon decay might be due to slow icon formation (Spaulding et al., 1980). Generally, three procedures have been used to investigate the abnormal decay hypotheses: temporal integration, visual masking, and interstimulus 'gap' resolution. There is some evidence for the slow decay hypothesis but none for the rapid decay hypothesis.

In the temporal integration task, two successive

displays are presented, each containing features of the 'to-be-identified' object. On its own, each display appears to be a random collection of object-features but when the two displays are superimposed the object is readily identified (Eriksen & Collins, 1967). By presenting the two displays in rapid succession one can measure the minimal separation required for the perception of an integrated image, and this interval is taken to be a measure of the persistence of iconic information (Coltheart, 1980). Using this technique, Spaulding et al. (1980) failed to find any evidence for abnormal persistence of iconic information in schizophrenia. If schizophrenics had slower decay than controls then they should have been able to integrate information over longer interstimulus intervals than controls. Notably, Spaulding's et al. results also failed to support the 'shorter decay' hypothesis. Similarly, Knight, Sherer, Putschat and Carter (1978) failed to find abnormal integration in schizophrenia using complex picture stimuli and longer temporal gaps than Spaulding et al. (1980). Together these results do not suggest any information processing deficit in schizophrenia.

The results of visual masking studies are inconclusive on the iconic decay hypotheses. Visual masking is thought to disrupt stimulus processing within the development of the icon by either displacing the stimulus icon or by integrating with it (DiLollo, Lowe, & Scott, 1974; Felsten & Wasserman, 1980; McLelland, 1978; Turvey, 1973; the relevance of these hypotheses to schizophrenia will be discussed later in this Chapter). In his doctoral dissertation, Davidson (1977, cited in Neale & Cromwell, 1977) investigated the rapid decay hypothesis using backward masking. Davidson reasoned that if

icon decay is more rapid in schizophrenia, then the performance of controls should approximate the poor performance of schizophrenics at smaller masked stimulus durations.

The results indicated that schizophrenics were poorer than controls in all mask delay conditions. Such an effect can be explained by a number of non-processing hypotheses including inattention to the task. In contrast, Saccuzzo's work (e.g. Saccuzzo & Braff, 1981; Saccuzzo et al., 1974) (which will be reviewed in detail below) suggests that there is an abnormal vulnerability to masking in schizophrenia. Saccuzzo has interpreted the result as indicating a post-iconic deficit in attentional selection. However, it will be argued below that the result may indicate poor processing at the level of icon formation since in most of this work stimuli were presented at threshold durations and since this is suggested by the mechanisms of masking (Felsten & Wasserman, 1980; Turvey, 1973).

Using the gap resolution task, Schwartz and Winstead (1982) found support for the slow-decay hypothesis. In the gap resolution task, subjects are required to judge whether two successive displays were presented or only one was presented. If decay is abnormally slow in schizophrenia then their ability to detect 'gaps' should have been poorer than controls. Schwartz and Winstead (1982) found that chronic schizophrenics, were poorer at the task than acute schizophrenics, who in turn performed more poorly than controls.

In order to investigate the perceptual processes that

might be responsible for performance Schwartz and Winstead (1982) also varied the spatial frequency of the displays. Previously it was suggested (Breitmeyer & Gantz, 1976; Meyer & Maguire, 1977) that low spatial frequencies activate specific physiological channels which respond transiently, are responsible for the detection of events in the visual field, and provide information for the orientation of attention to regions of the visual display. The analysis of stimulus details, on the other hand, was attributed to different channels that respond with sustained activity to high spatial frequencies. In schizophrenia there is no specific disorder in either type of channel (Schwartz & Winstead, 1982). Notably, the result suggests that the information content of the icon is irrelevant to processing disorder in schizophrenia and suggests that the problem lies in the mechanisms responsible for 'visible persistence' (Coltheart, 1980). This led Schwartz and Winstead to suggest that schizophrenics might have fewer sustained or transient cells, fewer inhibitory inputs to transient cells, or more random transient cell activity - all of which can lead to less information being registered in the icon. However, Schwartz and Winstead did not discount the possibility of a "general dysfunction in the perceptual processing mechanism" (Schwartz & Winstead, 1982, p. 1385) leaving open the possibility for a multi-level deficit hypothesis (i.e., at icon formation or in post-iconic processing).

To summarise, there is evidence for the slow-decay hypothesis but it seems that factors to do with the registration and formation of the icon have not been investigated concurrently with iconic decay. Dick (1974)

identified this to be a problem in the general literature on iconic processing. The results of the temporal integration task have not shown abnormal persistence of information in schizophrenia. In visual masking, evidence for masking vulnerability appears only when stimuli are presented at threshold durations (compare for example, Saccuzzo's work with that of Davidson). This result suggests that processes within the registration and formation of the icon might be disordered, a view tentatively supported by the results of Schwartz and Winstead (1982).

Finally, it is worthwhile noting the comments made by Spaulding et al. (1980) on the decay issue. They stated that in normal perceptual processing the icon rarely runs its full temporal course. It is truncated when new information is required (for further discussion see, DiLollo & Hogben, 1985; Hogben & DiLollo, 1985). Accordingly, Spaulding et al. stated that the icon in schizophrenics may run a longer course simply because processing within the period that the icon is constructed is abnormally slow.

3.2 Dysfunction in icon formation and quality

This section will review studies which suggest that the information processing disorder in schizophrenics is at the preattentive level. Contrary to the conclusions of Schwartz and Winstead (1982) above, the deficit suggested in this section is not one of registration of information at the icon, but it is of a dysfunction in the preattentive segregation and organization of the display. Two groups of studies which suggest this are to be presented. First are the studies which varied the energy parameters of displays, and second, are the

studies with variables which indicate preattentive processing. As noted above, 'simple' threshold studies have not indicated processing impairment in schizophrenics. In contrast, schizophrenics tend to perform more poorly than controls when performance is dependent on preattentive analysis.

3.21 Simple thresholds and the registration of information

Maher's (1966) review of the early studies of thresholds agreed with Kraepelin's conclusion that there is no sensory deficit in schizophrenia. However, several more recent results have contradicted this conclusion. For example, the results of the study reported by Collins, Sutton and Shapiro (1978) suggested a failure in the integration of stimulus energy. In their task, either one or two flashes of light were presented and reaction time to their onset was measured. The intensity and the duration of the flashes were varied so that the product of these two variables was constant. Under these conditions the subjective stimulus intensity is also constant and so too is reaction time to stimulus onset, regardless of whether one or two stimuli were presented. In the Collins et al. study schizophrenics did not conform to this pattern of performance: they had longer reaction times than controls to the two stimuli condition although equal reaction times were observed in the one stimulus condition. From this finding, Collins et al. suggested that there exists a "sensory difference between schizophrenic patients and other psychiatric patients and normal controls" (1978, p. 250). Although this would be consistent with Schwartz and Winstead's (1982) conclusions, a number of attempts to replicate this experiment have failed (unpublished studies by Berenhaus,

Gottlieb, Manuzza & Kietzman, cited in Zubin, Keitzman & Steinhauer, 1985).

Further evidence for sensory deficit comes from Saccuzzo's work (to be reviewed below) which shows that the stimulus duration required for the identification of visual stimuli to a criterion (the critical stimulus duration) tends to be longer in schizophrenia than in other groups of psychiatric patients. On the other hand, although the result is common it is not present in all of the Saccuzzo studies (see below). Magaro and Page (1982) too have failed to find any difference in threshold durations between schizophrenics and controls and they concluded that the perceptual deficit might be observed more reliably in tasks that include more 'cognitive' rather than 'peripheral' factors. (It should be noted that this statement does not provide sufficient explanation of Saccuzzo's results.)

Other results have supported Maher's (1966) conclusions of no sensory difference between the groups. For example, Schwartz and Winstead (1985) compared luminance contrast functions of schizophrenics and controls using a number of spatial-frequency grating patterns as stimuli. As the contrast was increased, subjects were asked to indicate when they first detected the stimulus. This point on the contrast continuum was taken as an indication of the availability of the icon for report. The results yielded normal contrast sensitivity functions and no differences were observed between the groups according to spatial frequency suggesting that there is no sensory abnormality in schizophrenia.

To summarise, there is little evidence to suggest that simple threshold measures differ in schizophrenia. The results

of Collins et al. have not been replicated and the Saccuzzo findings of abnormal critical stimulus duration, which may be considered as a measure of icon formation, has not been found to differ in schizophrenia consistently. Contrast sensitivity functions are also normal. These observations do not support the contention that registration of information at the level of the icon is disordered in schizophrenia (for similar conclusions see, Spaulding et al., 1980).

3.22 'Complex' thresholds and preattentive grouping

As noted earlier, Stilton and Kopell (1964) compared 'simple' and 'complex' thresholds for the recognition of familiar geometric forms in schizophrenics and controls. In each condition thresholds were obtained by increasing the illumination of the display. Although no differences in recognition were obtained between the groups in the absence of visual noise, in the noise condition, schizophrenics had higher recognition thresholds than controls. Stilton, Kopell, Vandenberg and Downs (1966) replicated these results.

Similar results were obtained by Pharr and Connor (1977) who employed Sternberg's (1969) analysis of reaction time to investigate which processing stages might be disrupted in schizophrenia. Pharr and Connor varied the type-face of the single letter displays as well as the presence of an overlaying grating pattern (noise). The results indicated that, although the type-face variation (a manipulation of stimulus complexity) did not diminish the performance of schizophrenics abnormally, the introduction of noise prolonged the reaction time of schizophrenics but not that of controls.

The failure of schizophrenics to discriminate between

physical features of visual stimuli was also observed by Cox and Leventhal (1978). They investigated the performance of schizophrenics in three tasks considered to measure preattentive processing. In addition to this comparison, Cox and Leventhal presented the same tasks but with greater target-noise discriminability ('enrichment'). Cox and Leventhal considered that if enrichment 'corrects' the deficits observed under non-enriched conditions, then perhaps the schizophrenic deficit can be localised at the preattentive level of processing. Two of these tasks were obtained from Beck's work (Beck, 1972; Beck & Ambler, 1972) while the third investigated the "visual suffix effect" (Kahneman, 1973, p. 132). In each task the availability of preattentive analysis should have improved performance over its absence and consequently the observed poor performance of non-paranoid schizophrenics, on each of the tasks, was interpreted with the notion of dysfunctional preattentive processing. It was also shown that if the target-noise discriminability is increased, then the non-paranoid schizophrenic group performed normally. Notably, Cox and Leventhal concluded with the suggestion that the presupposed attentional disorder in schizophrenia might be due to dysfunctional preattentive processing:

"Since the only information available for further processing is that contained in the icon, the secondary processes of selective or focal attention may in part act upon distorted perceptual information."

(Cox and Leventhal, 1978, p. 716).

The experiments of Place and Gilmore (1980) have provided considerable support for the preattentive-deficit hypothesis (see, Knight, 1984, Knight et al., 1985). Their

task involved the estimation of the number of shapes ('numeration') presented within a display. The task of the first experiment involved the numeration of small horizontal or vertical lines arranged at the points of an imaginary hexagon, in the presence or absence of distractor stimuli. The results indicated that under the 'no-noise' condition performance of both groups simply deteriorated with the increase in the size of the display. Under the distractor condition, however, schizophrenics experienced a greater failure in performance than controls.

These results can be explained by a failure of schizophrenics to utilise grouping principles in an early stage of processing leading them to adopt an attentional serial comparison strategy. The failure of early organization of information was supported by the results of their second experiment where displays contained inherent organization which might elicit preattentive grouping (Place & Gilmore, 1980). The task itself, however, required that groupings be ignored - subjects were asked to count all the shapes as a single group. If schizophrenics were insensitive to the organization in the display, as hypothesised, then Place and Gilmore expected that they should not observe performance differences between displays with good and those with poor organization. Controls, on the other hand, should have been interfered with in counting in displays with good organization since they would have to undergo an 'extra' processing stage. Results consistent with these interpretations were observed (and replicated by Wells & Leventhal, 1984).

Place and Gilmore's conclusions agree with the results of Frith et al. (1983) who also investigated the effect of

stimulus organization. The task involved sorting cards displaying one of three types of design: faces, face-like forms, or 'histoforms'. It was expected that both faces and face-like stimuli could be integrated preattentively as wholes while processing of the histoforms required attentional feature by feature analysis (serial processing). The results indicated that controls sorted the face stimuli better than the histoforms but no differences in performance were obtained between histoforms and the face-like shapes. Schizophrenics, consistent with their processing in a serial manner, did not show any sensitivity to the type of material presented for sorting. (An alternative explanation to the failure in perceptual integration of schizophrenics, in this study, is that they simply failed to integrate familiar stimuli such as faces in comparison to controls. The familiarity issue is deferred to Chapter 7.)

Finally, Knight et al., (1985, see also, Knight, 1984) published a masking study whose results were interpreted with the notion of preattentive dysfunction. Recognition accuracy of briefly presented complex, coloured, naturalistic scenes was compared in normal controls, non-schizophrenic psychotics and, in good- and poor-premorbidity adjustment schizophrenics. The effects of three types of masks were compared: masks consisting of light and dark dots (random noise mask), a random array of coloured shapes (pattern mask), and a picture of a real-world scene (cognitive mask). The results indicated that the 'poor- premorbidity' schizophrenics were interfered with by pattern masks as much as by cognitive masks (which produced the greatest disruption to performance for all groups). Knight

et al. (1985) concluded from this that there is some deficiency in the preattentive organization of the masks. Such organization, they suggested, normally allows the observer to determine that a pattern mask is not a cognitive mask and thus further processing of the mask is terminated. A more obvious explanation, derived from the literature presented above, is that schizophrenics are poor at discriminating the features of the target from those of the mask. The obtained results are to be expected since masking difficulty increases with the sharing of features between the mask and the target stimulus (e.g. Hellige, Walsh, Lawrence & Prasse, 1979). Notably, both explanations ascribe the deficit to a disturbance in preattentive processing.

The literature presented so far has suggested a preattentive deficit in schizophrenia. However, there are several experiments that have failed to support this notion (e.g. Davidson & Neale, 1974; Russell & Knight, 1977). In Russell and Knight (1977) subjects were presented with displays varying in display load between 10 and 40 items some of which (targets) differed in the physical features from the rest (noise). Subjects were asked to determine whether the display contained letters all of which were replicates of a single letter or whether a different letter was represented. The results 'appear' to indicate abnormal search time functions for paranoid schizophrenics when a single item differed from the noise. This would be consistent with the observations of Cox and Leventhal (1978) where deficit was observed only in conditions of difficult target discriminability. However, the Russell and Knight result was not found to be significant statistically leading to the

conclusion that "the experimental manipulations not only affected all groups in the same way but also to much the same extent" (Russell & Knight, 1977, p. 21).

However, in another visual search experiment the same group of paranoid schizophrenics performed aberrantly from comparable groups (Russell & Knight, 1977). Visual search time was compared in conditions where the targets and noise shared features (difficult discrimination) or they did not (easy discrimination). Feature sharing should have elicited grouping by similarity preattentively and thus prolonged search time. Search rates, which were determined by varying the display load, did not differ between the groups, as Russell and Knight pointed out. However, the results also showed that the effect of discriminability was on the value of the intercept of the regression line relating search latency and display load (Russell & Knight, 1977, p. 19, Table 3). It can be observed in these results that controls and non-paranoid schizophrenics improved in the order of 0.36 and 0.32 units, respectively, as the discrimination difficulty was reduced. Comparatively, paranoid schizophrenics improved in the order of 0.01 units suggesting a failure to gain from target discriminability. Despite this possible interpretation of their data, Russell and Knight concluded that the intercept value reflects the time taken in "setting up search and/or organising and producing the response" (1977, p. 24). The perceptual explanation is at least equally likely (see, Knight, 1984 for a similar argument).

Davidson and Neale (1974) also concluded that manipulations of target discriminability do not play a role in

discriminating the performance of schizophrenics and controls. Davidson and Neale tested various levels of feature-sharing of targets and noise and their effects on visual search. Schizophrenics were found to be poorer than controls in visual search across all levels of discriminability. Furthermore, massed practice was equally effective in improving the performance of both groups and it did not overcome the generalised diminished performance of schizophrenics compared with controls. These results do not support the notion of preattentive disorder in schizophrenics but they do suggest, as Davidson and Neale pointed out, an overall slowing in processing in schizophrenia. From this study it is not clear what mechanisms are responsible for this 'slowing'.

To summarise, although a number of studies have found that schizophrenics perform more poorly than controls in visual search tasks requiring preattentive analysis, not all studies have found this result. Some of the studies with negative findings regarding the preattentive deficit hypothesis are open to reinterpretation in accord with the hypothesis (e.g. Russell & Knight, 1977) but the study of Davidson and Neale (1974) is not.

3.3 Dysfunction in post-iconic selection

The studies in this section are concerned with the issue of the efficiency of attentional processing in schizophrenia. These studies are divided into those that have not attempted to control for a potential difference between schizophrenics and controls in the 'quality' of the icon, and those studies that have. The first group of studies have emphasised information processing of displays containing multiple items

which is likely to indicate, dependent on task instructions, the functioning of selective attention, organization and encoding strategy in search, and the ability to handle multiple sources of information in parallel. Closer analysis of the functions of attention in perception, as will be seen in latter Chapters, suggests that attention is required for the accurate localization of information in perception - if attention is diverted, information may reach reportable encoding levels but its organization in the display will not be encoded accurately (e.g., Butler, 1980, 1981; Treisman & Gelade, 1980). This issue will be discussed further in Chapter 5. For the present, the literature review will focus on whether information processing disorder is present only in multi-item displays, which would suggest attentional impairment.

The second group of studies is represented by Saccuzzo's work where displays of single letters were presented but subjects observed these at their own critical stimulus durations. Saccuzzo and associates have argued that this procedure 'equates' subjects regarding the quality of information at the icon. They have consequently interpreted their results as an abnormal vulnerability of schizophrenics to the effects of masking due to slow processes responsible for the translation of information from the icon. Despite this, it will be argued that preattentive processing disorder might be the basis for Saccuzzo's findings.

3.31 Encoding of multi-item displays

Studies using a variety of procedures: visual search (e.g. Neale, 1971); object numeration (e.g. Place and Gilmore,

1980); Sperling's (1960) whole-report and partial-report tasks (e.g. Cash, Neale & Cromwell, 1972; Knight et al., 1977), have not led to any consistent results regarding the effects of display size in schizophrenics. Display size effects were investigated in Neale's (1971) study which was one of the earliest attempts to apply information processing theory and methodology to schizophrenia. Subjects were asked to determine whether presented displays contained a T or an F when these were embedded in displays containing variable numbers of noise letters. Neale found that, within the 70 msec display duration, schizophrenics could match the controls at the small display loads but as the number of noise items was increased, performance of schizophrenics deteriorated from controls. Importantly, controls in this study included institutionalised psychiatric patients and penitentiary inmates suggesting that sensory deprivation, associated with institutionalization (e.g. Johnstone, Owens, Frith & Calvert, 1985; Johnstone, Owens, Gold, Crow & MacMillan, 1981) was not a significant influence on the results. Indeed, Asarnow, Steffy, MacCrimmon & Cleghorn (1978; see also, Asarnow & MacCrimmon, 1981) have since shown similar deficits in the performances of both 'remitted' and 'unremitted' schizophrenics.

On the other hand, there have been failures to replicate these observations. For example, Davis, Glaros and Davidson (1981) using essentially the same search task did not find any special effect of display size on the performance of schizophrenics. Furthermore, concurrent assessment of alpha-blocking activity as indicated in encephalographic records (EEG) showed that, despite normal central activation to displays, schizophrenics reported less information from all

displays - display size effects did not differ between schizophrenics and controls.

Another failure to replicate was reported by Alumbaugh (1976) who use a visual search task requiring subjects to count the number of dots presented in displays. The dots, which ranged in number from three to twelve, constituted different levels of stimulus complexity. Dots were presented either on their own or in the presence of up to three irrelevant triangles - constituting a variation of display-size. In contrast to Neale's (1971) task visual search in Alumbaugh's task could not terminate when a single target was found - that is, Alumbaugh's task encourages exhaustive visual search of the items. It was found that display-size had proportionally equal effects on the performance of schizophrenics and controls with chronic patients scoring generally poorer than acute schizophrenics who were in turn poorer at the task than 'inmate' (prisoners?) controls. Diagnosis, however, was found to interact with stimulus complexity showing that schizophrenics were poorer at dot-counting when few rather than many dots were presented. This may be of some interest because numeration of a few dots, termed 'subitizing' (Neisser, 1967, p. 42) is supposed to reflect the adequacy of pre-attentive processing.

Russell, Consendine and Knight (1980), adopting the visual search paradigm advanced by Schneider and Shiffrin (1977), also failed to find a differential effect of display size in schizophrenics. In this task subjects were instructed to search for a letter from a pre-memorised set (memory-set) when the number of displayed items also varied (display-set).

The time taken to decide whether or not a memory-set item is part of the presented display set is a function of the product of the number of items in each of these two sets (Schneider & Shiffrin, 1977). This relation suggests that each letter of the memory set must be compared with each letter of the display set until a match is found (serial search). The relation reflects such processes as an efficient search through short term memory, the comparison operation, the decision of match/mismatch, and the initiation of visual scanning and eye movements to the relevant portions of the display. Russell et al. found that chronic schizophrenics (paranoid and non-paranoid) demonstrated normal decision times as a function of the product of the two sets, suggesting no processing disorder.

As noted earlier, Place and Gilmore's (1980) results using the numeration task showed normal display-size effects in schizophrenics when preattentive analysis was not relevant to performance. Similar observations were noted in the easy discrimination condition in Cox and Leventhal (1978) along with the general findings of Russell and Knight (1977, save the noted exceptions).

Using the whole-report procedure Cash et al. (1972) found that display-size was actually associated with an increase in the number of reported letters. As no differences were observed between schizophrenics and controls, it was concluded that there is no information processing disorder in schizophrenia. To accommodate Neale's (1971) finding Cash et al. suggested that perhaps the deficit is present only when the subject must carry out information selection. However, this explanation is inadequate since it wrongly suggests that

there is no selection involved in the whole-report task. Selection is involved but in contrast to the partial-report task selection strategy is not imposed by the experimenter. Perhaps schizophrenics failed to adapt their selection strategy in the partial-report task to match that required for normal performance. Furthermore, as Knight et al. (1977) pointed out, the whole-report task is susceptible to the effects of response interference and cannot provide reliable results regarding the processing issue. It is possible, for example, that a subject who has processed a few items to have equal report levels to one who has processed more but who is unable to report the items due to response interference. It is therefore possible that some schizophrenics have 'limited iconic capacity' (Knight et al., 1977). (However, the direction of the display-size effect in Cash et al. argues against this idea.)

In itself the notion of 'limited iconic capacity' as proposed by Knight et al. (1977) does not conform to the generally accepted idea of the icon (Neisser, 1967). It is unlikely that the icon of schizophrenics contains fewer items than controls; rather, it is more likely that the clarity or quality of the information of the icon is poorer in schizophrenics. Nevertheless, Knight et al. (1977) used this idea to explain their findings regarding the performance of schizophrenics on both partial-report and whole-report tasks. These results showed that a particular subgroup of schizophrenics reported less information than controls in both tasks. Their sample of schizophrenics was subdivided according to scores in Payne's Object Classification Test (Payne, 1962).

(This is a measure of the degree to which conceptualization of a category is intruded by irrelevant constructs. High scores imply over-inclusive categorization while low scores suggest an inability to perceive normally-regarded relations between objects.) It was found that under-inclusive schizophrenics performed more poorly than over-inclusive schizophrenics and controls while over-inclusive schizophrenics performed normally. Notably, the display size effect was significant but its direction was not systematic and consequently uninterpretable.

Partial-report performance was also investigated by Broga and Neufeld (1981) using a task where a single cued letter was to be reported. It is noteworthy that the Knight et al. results can be re-interpreted in terms of response interference since response required the report of a whole row of letters. For example, it is possible that under-inclusive schizophrenics were more susceptible to the effects of response interference than the other groups. In the Broga and Neufeld task, however, response interference is expected to be minimal. Cues indicating which letter was the target appeared either before, during or after the letter display, at various display/cue onset asynchronies. Broga and Neufeld suggested that pre-stimulus cueing should indicate the function of selective attention while post-stimulus cueing conditions emphasise iconic storage and decay. It was found that both paranoid and non-paranoid schizophrenics reported less information from the displays than controls in the pre-stimulus cueing condition and only paranoid schizophrenics were poorer than controls in one (out of six) of the post-stimulus cueing conditions. The results suggest either a

selection problem or a relative unavailability of information in the icon in schizophrenia. Unfortunately display size was held constant in this study and so the efficiency of selection cannot be ascertained confidently.

Finally, Spohn et al., (1985) reported results to the whole-report procedure with an interesting variation. Stimuli of six letters were presented for 750 msec exposure duration under three conditions. In the first condition (control condition), the stimuli were simply presented for the defined exposure duration. In the second condition (early distraction condition), a second stimulus was presented at 150 msec from the onset of the first stimulus. In the last condition (late distraction condition), the second stimulus arrived at 500 msec from the onset of the first display. Subjects were asked to report letters only from the first display. To assess the effect of distraction, both the total number of letters reported and the number of reports of letters from the distractor stimuli were noted. The results indicated that chronic schizophrenics showed substantial effects of distraction and particularly in the late distraction condition. Spohn et al. concluded that the interference occurred within the period of icon formation and particularly toward the late component of this process. This would be consistent with the 'selection disorder' hypothesis. Unfortunately, since the primary interest was to investigate the effects of neuroleptics on the measures of information processing, the study did not include control groups. It is difficult, therefore, to know what degree of interference is to be expected, normally, from the distractors.

To recapitulate, the general assumption in the studies presented in this section is that the iconic information is essentially the same for the diagnostic groups, and that poor performance may reflect disordered selective attention and slow translation mechanisms. However, it is clear that selection is confounded with the registration of information and with the integration of the icon. The stimulus variation, of display size, which can provide evidence for the adequacy of attentional processing (Butler, 1980, 1981) has not shown a decisive pattern in these studies. Using the whole-report procedure Cash et al. (1972) found a systematic increase in reported items with increasing display size while Knight et al. (1977) reported an unsystematic effect. Neale's visual search study (and replications) indicated group differences only at the greater display sizes but the results of a similar studies have failed to find this interaction (e.g. Davis et al., 1981). From these studies, only a nondiscriminating conclusion can be made, that the sources of the observed deficit are likely to be in:

"...reduced quality of the iconic image generated by the brief item array ...[or in]... less efficient extraction of relevant information for iconically held material."

(Broga & Neufeld, 1981, p. 506).

3.32 Studies attempting to control icon 'quality'

As mentioned earlier, these studies are represented by the work of Saccuzzo and associates. Consonant with the above conclusions, the work suggests that both the formation of the icon and post-iconic transfer of information are disordered in schizophrenia. Generally, the findings were, that schizophrenics required longer critical stimulus duration to

match the controls' performance for identifying letters, and, that once these durations are matched for the groups, the 'readability' of the icon measured by the backward masking procedure is poorer for schizophrenics than controls. For example, in the Saccuzzo and Schubert (1981) study subjects were asked to discriminate between single letter displays. Threshold durations were determined in the groups: for schizophrenics the critical duration was found to be 8 msec; controls required about 3 msec (for normals) or 4 msec (for schizotypes). In the second part of the experiment the stimuli were shown at either 4 or 6 msec duration followed by a masking display at various delays following the stimulus. The results indicated that schizophrenics improved in their performance toward the levels of controls, as the duration of the stimulus came to approximate their own critical stimulus duration-consistent with the poor iconic quality hypothesis. As the interval between the stimulus and the mask increased, performance for all groups increased. However, schizophrenics failed to improve to the extent of the other groups. This result was interpreted by Saccuzzo and Schubert as a slowness in the transfer of information from the icon.

Although a number of methodological problems of this study have been pointed out (Schwartz, 1983), similar studies do not share those difficulties (e.g. Braff & Saccuzzo, 1981; Braff & Saccuzzo, 1985; Saccuzzo & Schubert, 1981). Since the same procedure was followed in most of the Saccuzzo studies, the results are presented below in point form:

1. The critical duration of schizophrenics and particularly of poor prognosis (paranoid or non-paranoid) tends to be longer

than that of normal controls (Saccuzzo & Braff, 1981; Saccuzzo & Schubert, 1981).

2. When the critical duration is compared for schizophrenics and patients who are hospitalised for depression, some studies (e.g. Braff & Saccuzzo, 1981; Braff & Saccuzzo, 1985) indicate prolonged critical duration for schizophrenics, while others (Braff & Saccuzzo, 1982; Brody, Saccuzzo & Braff, 1980; Saccuzzo & Braff, 1981) find no differences.

3. Poor prognosis schizophrenics have longer critical duration than manic patients and good prognosis schizophrenics.

4. The critical duration of normal elderly exceeds that of both schizophrenics and depressives (Brody et al., 1980).

Generally, schizophrenics appear to require longer exposure durations to match the performance of controls. However, depressed patients and non-pathological elderly demonstrate similar critical stimulus duration to schizophrenics. Moreover, as noted earlier, Magaro and Page (1982) using a slightly different threshold procedure failed to find differences between schizophrenics and normal controls in critical stimulus duration. Furthermore, it is possible that the procedure of estimating critical stimulus duration is influenced by non-processing factors, as pointed out by Stantovich and Purcell (1981). The procedure, for example, might be influenced by periodic inattentiveness to the task on the part of schizophrenics. Since subjects are usually required to report 6 or 7 correct successive trials, a single failure, caused by, for example, to inability to concentrate on a trial, may raise the threshold by several milliseconds. The higher the criterion the greater the influence of

inattention.

Studies indicating a vulnerability of schizophrenics to masking show that:

1. Schizophrenics are out-performed by normals, depressed patients (Braff & Saccuzzo, 1981; Braff & Saccuzzo, 1982; Braff & Saccuzzo, 1985; Saccuzzo & Braff, 1981), manics (Saccuzzo & Braff, 1981), and the elderly (Brody et al., 1980) when stimuli are shown at the critical duration for each group.

2. Poor premorbid schizophrenics seem to be the more susceptible group to backward masking when compared to schizotypes (Saccuzzo & Schubert, 1981) or to good premorbid schizophrenics (Saccuzzo & Braff, 1981). The latter group seemed to overcome the deficit over several practice sessions but this finding is confounded with the possibility that the improvement was due to recovery from psychosis (Saccuzzo & Braff, 1981). This is consistent with the finding that those scoring higher on measures of 'healthy' behaviour in the past week showed higher accuracy than low scorers (Braff & Saccuzzo, 1982). On the other hand, remitted schizophrenics also show the masking deficit (Braff & Saccuzzo, 1982; Saccuzzo & Braff, 1981).

3. Unmedicated schizophrenics who were considered, on the basis of general pathology scales, to be functioning better than a medicated group showed a greater susceptibility to backward masking than the latter group (Braff & Saccuzzo, 1982).

4. 'No-masking' conditions (Braff & Saccuzzo, 1982), excessively delayed masking conditions (Saccuzzo & Braff, 1985), and forward masking conditions (when the mask precedes

the stimulus display, see, Saccuzzo & Braff, 1981) all show equal performances for schizophrenics and controls suggesting that motivation or general inattention to the task cannot account for the backward masking vulnerability of schizophrenics. In support, signal detection analysis of the masking results (Saccuzzo & Braff, 1981) showed that the performance difference was accounted for by the discriminability factor and not by the response bias factor.

Generally, schizophrenics appear to be more susceptible to masking. This supports the slow processing hypothesis. At small intervals between the mask and the stimulus the performances of schizophrenics and controls tend to perform at chance levels. As the masking interval is increased, controls accumulate stimulus information much more rapidly than schizophrenics. The deficit finally disappears at the longest mask delays.

Noteworthy in this series of studies, are two studies which varied the kind of mask presented. In the first of these, Saccuzzo and Braff (1981) compared forward masking and backward masking while in the second, Miller, Saccuzzo, and Braff (1979) compared the effects of a blank, high luminance mask with that of a pattern mask. The failure to find that the forward mask interferes with the performance of schizophrenics more than controls suggests that the registration of the icon does not differ between the two groups. The differential effect of the backward mask on the stimulus may reflect both a failure to segregate the stimulus information from the mask information, or it may reflect the susceptibility to the rapid truncation of the stimulus image by the mask. These

alternatives will be considered in the concluding section.

Likewise, Miller et al. (1979) suggested that a blank mask may alter the registration of information in the icon whereas the pattern mask may interrupt the transfer of information from the icon. In their analysis of the effects of the two masks on schizophrenics they concluded that, in comparison to controls, the pattern mask affected schizophrenics more than the blank mask. A close look at their results however suggests that the interaction effects of groups and kinds of masks may have been the result of the control group having reached ceiling levels of performance for the blank mask when stimuli were shown for 4 msec. As such the results should be considered cautiously.

3.33 Comments on Saccuzzo and the slow processing hypothesis

Although Saccuzzo's work suggests a slow transfer of information from the icon, it is not clear what is meant by this term. Partly, its meaning relies on the interpretation one places on the masking effects of the second stimulus. There are three hypotheses about masking mechanisms in the literature (see, Eriksen & Lappin, 1964; Felsten & Wasserman, 1980; Turvey, 1973; Hellige et al., 1979). At very small intervals (i.e., 20 to 30 msec), between the onsets of mask and the target stimulus, the predominant mechanism appears to be that of energy summation. In this case, the energy of the mask and that of the stimulus combine to reduce the contrast of the information presented in the target stimulus. As Hellige et al. (1979) pointed out, the mechanisms of masking beyond small intervals are less agreed on. The first of the two prominent hypotheses is that the mask completely

interrupts processing of the target stimulus, while the second hypothesis is that the features of the mask integrate with those of the stimulus forming a hybrid, montage-like percept.

Hellige et al. (1979) presented results consonant with the early involvement of energy summation (see also, Turvey, 1973). They varied the degree to which features of the mask superimposed on the features of the target stimuli. If summation is the dominant early mechanism, the more superimposition, the greater the energy summation in the contours of the original target stimulus, and the result expected is better performance for 'same' featured masks than for 'different' featured masks (less superimposition of features). This was the obtained result. Moreover, altering the relative intensity of the mask and the target stimulus affected the severity of masking. Beyond the 20 msec interval however, stimuli were interfered with more if the mask and the target contained same features rather than if features differed (see also, Breitmeyer, 1984; Turvey, 1973). Hellige et al. suggested that the masking mechanism, in this case, cannot be one of complete replacement (wholistic interruption) but instead the mask may have integrated with the target stimulus in a 'montagelike' fashion. Wholistic interruption also appears to occur at prolonged intervals and appears to involve a switching of processing resources to the mask (DiLollo & Moscovitch, 1983; Moscovitch & Klein, 1980).

Although the slow processing hypothesis is not negated by the observation that a number of masking mechanisms exist, the exact problem of encoding posed for the schizophrenic by the mask may be, theoretically, a disorder of energy summation, an inability to disengage perceptually the features

of the target and the mask, or a vulnerability to wholistic disruption of target processing. The failure to find a differential effect of forward masking in schizophrenics, the separation of detection performance in the middle interval values of mask delay, together with the Miller et al. (1979) claim that blank masks affect schizophrenics less than pattern masks, all suggest that schizophrenics are vulnerable to masking mechanisms that are effective beyond the range of energy summation. This would be consistent with the earlier conclusions that there is no icon registration abnormality in schizophrenia. 'Slow transfer' then, might mean either an abnormal tendency to shift attentional resources to the mask or a susceptibility to the influence of camouflage. The latter alternative is consistent with the preattentive deficit hypothesis.

Abnormal susceptibility of schizophrenics by montage-like integration of the target stimulus and the mask has been suggested previously. Schwartz, Winstead and Adinoff (1983), for example, concluded their analysis of the issue by stating that, for chronic schizophrenics, within the period that the icon is formed, the process of "coding contours and/or detailed information" (Schwartz et al., 1983, p. 1319) is abnormally susceptible to masking. And,

"information from the target is more likely [in schizophrenics] to be interfered with when the mask superimposes its neural representation upon the neural trace of the target ..."
(Schwartz et al., 1983, p. 1319).

3.4 Chapter summary

In the present Chapter a review was conducted of studies deriving largely from the iconic model of information

processing. Broadly, the model has stimulated research into the registration, early coding, and subsequent transfer of iconic information. Comparisons of schizophrenics and control groups have led to two relatively undisputed hypotheses that the formation of the icon and that subsequent transfer of information from the icon are slower in schizophrenics. It is by no means clear that these are two distinct deficits. It is possible to accomodate most of the findings by the hypothesis that schizophrenics are slower in organising the critical features of the stimulus object at the preattentive level. The actual sensory registration of features does not seem to differ in schizophrenics but subsequent encoding, to do with the segregation and organization of features by the Gestalt principles (Wertheimer, 1923), has been suggested to be less efficient in schizophrenics. Notably, display size variations, which are thought to influence attentional processing, have not been shown to differ reliably in schizophrenics and controls. On the other hand, some studies have failed to support the preattentive deficit hypothesis.

CHAPTER 4. AN INTRODUCTION TO THE PRESENT WORK: AIMS, MODEL, OUTLINE, CLINICAL MEASURES AND SUBJECT INCLUSION

The purpose of this Chapter is to introduce the aims and general strategy of the present investigation along with a general model for information processing. The processing model will be described in outline form while evidence for it will be presented in the experimental Chapters which follow this one. Furthermore, the Chapter will describe the present process-oriented approach to investigating perceptual impairment in schizophrenia, comparing this approach to the individual differences view (Chapman & Chapman, 1973). In addition the chapter presents the following: a brief description of the clinical variables that were used in the studies; correlations of 'patient-reported pathology' with 'observer-reported pathology' (i.e., psychiatrist and nursing staff) to assess the reliability and validity of the clinical research measures; correlational analysis of the 'patient-reported pathology' to establish the internal consistency of this information; a description of the procedure and criteria for subject selection; and, a description of the subjects in terms of the clinical and demographic variables. In the Chapters following the present, the experimental work will be presented with reference to the clinical measures introduced in this Chapter.

4.1 General aims of the work

As noted in the Preface, the aim of the present work is two-fold: to clarify the level of information processing that might be dysfunctional in schizophrenia; and, to determine whether particular clinical variables are associated with

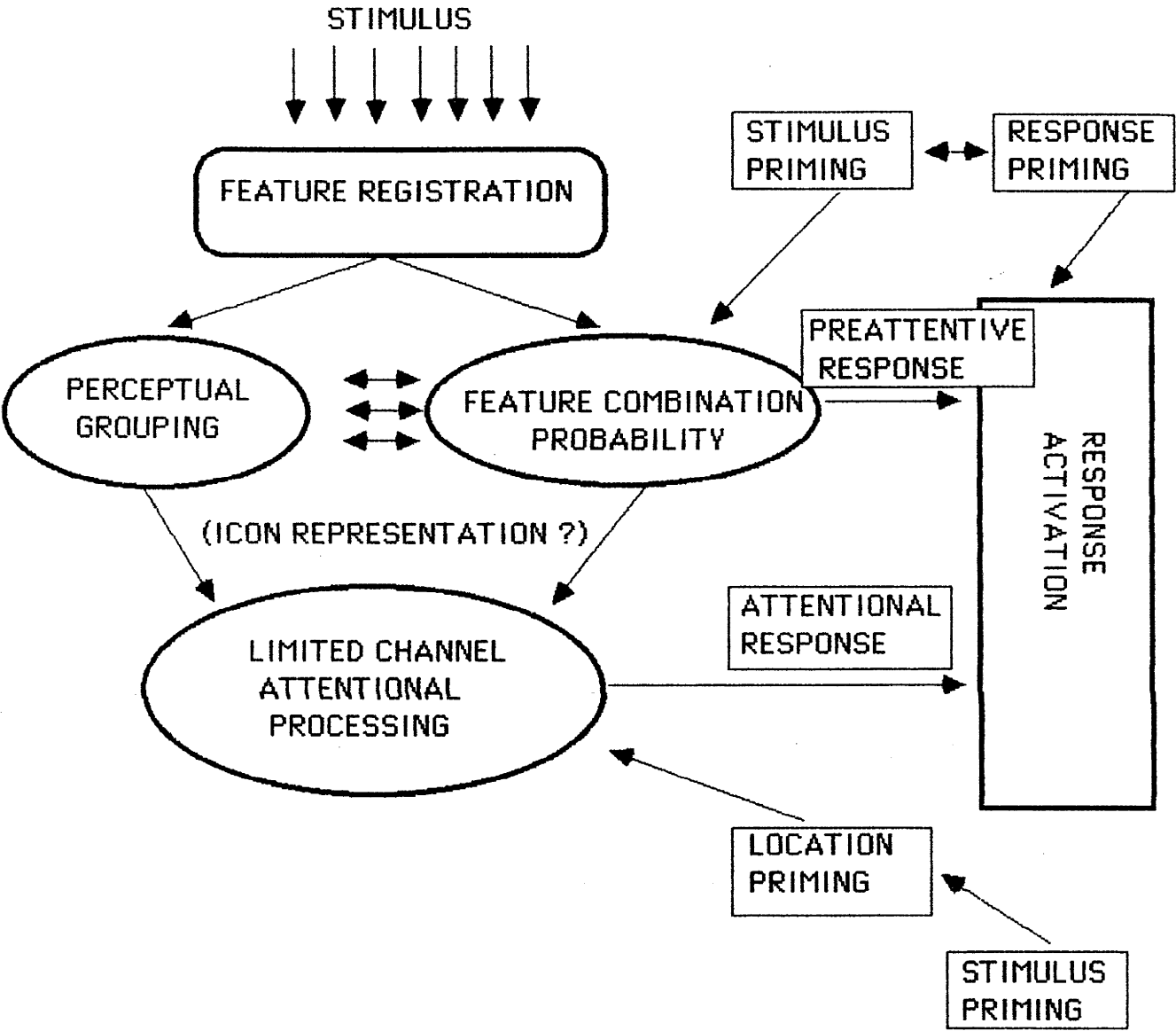


FIGURE 4.1 Guiding model for information processing in the present work.

processing disorder. The first aim is served by the experimental investigation of variables that are thought to influence different levels of information processing while the second aim is served by correlational analyses between the clinical variables and the performance measures.

4.2 A guiding information-processing model for the present work

In explaining 'figural synthesis' Neisser (1967) distinguished between two general levels of information processing. According to Neisser, very early representations of the visual event involve a preliminary organization of the features of the stimulus based, primarily, on the rules of Gestalt integration (Wertheimer, 1923). The preliminary analysis of the stimulus, termed by Neisser the "preattentive process" (1967, p. 89), provides the "raw material" (1967, p. 97) or preattentive "objects" (1967, p. 89), for a latter level of processing called 'focal' attention. According to the theory, the latter analysis gives detail to the preliminary primitive representation. In contrast to preattentive analysis, which involves processing information from multiple locations in the visual field with little loss in efficiency ('parallel' processing), focal attention is limited in its capacity and it 'handles' information in the display in a selective, serial manner.

Since Neisser's early proposals evidence has accumulated in support of viewing information processing as a dual process but there is substantial literature which requires the model to be elaborated further. A summary of the elaborated model is presented in Figure 4.1 which forms the basis for the present Experiments. It is clear from a number

of studies (Beck, 1966,1967,1972; Beck & Ambler, 1972; Olson & Attneave, 1970; Banks & Prinzmetal 1976; Prinzmetal & Banks, 1977; Treisman & Gelade, 1980) that preattentive analysis serves to segregate regions in the visual representation, as Neisser suggested, according to similarity, good continuation, goodness of figure, and possibly other gestalt principles (Wertheimer, 1923). Responses based on this level of analysis are possible as shown by the model in Figure 4.1, labelled preattentive response. For example, Sagi and Julesz (1985) indicated that when responses were based on the simple presence or absence of features, display-size and delay of some of the targets had no effect on the subjects response. This indicates an early parallel processing channel. On the other hand, when the response required the discrimination of objects based on their relative orientation, both the increase in display-size and delay of some targets reduced the subjects performance. The second result indicates, consistent with previous work (e.g., Beck & Ambler, 1972), that configurational aspects of the stimulus display were processed through a second serial processing system (represented in Figure 4.1 as the "limited channel attentional processing" system).

A second major component of the model is that priming of the stimulus configuration contributes to the elicitation of a preattentive level response. This is suggested by LaBerge's (1973; see also, Farell, 1984) findings that practice with unfamiliar stimuli leads to their being processed as units (this will be discussed in more detail in Chapter 7). Similarly, Treisman and Souther (1986) inferred from these results that prolonged practice might lead to the formation of

new feature detectors which respond to the stimulus as a whole rather than an aggregate of low-level features. More convincing evidence for stimulus priming comes from Dykes and Pascal (1981) who indicated that subjects processed more efficiently targets which were similar to high probability non-targets than to low probability non-targets. They suggested that,

"Although encoding may be a feature extraction process and although the transfer effect may be due to 'tuning' feature analysers, the intentional aspect of the modification process occurs at the level of letters. Being informed that one letter is more probable than the others, observers actively modify the encoding process in order to minimise RT [reaction time] for that letter."

(Dykes & Pascal, 1981, p. 536)

Other results consistent with this view will be reviewed in Chapter 7, however, contrary to this view Treisman & Gelade (Experiment 4, 1980) failed to find evidence that letters (as over-learned configurations) could be processed as units. Butler and Morrison (1984) suggested that the failure may have been due to the kind of stimuli used in the Treisman and Gelade experiment, namely that subjects were required to make very fine discriminations within relatively large displays. This kind of stimulus may have led subjects to attend to each letter in the display as "an aggregation of features" (Butler & Morrison, 1984, p. 235) rather to treat a letter as an integral unit. In terms of the model presented in Figure 4.1 both possibilities can be explained. When targets represent well integrated, separable units by virtue of perceptual grouping, feature combination probability can elicit a preattentive level response. On the other hand, when the target is not separable from noise items each item must be

attended to before an accurate response is elicited.

The third component of the model is the limited channel attentional system. This system is responsible for processing information derived from earlier analysis (e.g., Beck, 1972; Harms & Bundensen, 1983; Neisser, 1967). It is conceptualised by Treisman and Gelade (1980) as a 'spotlight' within the early representation which can be focussed by reference to the products of preattentive processing (Harms & Bundensen, 1983). Attentional focussing minimises the risk of feature transpositions (Butler, 1980; 1981; Treisman & Schmidt, 1982) by enabling a correct spatial alignment of separable features detected by preattentive processing (Butler, 1980, 1981; Rock & Gutman, 1981). Although Treisman and Gelade (1980) view focal attention as necessary for the correct conjunction of separable features and the localization process as a case of feature conjunction (i.e., feature-location conjunction), others (e.g., Butler, 1980, 1981) regard localization to be the primary function of attentional processing. By this it is meant that the primary function of attention is to address features to their correct spatial position within the representation.

In the model presented in Figure 4.1 it can be seen that stimulus priming can also influence the direction of the attentional spotlight. Evidence for this comes from demonstrations stimulus familiarity can influence whether feature transposition errors will occur (e.g., Mewhort et al., 1981; Prinzmetal & Millis-Wright, 1984; McClelland & Mozer, 1986). Mason (1982) indicated that stimulus familiarity led to different serial position curves in comparing the detection of letters, digits and unfamiliar Greek symbols.

Pre-cueing the position of the target eliminated the differences in serial position for detection across the different stimulus types suggesting a primary role of stimulus priming through spatial information. In the model of Figure 4.1 the two stimulus priming effects have been presented individually, one occurring at the preattentive response level and one in the attentional response level. This separation is based on the fact that some experiments indicate that stimulus familiarity influences what features are detected (e.g., Mewhort et al., 1981; Campbell & Mewhort, 1980) whereas other experiments suggest an influence on localization of identified features (e.g. Butler, 1980; 1981). It is unclear however, that there are two effects. For example in the Mewhort et al., (1981) work stimulus familiarity might have influenced the localization of low-level features (i.e., features of single letters) whereas in Butler's (1980;1981) experiments localization of whole letter units might have been more likely by virtue of a wider attentional 'spotlight' (Butler & Morrison, 1984; Treisman & Souther, 1986). This issue cannot be resolved with the present literature and two recent attempts (Treisman & Souther, 1986 and McClelland & Mozer, 1986) have produced mixed results. For the purposes of the present work it is merely necessary to acknowledge an influence of feature combination probability on processing.

(Finally, the model views the 'icon' as a relatively well processed representation containing at least three identifiable processes - feature registration, perceptual grouping, and feature combination probability. Selection is viewed as a post-iconic process based on spatial location

information.)

4.3 Outline of the experiments based on the guiding model

More detailed rationale for the Experiments and stimulus variations will be presented in the following Chapters along with the specific hypotheses. In the present section the general rationale will be presented as it fits the above model. Experiment 1 in Chapter 5 attended to the distinction between preattentive and attentional level responses by analysing the types of errors subjects make in tachistoscopic letter-identification. The experiment was devised from Butler's (1980, 1981) work which distinguished between extra-display intrusion errors and intra-display mislocation errors. Preattentive errors are regarded as reflecting inadequate processes of registration, perceptual grouping and feature-combination probability. A failure at a preattentive level, as suggested in schizophrenics, should lead the subject to respond with more extra-display intrusions because each letter presented is not a fully organised representation. An exclusive failure at the attentional level should lead to adequate identification of presented objects but knowledge of their location in the display should be impaired. This would lead to a higher rate of intra-display mislocation errors than if attentional function was adequate.

Experiment 2, in Chapter 6, investigated the role of preattentive grouping by colour as it provides cues for attentional focussing in visual search. Subjects were required to detect a primed stimulus (a green coloured X) presented within conditions where the number of green letters was varied. If schizophrenics are not able to utilise the products of preattentive processing they were expected to search each

letter of the display in a serial manner, showing no effect of colour congruent display size, as controls were expected to do. Because of the possibility that colour coding in Experiment 2 represented a high salience cue for attentional localization and therefore the allowed possibility that a functional but inefficient preattentive process in schizophrenics could still provide adequate information for attentional search, Experiment 3 varied the salience of the target. Discrimination difficulty was investigated as it related to the detection of primed targets with the primary question being whether schizophrenics would show a processing deficit as target discriminability was diminished.

In Chapter 7, Experiment 4 investigated the influence of stimulus familiarity within a task which distinguished between preattentive and attentional level responses. Two questions raised in this enquiry were: which level of processing is dysfunctional in schizophrenia, responses based on preattentive organization or responses requiring attentional search and integration; and, would schizophrenics improve in processing when feature combinations are probable (i.e., when they are presented with familiar stimuli) as controls were expected to do. Experiment 5 addressed the issue of stimulus familiarity using an interference paradigm, comparing familiar, unfamiliar but organised, and random organization distractor conditions. If schizophrenics do not process familiarity and organization in the distractors then it was expected that they would process these just like the random organised distractors. Controls on the other hand were expected to show processing failures in the first two

conditions relative to the random organised distractor condition (see for example, Regan, 1981).

4.4 A note on research orientation

Two broad approaches have developed to the investigation of cognitive deficit in schizophrenia - the individual differences approach (Chapman & Chapman, 1973, 1978) and the process-oriented approach (Carbotte, 1978; Strauss, 1978; Knight, 1984, 1987). In this section it will be argued that the individual differences approach makes unacceptable assumptions about the cognitive processes involved in the performance of a task to be of value as an independent strategy for localising the processing impairment in schizophrenia. It has however, valid implimentation in the development of tasks which discriminate schizophrenics and other groups once one knows what cognitive processes contribute to performance variance. On the other hand, the process-oriented approach makes specific predictions about the pattern of performance and the influence of the variables, selected on theoretical grounds, on performance variance. This presents as a more fruitful approach to resolving the issue of processing impairment in schizophrenia.

The individual differences approach attempted to develop tests which discriminated between schizophrenics and control populations. This type of research tended compare performance in one task against another, one supposedly including an ability under investigation the other acting as a control condition. The deviant responses of schizophrenics from controls in the one task over the other was considered to reflect a deficit in the assumed ability. Chapman and Chapman

(1973, 1978) however, showed clearly that group by task interactions could arise as an artefact of the psychometric properties of the two tasks. This is especially the case if one assumes, as the Chapmans did, that schizophrenics suffer from a generalised performance deficit (Chapman & Chapman, 1973, 1978). They argued that tasks can vary in their discriminatory power particularly because they can vary in their 'level of difficulty'. Simply put, easy tasks (acting usually as the control tasks) are less likely to discriminate subjects who suffer from a generalised processing deficit from controls while difficult tasks (usually containing the experimental ability under investigation) will tend to show group differences. According to this view, 'level of difficulty' counfounds the variable thought to reflect the process under investigation. The Chapmans' recommended that the investigator control the level of difficulty of in the control task by some means other than the experimental variable and compare the two task performances. In this way they hoped to establish a 'differential deficit' due to the experimental variable when task complexity is controlled.

The Chapmans' criticisms led them to recommend that researchers should match tasks on their discrimination power by preliminary investigations of normal subjects' performances with a wide range of ability levels. This would provide information about 'adequate' test-item selection from a wide pool of items with varied difficulty from the each of the two tasks. The aim of this endeavour was to meet three criteria for task equivalence: that the tasks have equal true-score variance; that their dependent variables are equally reliable; and, that the shape of the distribution of item difficulty is

the same for the two tasks. Equal true score variance and equal shape of the distribution of item difficulty were usually sought by careful selection of items in each task while reliability was usually manipulated by varying the number of items (test length) in the each test (Chapman & Chapman, 1973, 1978).

As an example, Raulin & Chapman (1976) conducted a matched task investigation of word-recall in schizophrenics and controls comparing the effects of high and low contextual constraint. They attempted to verify the previously reported effect (demonstrated with unmatched tasks) that schizophrenics showed a greater deviance in performance compared with normals when recalling high contextual constraint passages than when recalling more random passages. After investigating word lists with normal subjects they selected relatively short lists of low constraint words to be matched with longer lists of high constraint words, the two sets matching on the criteria described above.

However, the example illustrates some fundamental concerns with the differential deficit approach. As Strauss (1978) suggests, it assumes that the researcher knows that the two different tasks differentially tap the ability under investigation and that the tasks tap the same ability in the two different populations investigated. To these concerns it may be added that the procedure assumes that the investigator knows what variables contribute to task difficulty and therefore might be confounding the experimental variable. In the case of above example, it is assumed that task 'difficulty' is a function of the contextual constraint (the

experimental variable) and the length of the recall list (a confounding variable). Although for word recall performance variance might be relatively easily attributed to these two variables, for other multi-process tasks the identification of confounding variables may not be possible in this manner. Infact, the identification of variables determining performance in a particular task may only be possible by investigating the so-termed confounding variables as experimental variables. This is exactly the tact taken by the process-oriented approach to the task of specifying the cognitive impairment in schizophrenia (Carbotte, 1978; Knight, 1984, 1987). Indeed, Strauss (1978) recommended that understanding how performance is sustained in a task (i.e., what mechanisms are involved) by use of the process-oriented methodology must be preliminary to the development of differential deficit methodology.

Closer to the present work, consider the following problems raised by the Chapman and Chapman (1978) recommendations. In Neale's (1971) visual search experiment, mentionned in Chapter 3, it was found that in varying the display size from one to eight letters, target detection in schizophrenics was adequate in small display sizes but it fell away from normals as the number of items of the display was increased. Under the Chapmans' recommendations Neale might have manipulated other parameters than display size in the low load conditions (for example) so that the potential for arbitrary interactions between groups and display size, due to differential difficulty across conditions, could be minimised. However, just what manipulations are acceptable is far from clear in such a task (as Chapman & Chapman, 1978 conceded).

Carbotte (1978) recommended for example that the researcher might reduce the stimulus contrast or display exposure duration in the low load relatively to the high load conditions to equalise the difficulty level across the various display sizes. The problem, according Carbotte, with this procedure is that the researcher does not know which condition among the high-load displays should act as a standard for low-load displays to be matched with. However, this is only a practical problem of criterion selection. There is a more fundamental problem with the approach. Namely, such manipulations, would introduce preattentive level limitations (in terms of the model presented in Figure 4.1) in the small display sizes but not in the larger display sizes thus confounding the processing levels under investigation. As Knight puts it,

"To match on difficulty in many paradigms would mean to unmatch on process. Thus to require matched tasks would eliminate powerful analytic tools from the process-oriented researcher's arsenal."
(Knight, 1987, p. 6)

A related concern with the differential deficit approach is the assumption that the schizophrenics fail in every task because of some general (i.e., unspecified) processing problem. This is dissonant to the notion of finding out what processes underly their performance failure. For example, Yates (1966) postulated that an impairment in an early level of processing would influence all other processes dependent on the products of that first stage. In this case the generalised deficit is an epiphenomenon of a specific processing deficit. That this is not the case in schizophrenia is not at all clear from the data and therefore to assume that there is a non-

specific retardation of cognitive function in schizophrenia might be misleading.

The process-oriented approach investigates two variables (or more) independently which are considered from theoretical grounds to be diagnostic of two (or more) levels of processing with the expectation that certain relationships (a pattern, Knight, 1984) will be upheld between these variables and the dependent measure (especially in the control group's performance). There is a variation of 'difficulty' for each independent variable inherent in this process. It is through the deviation from the expected pattern that processing impairment is assessed. The variation of 'difficulty' in each independent variable is necessary to the description of processing efficiency by the various processing levels. For example, in Experiment 1 in the present work display size is varied independently with masked display duration. Each variable is intended as a diagnostic of a particular level of information processing. Each independent variable is varied in 'difficulty'. Observation is made of the way total performance variance relies on the difficulty level for each variable. Performance limits induced by the difficulty level of any one variable are interpretable in terms of a theoretical framework. The problem (or insight?) in interpretation arises only when 'difficulty' variations in all variables limit performance in the experimental group relative to controls. In such circumstances it is not clear whether performance deficit is a function of task difficulty (regardless of process) or whether all mechanisms reflected by the dependent variables are actually impaired. But it is clear, however, that independent variations of theoretically derived variables can

comment, through their effects on performance variance, on whether an observed performance deficit is a function of a level of processing being impaired or whether task difficulty is influencing the results in a general manner.

Pattern of performance also has implications for assessing the reliability of a dependent measure. If, for example, performance variance was dominated by measurement error (i.e., unreliable measurement) one would not be able to obtain the variation in performance predicted on theoretical grounds. Overcoming measurement error by increasing the number of estimations of the true score (i.e., by increasing test length), by sophisticated experimental procedure and by appropriate dependent measure selection (Sutcliffe, 1980) is clearly a critical process in the design of an experiment. Process-oriented methodology with its repeated estimations of the true score of a subject does not have the problems of reliability as those suggested in the Chapmans' comments. The problem is more serious in the individual differences methodology where a single score in performance is often considered to reflect the true ability level of the subject and there is no systematic observation on the pattern of scores across difficulty levels to refer to. In such circumstances the recommendations made by Chapman and Chapman (1973, 1978) are clearly valid.

Moreover, the Chapman's resolution of the reliability issue across two measures cannot be easily applied to information processing tasks. They suggested that reliabilities in two tasks might be matched by having more tests contributing to the subject's score in the more

difficult task compared to the easier task (i.e., differentially varying test length across the two tasks). This, however, translates to greater practice effects (or fatigue effects in blocked trials) in some conditions compared to others in an information processing task which, again, returns an unacceptable confounding of the variables under investigation. Furthermore, as Knight (1987) pointed out the Chapmans' assumption that the increasing reliability of a task (by increasing its length) actually leads to a greater discriminatory power is questionable. Nicewander and Price (1983) for example, indicated that the relationship between power and reliability, as Chapman and Chapman (1973, 1978) assume, holds only when exactly parallel forms (replications) are added but when slight variations exist in the 'parallel' forms, which is sometimes true in practice (see, Raulin & Chapman, 1976), then test length does not guarantee an increase in discriminating power. Consequently, Nicewander and Price suggested that reliability coefficients are of little value in assessing the adequacy of the dependent variable in an experiment and further suggested that dependent variable selection should be dominated by theoretical and practical considerations.

A final point, the possible confoundings of task difficulty, practice or fatigue effects with the experimental variable makes difficult the process of interpreting attempted correlations between clinical variables associated with schizophrenia and the processing measures (Knight, 1987).

It is concluded that the process-oriented approach has primary status in the investigation of cognitive or perceptual deficit in schizophrenia. Moreover, differential deficit

UNIVERSITY SETTING	
DEVELOPMENT OF MEASURES AND PILOTING	
COLLECTION 1	COLLECTION 2
PSYCHIATRIC HOSPITAL	PSYCHIATRIC HOSPITAL
<u>WARDS 1 & 2</u> Recent admissions schizophrenics (inpatients) Nursing staff controls	<u>WARD 1</u> Some recent admission schizophrenics (inpatients) Some nursing staff controls
	<u>COMMUNITY CENTER 1*</u> supplementation of schizophrenic group (outpatients)
	<u>REGIONAL HOSPITAL</u> <u>COMMUNITY CENTER 2*</u> supplementation of schizophrenic group (outpatients)
	<u>UNIVERSITY SETTING</u> supplementation of control group
<u>DATA FOR:</u>	<u>DATA FOR:</u>
EXPERIMENTS 1 & 2	EXPERIMENTS 2,3,4, &5

* outpatients were tested
in the hospital setting

methodology might be more appropriate in the development of 'tests' which distinguish schizophrenics from controls based on processes which become known through the process-oriented approach. Such test development could serve as a confirmation that a deficit thought to be specific is not due to a generalised incapacity to perform under increased task complexity (Chapman & Chapman, 1973) especially in conditions where all variables in a task have demonstrated limitations in schizophrenics relative to controls. (Alternatively, adequate confirmation within the process-oriented approach can be sought through designs, such as that of Place and Gilmore (1980) and that of Experiment 5 in the present work, where conditions predict performance limitations in controls relative to schizophrenics.)

4.5 Outline of the data collection procedure

There were two periods of data collection, headed Collection 1 and Collections 2 and they were separated by approximately four months. Figure 4.2 shows the general procedure adopted for each Collection. As can be discerned from the figure, following piloting of the experimental conditions and materials in the University, testing was transferred to the clinical settings for each of the Collections. For Collection 1, the apparatus was set-up in one of the two 'recent-admissions' wards (Wards 1 & 2), that provided patients for the studies. Controls were recruited from both established and trainee nursing staff in the wards. Collection 1 provided data for Experiments 1 and 2, appearing in the next couple of Chapters.

Collection 2 was problematic due to a closure of Ward 2

and a reallocation of hospital resources. Moreover, due to changes in Government legislation, regarding 'de-institutionalization', a major source of patients to the hospital was truncated. These changes forced a reallocation of the experimental setting to a different hospital (in a different town) and the supplementation of the in-patient schizophrenic group with patients receiving treatment in two community centres. In the first hospital, the apparatus was set-up in a quiet, dimly-lit room within the Clinical Psychology Department, while in the second hospital the Ophthalmologist's Consultancy room was used since similar lighting conditions prevailed there. Controls were drawn from the nursing staff of the first hospital and then supplemented with data obtained from University students (see Figure 4.2). As will be seen in later Chapters, reasonably consistent patterns in performance were obtained despite the various translocations of the experimental setting.

4.6 The Clinical Variables

In Chapters 2 and 3, a number of clinical dimensions of schizophrenia were mentioned in passing. These dimensions included, chronicity, the presence of paranoid symptoms, over-inclusive thought disorder, and premorbid psychosocial adjustment. Chronicity, poor pre-morbid adjustment, and 'non-paranoid' syndrome have been associated with cognitive deficit in a number of tasks (see, Buss, 1966; Maher, 1966; Payne, 1960). However, in the visual processing literature it is unclear that performance deficit is associated with any of these dimensions (Wells & Leventhal, 1984). Phenomenological reports suggested that perceptual aberrations were prevalent

FIGURE 4.3: Clinical measures of Collections 1 and 2.

INSTRUMENT	PURPOSE
<u>COLLECTION 1</u>	
MaineScale	Verification of Hospital Diagnosis and subject selection
Vocabulary IQ	Subject Description & selection
Proverbs Test	Thought disorder index ('concrete thinking' attitude)
Lovibond Object Sorting Test	Thought disorder index ('over-inclusive' thinking)
Delusions-Symptoms and Signs Inventory	Diagnosis validation & analysis
Antipsychotic Medication information	Subject description & analysis
Age	Subject description & analysis
<u>COLLECTION 2</u> (additional measures)	
Global Assesment Scale	Index of current and past mental health
Harris Premorbid Adjustment Scale	Index of psychosocial adjustment history

in the acute phases of the illness. The eye-tracking studies suggested that chronic schizophrenics were more likely than acute schizophrenics to show abnormality due to poor stimulus processing. In the constancy studies chronic, non-paranoid schizophrenics seemed to 'live in a flatter world' than comparative groups (Weckowycz & Blewett, 1959) whereas paranoid schizophrenics were occasionally shown to miscalculate the size-distance relation. In the studies using 'static', tachistoscopic displays none of these dimensions were consistently associated with performance deficit (see, Wells & Leventhal, 1984 for similar conclusions).

In the present experiments the influence of the clinical dimensions on performance will be explored through correlational analysis. The following is a description of the various measures which are also summarised in Figure 4.3. Clinical variables in the present study included, measures of disordered premorbid psychosocial functioning, global severity of pathology, and current-episode measures. The instruments used included a variety of information sources such as, patients' clinical records, hospital-staff ratings, patient 'self-reported' symptoms, and performance on standard psychological tests. These data are also used toward the description of the present sample of schizophrenics for the purposes of inter-study comparison. In both data Collections the Maine Scale, a measure of psychotic symptoms associated with schizophrenia, was completed by each patient's psychiatrist and by a psychiatric nurse who was familiar with the patient's condition and history. These staff also completed the Global Assessment Scale in Collection 2. All

FIGURE 4.4 Syndromes and symptoms measured by the Maine Scale.

Paranoid Syndrome

1. the unfounded belief that external forces or other people are influencing the patient's actions and thinking
2. the unfounded belief of being conspired against, being cheated, deprived or punished
3. an exaggerated opinion of him/her self or the conviction of special unusual abilities, knowledge, power, wealth etc.
4. the unfounded belief that people talk about or watch the patients actions
5. expressed hostility, resentment, bitterness or hate towards others.

Non-paranoid Syndrome

1. auditory and visual hallucinations
 2. thought disorder as exhibited in confused, disconnected or disorganised speech
 3. affect inappropriate to the situation (e.g. giggling or crying for no apparent reason) or blunted affect
 4. disorientation for time, place and length of hospitalization
 5. the presence of peculiar or bizarre postures or mannerisms
-

other measuring instruments were administered by the present author. A hospital psychologist provided reliability data for the Harris Premorbid Adjustment measure in the second Collection.

4.61 Collection 1: Clinical instruments and variables

The Maine Scale

The Maine Scale (Magaro, Abrams & Cantrell, 1981) comprises of a list of ten symptoms associated with schizophrenic psychosis along with a measure of symptom severity. There are two subscales which measure Paranoid and Non-paranoid schizophrenic symptoms. A summary of the symptoms is presented in Figure 4.3. In the present study the Maine Scale was used to verify the hospital diagnosis of schizophrenia. Two subscale scores were provided for each patient by a psychiatrist and a nurse. In the present study the arithmetic average of the two ratings was taken as the basic datum for each of the Paranoid and the Non-paranoid scales as well as for the Maine total score. This was made possible since judgements of the presence/ absence of symptoms made by these two raters showed fair concordance. In Collection 1, for example, out of the 100 judgements (i.e., 10 Maine symptoms x 10 subjects), 79 percent were in agreement. In Collection 2 a similar concordance estimate yielded 72 percent agreement from 150 judgements.

Notably, the Maine Scale provides an adequate survey of DSM III cross-sectional criteria for schizophrenia (compare Figure 1.2, particularly, Part A, with Figure 4.4). Furthermore, it has good concurrent validity with older instruments for identifying schizophrenics (e.g., New Haven

Schizophrenia Index; Magaro, Abrams & Cantrell, 1981). In addition to its capability for distinguishing between paranoid and non-paranoid schizophrenics reliability it shows good discrimination of schizophrenics from other psychiatric groups based on empirically derived cut-off scores (Magaro, Abrams & Cantrell, 1981). Indeed, Magaro et al., (1981) indicated that there is a 71 percent agreement between Research Diagnostic Criteria and Maine Scale criteria in the classification of paranoid non-paranoid schizophrenia versus non-schizophrenic patients. As Magaro et al., (1981) state, this is a reasonable level of reliability given that similar levels have been obtained, in classifying schizophrenics by other diagnostic systems. The Maine Scale was therefore used in the present study as the primary diagnostic instrument for selecting patients.

The Vocabulary subscale of the 'WAIS'

The vocabulary subscale of the Weschler Adult Intelligence Scale (WAIS) was administered for subject selection purposes. This scale shows a correlation of 0.9 with the verbal scale IQ and was used here as a measure of premorbid intellectual functioning. As Heaton and Pendleton's (1981) review indicated, measures of intelligence (e.g., WAIS Intelligence Quotient) correlate well with measures of academic achievement (e.g., academic performance, years of completed education), and with measures of vocational functioning (e.g., occupational prestige ratings, future vocational attainment, and job performance). As such the vocabulary score in the present work was used as a single estimate of the level of functioning in these areas.

Gorham's Proverbs Test

The multiple choice version of the Proverbs Test (Gorham, 1956 a,b) was administered to provide a measure of the subject's ability for 'abstract conceptualization'. Payne (1960) pointed out that chronic schizophrenics, or those with an insidious onset of the disorder ('process' schizophrenics) tend to interpret proverbs in less abstract and more concrete (Gorham, 1956 a,b) or idiosyncratic fashion (Shimkunas, 1972). Although much of the variance in the abstraction score can be accounted for by the intellectual level there remains a portion which is explained by diagnosis (i.e., schizophrenic versus controls, Shimkunas, Gynther & Smith, 1966). This is also evident in Gorham's work (1956 a, b) which shows that even when matched on intelligence level schizophrenics have lower abstraction scores than controls. Moreover, the tendency for non-abstract interpretations appears to be related to psychosis (Gorham, 1956a; Payne, 1960; Shimkunas, Gynther & Smith, 1966). Shimkunas (1970) for example, indicated that while WAIS vocabulary scores remained stable (notably, in the normal range), phenothiazine treated schizophrenics improved significantly on abstraction scores with the remission of psychotics (as indicated by independent clinical ratings of psychopathology). Thus it seems that abstraction scores are sensitive both to long-term deterioration and to psychotic disorganization.

The multiple choice form of the Proverbs Test (Gorham, 1956 a,b) provides a composite score of the 'abstract' score minus the 'concrete' score and this index, the 'adjusted score', was used in the present study. The score, because of the selection of subjects with at least normal level

intelligence (i.e., adequate premorbid functioning), is most likely to reflect an effect of the current episode of psychosis on the process of thinking.

The Lovibond Object Sorting Test

The Lovibond Object Sorting Test was included to assess the degree of 'overinclusive thinking' (Lovibond, 1954; Lovibond, undated Manual). As noted in Chapter 3 this type of thinking is characterised by 'overextensive' boundaries between concepts (Cameron, 1939); distantly related ideas tend to become unified within a single concept. Cameron (1939) maintained that the inability to form adequate boundaries between concepts was responsible for the distractibility that is characteristic of schizophrenia:

"Our schizophrenic patients... showed themselves unable to organise and subordinate the events occurring simultaneously in their organism - perceptual, memorial, imaginal. Consequently they included such a variety of categories at one time that the specific problems became too extensive and too complex for a solution to be related."

(Cameron, 1939, p. 269).

Since Cameron's formulation there have been numerous tasks (for a survey see Payne, 1960) which have been developed as measures of overinclusive thinking. These have been broadly classified (Payne, 1960) as verbal reasoning and abstraction tests, and object sorting tests. It is unclear however, that the different measures have a common underlying process though some views suggest that they do measure the same construct (e.g., Shimkunas, 1972). Small but significant correlations between different measures of overinclusive thinking have been reported (e.g., Craig, 1970; Romney, 1969) suggestive, but by no means conclusive, of a common underlying

construct. However, failures to find the expected correlations have also been reported (Hawks, 1964; Watson, 1967).

Furthermore, it is not clear what aspect in the course of schizophrenia the tests are associated with - namely, whether they are measures of psychosis or whether they are measures of enduring tendencies in schizophrenic's thinking style. The latter view is supported by McConaghy (1959) who observed a high incidence of overinclusive thinking in the parents of overinclusive schizophrenics (60 percent were clinically overinclusive as defined by an empirically derived cut-off score in the Lovibond Object Sorting test) compared to parents of non-schizophrenics (comparatively, nine percent). McConaghy (1959) speculated that the result might represent the genetic inheritance of a 'schizoid personality', though it is clear that the data do not rule out the possibility of social learning (or, for that matter, 'reversed' influences of the child's communication on the parents).

On the other hand, attempted replications of the McConaghy's result have found reduced differences in the incidence of overinclusive thinking (e.g., Rosman, et al., 1964) between the two parent types. Rosman et al., (1964) indicated that support for the higher incidence of overinclusive thinking in the parents of schizophrenics could only be replicated at upper range levels of intelligence and educational status. Parents at the lower levels showed equivalent incidence of overinclusive thinking. Wright (1973) failed to replicate McConaghy's result while Lidz et al., (1962) could only replicate the pattern of results using another scoring system after an initial failure at using

McConaghy's original criteria. At best, the results of studies of parents of schizophrenics, which were originally considered to constitute evidence of an inherited enduring tendency for overinclusive thinking in schizophrenics, are inconclusive (Saccuzzo, Callahan & Madsen, 1988).

Alternatively, according to Payne (1970), acute, reactive rather than chronic, process schizophrenics tend to exhibit overinclusive thinking (although some studies have indicated overinclusive thinking in chronic schizophrenics when compared with normals, e.g., Chapman & Taylor, 1957). Payne (1970) pointed out that overinclusive thinking tends to be accompanied by heightened perceptual awareness, overactivity and excitement, as are common in psychosis. Furthermore, there is some evidence (e.g., Namyslowska, 1975) that overinclusive thinking tends to reduce with the remission of psychosis. These observations suggest that overinclusive thinking might be a symptom of psychosis in an otherwise non-overinclusive individual. Alternatively, and consistent with McConaghy's position, psychosis might be associated with an exacerbation of overinclusive thinking which is a persistent style of thinking in schizophrenics.

Although Lovibond (undated manual) presented an extensive scoring system for the Object Sorting Test, in the present study each response was classified only according to his criteria for 'essentiality' (as this is a measure of the degree of 'belongingness' in the subject's categorization responses). This is the same measure of overinclusive thinking as used by McConaghy (1959) and fits well with Cameron's notion of 'overextensive' boundaries between concepts. Accordingly, both in parts of the test, the subject's

descriptions (i.e., responses) were scored as to whether the nominated grouping principle for an item applies (i.e., essentially 'describes'):

1. only to the objects selected or presented in the item
(score 0,)
2. to at least half of all the stimulus objects available in the test (score,1)
3. to, approximately, all objects available in the test
(score, 2)
4. to all objects within and beyond the stimulus objects
(score, 3).

Consistent with McConaghy (1959), if a subject failed to provide a response for an item s/he was not penalised.

A note on the Proverbs Test and Lovibond Object Sorting Test as measures of Thought Disorder

In the present study the Proverbs Test and the Lovibond Object Sorting Test were included as measures of 'thought disorder'. These tests were originally intended as objective demonstrations of associative disturbances in schizophrenia (e.g., Lovibond, 1954; Payne, 1960; Shimkunas, 1972). The recent psychiatric literature, however, has tended to focus on schizophrenics' discourse and to assume the presence of association disturbances in thinking by the form (rather than content) of the patient's speech (Andreasen, 1979). Scales for 'thought' disorder have been developed (based largely on face validity) in the form of ratings on schizophrenics' discourse with variables including, circumstantiality, tangentiality, derailment, incoherence, illogicality, etc. (Andreasen, 1979).

The independence of these measures is questionable as is the issue that raters can make fine discriminations between these constructs in a typical psychiatric interview. For example, using objective linguistic analysis of discourse, Rochester and Martin (1979) demonstrated that clinically rated thought disordered schizophrenics differed only on two measures from non-disordered schizophrenics. The first finding was that thought disorder involved disturbances in the coherence of clauses while the other finding involved intrusion of environmental events as content into the discourse.

Secondly, the relation of discourse disturbances to traditional measures, as used presently, of association disturbance in schizophrenics has not been elucidated. This has led, for example, to some argument as to whether discourse disorder in schizophrenia is purely a language disorder (in the sense of Wernicke's aphasia) or whether it is secondary to a disturbance in some other cognitive processing (Maher, 1972; Schwartz, 1982). The enduring view is that discourse disturbance in schizophrenia is secondary to cognitive processing impairment, namely attentional disturbances (Maher, 1972; Schwartz, 1982). In view of these considerations, the present work included the two traditional tests as more direct measures of schizophrenics' association disturbances.

The Delusions-Symptoms and Signs Inventory

The Delusions-Symptoms-Signs Inventory (DSSI, Bedford & Foulds, 1978) was included to assess aspects of psychopathology as reported by the subjects. Discussion of the relationship of observer- and patient- reported pathology will be presented later in this Chapter. The inventory, which

consists of 84 questions, contains twelve subscales. Each subscale consists of seven items. Each of the items measures the degree of perceived severity of the represented symptom. The twelve subscales are compounded into four classes of 'Personal Illness':

1. Dysthymic States (subscales of anxiety, depression, and hypomania);
2. Neurotic States (subscales of conversion symptoms, dissociative symptoms, phobic symptoms, compulsive and ruminative symptoms);
3. Integrated Delusions (subscales of persecutory delusions, delusions of grandiosity, delusions of contrition);
4. Disintegrated Delusions (consists of a single subscale bearing this label).

Scores from these subscales were used to investigate the correlation of pathology with the performance measures.

4.62 Collection 2: clinical instruments and variables

In Collection 2, as shown in Figure 4.2, two other measures were included: the Global Assessment Scale (Endicott, Spitzer, Fleiss & Cohen, 1976) and the abbreviated version of the Phillips Premorbid Adjustment Scale (Phillips, 1953) as presented by Harris (1975). Prior to its formal scoring the decision was made to omit the Lovibond Object Sorting Test to keep the total testing time for each subject within reasonable bounds.

The Global Assessment Scale

The Global Assessment Scale (GAS) is a measure of the subject's mental health (i.e., higher scores indicate less

disorder). On the instrument observers rate the lowest value (i.e., the most pathology) that the patient has expressed within a specified period (usually a week prior to the rating, Endicott et al., 1976). In the present study ratings were made by both the psychiatrist and the nurse who completed the Maine Scale. The average of these two ratings will be denoted the 'Current Health' of the subject (referred to as "GAS current"). In addition, raters were asked to consider the most severe pathology that the subject had exhibited and to make a second rating (referred to as "GAS worst"). Apart from the descriptive utility, the GAS was included to provide a global measure of mental health and whether general pathology influences performance.

The Abbreviated Premorbid Functioning Scale

The Abbreviated Premorbid Functioning Scale was included since this measure has been associated with poor outcome schizophrenia. Poor premorbid adjustment has been related with a reduction in 'abstract thinking' and with an increase in 'autistic' responses to the free-response form of the Proverbs Test (Becker, 1956; Carpenter & Chapman, 1982; Herron, 1962; Miechenbaum, 1969). In comparison to 'good premorbid adjustment' patients, 'poor premorbid adjustment' patients tend to experience longer hospitalizations (Garfield & Sundland, 1966), they use more out-patient services, and, fail to adjust to the community for a longer period (Evans, Goldstein & Rodnick, 1973). These patients also experience earlier symptom onset than good-premorbid patients and they tend to score more poorly in some neuropsychological tests (Guy, Liaboe & Wallace, 1986).

In the present study the Harris scores were provided by two judges - the author and a hospital psychologist. The latter based her judgements on the notes of a semi-structured interview which was conducted by the author. The hospital psychologist was unfamiliar with the subject. The procedure resulted in good inter-rater reliability (Spearman Rank correlation, $r_s(15) = 0.90$). For the purposes of further analysis the average of these two ratings was considered as the measure of the premorbid functioning of each subject.

4.63 Additional measures

Additional data collected for the purposes of sample description were: age, number of hospitalizations, dose of phenothiazine medication. The influence of these variables on perceptual performance will be assessed in latter Chapters. The 'number of hospitalizations' was corrected for age by division and is considered here as a general measure of severity of the illness over time. Phenothiazine medication for each subject was calculated in 'chlopromazine equivalent units' (CPZ) by using the table provided by Hirsch (1982, p. 76). Subsequently the CPZ value was divided by the subject's body weight (which was expected to have some influence the active drug concentration, Goodman & Gilman, 1980).

(Measures of Orientation for Time and Place were also taken at the time of testing but since none of the subjects indicated any significant disorientation, this measure will not be discussed further. Green and Walker (1985), in the context of neuropsychological assessments of schizophrenics, also found a ceiling effect on a similar Orientation measure.)

TABLE 4.1 : Correlations between the Maine Scale scores and other measures for Collection 1.

	MAINE SCALE SYNDROMES		
	PARANOID	NON-PARANOID	TOTAL
Age	-.05	-.32	-.34
Vocabulary IQ	.22	.12	-.14
Hosp./Age	.09	.63 *	.54
Medication	.08	.20	.12
Proverbs Test	-.63 *	-.45	-.65 *
Lovibond Sorting	.28	.83 ****	.55
Dysthymic States	.66 *	.92 ****	.85 ****
Neurotic Symptoms	.36	.89 ****	.61 *
Integr. Delusions	.60 *	.88 ****	.79 ***
Disint. Delusions	.21	.90 ****	.49
DSSI Total score	.37	.88 ****	.62 *

One-tailed signif. levels, (n = 10)

* p < 0.05
 ** p < 0.025
 *** p < 0.01
 **** p < 0.005

4.7 Observer-reported pathology

As stated earlier, the Maine Scale was used in the present study to verify the hospital diagnosis of schizophrenia. In this section correlations are presented that indicate the success of observers in selecting subjects who had experienced psychosis. Correlation between the Maine Scale scores and patient-reported symptoms using the DSSI will be presented. Furthermore, it would be interesting, from the point of view of sample selection, to observe whether the Maine Scale scores correlate with variables of premorbid intelligence (as measured with the Vocabulary subscale), illness severity (as measured with the hospitalization rate index and premorbid adjustment measure), thought disorder (as measured with the Proverbs Test and Lovibond Object Sorting Test), and, with ratings of current and past 'mental health' (as measured by the Global Assessment Scale).

The results of these analyses are presented in Tables 4.1 and 4.2 for the respective data Collections. In Table 4.1 it is clear that the scales of the DSSI representing the classes of Personal Illness (e.g., Dysthymic States, etc.) were correlated with observer-reported pathology, and particularly with the Non-Paranoid Syndrome subscale of the Maine Scale. Furthermore, reduced 'abstract thinking attitude', as measured by the Proverbs Test, was found to be correlated with the Maine Scale Paranoid Syndrome (Table 4.1). 'Overinclusive thinking' disorder, as measured with the Lovibond Object Sorting Test, was found to be correlated with the Maine Scale Non-paranoid Syndrome. Overall these results favour the conclusion that observers in Collection 1 were accurate in their assessment of psychotic pathology.

TABLE 4.2: Correlations between the Maine Scale scores and other measures for Collection 2.

MAINE SCALE SYNDROMES			
	PARANOID	NON-PARANOID	TOTAL
Age	-.48 *	-.44 *	-.50 *
Vocabulary IQ	-.45 *	.07	-.19
Hosp./Age	.10	-.46 *	.22
Medication	.39	.26	.42
Proverbs Test	.03	.04	.03
GAS worst	-.50 *	-.46 *	-.54 **
GAS current	-.35	-.15	-.28
Harris Premorbid	-.44*	-.39	-.58**
Dysthymic States	.23	.59 **	.48 *
Neurotic Symptoms	.24	.51 *	.49 *
Integ. Delusions	.44 *	.38	.48 *
Disint. Delusions	.39	.28	.35
DSSI Total score	.34	.51 *	.52 *

One-tailed signif. levels, (n = 15)

* p < 0.05

** p < 0.025

The results of Collection 2, presented in Table 4.2, are not as clearly favourable of observer accuracy as those of the first Collection. The greater variability of the data, suggested by the correlations in Table 4.2, might have been due to the use of a variety of observers (e.g., Hospital and Community Centre staff). This was less the case in Collection 1, particularly since most of the subjects shared a single psychiatrist (but variable nursing staff). The psychiatrist's ratings in Collection 1 can be expected to show consistency over time. In any case, in Collection 2, a low correlation was observed between ratings of Maine Paranoid Syndrome and the DSSI 'Integrated Delusions' class. This would be expected since this class contains subscales of Delusions of Persecution and Delusions of Grandeur, both used commonly in the diagnosis of Paranoid Schizophrenia (e.g., DSM III).

Curiously none of the delusion level classes of the DSSI were found to be correlated with Maine Scale Non-paranoid syndrome. Closer analysis of the pattern of correlations of the subscales comprising the Integrated Delusions class indicated no correlation between Delusions of Grandeur and the Maine Scale Non-paranoid Syndrome but correlations were significant between Maine Scale Non-paranoid Syndrome and the DSSI subscale of Delusions of Persecution ($r(15) = 0.75$, $p < 0.01$, one-tailed test) and Delusions of Contrition ($r(15) = 0.50$, $p < 0.05$, one-tailed test). As in Collection 1, these results support the conclusion that observers reported psychotic behaviour accurately.

Another finding, presented in Table, 4.2, is the consistency in ratings of pathology by the Maine Scale and the Global Assessment Scale. It can be seen in Table 4.2 that 'GAS

worst', representing the rating of 'mental health' at the period of psychosis, was negatively correlated with Maine Scale scores - as to be expected. Current 'mental health' was not correlated with Maine Scale ratings. Furthermore, subjects with higher premorbid intelligence as measured by the WAIS Vocabulary subscale were less likely to score highly on the Maine Scale Paranoid Syndrome scale. Age was found to be negatively correlated with Maine Scale scores suggesting a reduction in observable 'florid' psychosis in the older patients. Finally, the measure illness severity over time, 'Hosp/age', was found to be negatively correlated with Maine Non-paranoid Syndrome. Previously, in Collection 1, a positive correlation was observed. The reason for this discrepancy is not immediately apparent.

Another discrepancy between Collections 1 and 2 is the correlation of Maine Scale scores and measures of thought disorder (i.e., Proverbs Test scores). However, since six of the 15 subjects in Collection 2 were outpatients, the discrepancy might be explained by the fact that Collection 2 patients, as a group, were not experiencing thought disorder at the time of testing. This is supported by the findings that the mean Proverbs Test score of Collection 2 patients was within normal limits and significantly greater than the corresponding mean of Collection 1 subjects. This result will be discussed below in the Subject Selection section.

4.8 Subject-reported pathology

This section reports on the consistency of subject-reported pathology, which were used above to assess the reliability of the observers' ratings, by inspecting the

TABLE 4.3 : Correlations among the Classes of Personal Illness
from the DSSI, in Collection 1 (n = 10).

	DSSI CLASSES OF PERSONAL ILLNESS			
	1	2	3	4
Dysthymic States (1)	-	.76 ***	.90 ***	.83 ***
Neurotic Symptoms (2)	-	-	.85 ***	.87 ***
Integrated Delusions (3)	-	-	-	.81 ***
Disintegrated Delusions (4)	-	-	-	-

TABLE 4.4 : Correlations among the Classes of Personal Illness
from the DSSI, in Collection 2 (n = 15).

	DSSI CLASSES OF PERSONAL ILLNESS			
	1	2	3	4
Dysthymic States (1)	-	.59 **	.74 **	.43
Neurotic Symptoms (2)	-	-	.68 **	.59 **
Integrated Delusions (3)	-	-	-	.58 **
Disintegrated Delusions (4)	-	-	-	-

One-tailed signif. levels
** p < 0.025
*** p < 0.01

correlations among the classes of Personal Illness of the DSSI. Secondly, an analysis of the Illness classes and the clinical variables is presented to investigate whether self-reported pathology is especially correlated with any of these.

According to Bedford and Foulds (1977, 1978) psychopathology increases in severity in the sequence of illness classes from Dysthymic States, Neurotic States, Integrated Delusions, to Disintegrated Delusions. For example, Bedford and Foulds (1978) indicated that a patient who experiences symptoms at a more severe class of Personal Illness is likely to have experienced symptoms at all less severe classes but that the reverse relation is rare (Foulds, 1976; Foulds & Bedford, 1975; Morey, 1985). This pattern of findings suggests that the present samples ought to score highly in non-psychotic symptoms (e.g., Dysthymic States and Neurotic Symptoms) suggesting a correlation between delusion scores and lower level pathology. The results presented in Tables 4.3 and 4.4, representing Collections 1 and 2, respectively, support this view.

The correlations of clinical variables and classes of Personal Illness are presented in Tables 4.5 and 4.6. In the first Table, indicating the results for Collection 1, high positive correlations were found between the Lovibond Object Sorting score (i.e., 'overinclusion') and all classes of Personal Illness. This is to be expected since both are measures of pathology. Although 'thought disorder' as measured by the Proverbs Test was negatively correlated with reported pathology, as to be expected, only one correlation (with

TABLE 4.5 : Self-reported pathology depicted as Classes of Personal Illness for Collection 1.

DSSI CLASSES OF PERSONAL ILLNESS					
	Dysth. States	Neurotic Symptoms	Integ. Delusions	Disint. Delusions	Total
Age	-.30	-.08	-.28	-.15	-.11
Voc IQ	-.22	.22	.13	-.10	.06
Hosp./Age	.63 *	.46	.55	.44	.43
Medication	.34	.23	.55	.25	.31
Prov. Test	-.63 *	-.49	-.48	-.49	-.51
Lovib. Sort.	.71 **	.91 ****	.79 ***	.72 **	.85****

One-tailed signif. levels, n = 10

* p < 0.05

** p < 0.025

*** p < 0.01

**** P < 0.005

Dysthymic States) reached significance (Table 4.5). The only other correlation was the illness severity index with Dysthymic States (although high but non-significant correlations with other illness classes are indicated in Table 4.5). Overall, self-reported pathology appears to be associated with other measures of pathology including 'thought disorder' and illness severity over time.

The corresponding results for Collection 2, presented in Table 4.6 were not as encouraging. Only three correlations reached significance. Curiously, medication level was negatively correlated with report of Disintegrated Delusions suggesting a possible influence of report compliance. That is, subjects on lower medication, and presumably less psychotic, might have reported more of these kinds of symptoms, compared with patients on high medication levels. Indeed the tendency for 'abstract thinking attitude' (measured by the Proverbs Test) and 'better premorbid psychosocial adjustment' (measured with the 'Harris Scale') to be associated with this illness class is consistent with this view. However, neither of these correlations reached significance.

Another inconsistent result in Collection 2 is the negative correlation between 'GAS worst' and self-reported Neurotic Symptoms, suggesting that those who experienced more florid psychosis reported less DSSI neurotic symptoms. This is inconsistent with the Bedford and Foulds (1978) notion of Illness hierarchy. The only 'consistent' correlation is that between the observer-rated current 'mental health' and patient-reported scores on the Integrated Delusions scale. Generally, the variability in raters noted earlier and the inclusion of outpatients who might not have been psychotic at

TABLE 4.6 : Self-reported pathology depicted as Classes of Personal Illness for Collection 2.

DSSI CLASSES OF PERSONAL ILLNESS					
	Dysth. States	Neurotic Symptoms	Integ. Delusions	Disint. Delusions	Total
Age	.11	.08	.22	-.03	.10
Voc IQ	-.05	-.01	-.06	-.17	-.02
Hosp./Age	.23	.31	.00	-.09	-.16
Medication	-.15	-.05	-.15	-.47 *	-.25
Prov. Test	.24	-.11	.26	.41	.27
GAS worst	-.15	-.50 *	-.15	-.18	-.26
GAS current	-.38	-.20	-.46 *	.11	-.27
Premorbid	.08	-.05	-.26	-.42	-.14

One-tailed signif. levels, n = 15

* p < 0.05

the time of testing might have contributed to the pattern of correlations of Table 4.6. This is supported by the observation that the correlations within the DSSI classes are generally smaller in Collection 2 than Collection 1 (refer back to Tables 4.3 & 4.4). This conclusion is tentative, however, given the small sample sizes.

4.9 Subject selection

The present section describes how the patients were selected, the criteria for inclusion and exclusion, and it provides a description of the constitution of the patient groups in terms of the clinical variables. Description of the controls is deferred to the Chapters describing the Experiments.

The selection procedure involved an initial inspection of records (i.e., name, age and hospital diagnosis was noted only) or verbal communication with doctors regarding potential subjects. Subsequently, each subject was approached and the nature of the study was introduced to him or her. Following a description of the various tasks subjects were asked if they would like to volunteer as participants to the experiments. Verbal permission was also obtained to study their files for further information. On the basis of file notes subjects were excluded if the description of their psychosis by psychiatrists, at intake mental status examination, did not mention hallucinations, delusions and thought disorder. Subjects were also excluded if they had psychosis diagnoses other than schizophrenia in their history (e.g., Psychotic Depression, Organic Psychosis).

Hospital diagnoses included were, Schizophrenia, Chronic

TABLE 4.7 : Details of scores on the various instruments for the two samples.

	Collection 1		Collection 2	
	mean	sd.	mean	sd.
Age	30.0	7.4	28.0	6.0
Voc IQ	11.1	2.3	12.1	2.0
Hosp/Age *	10.2	6.6	16.8	9.2
Medication	13.3	4.1	18.7	24.3
Maine Paranoid	14.1	3.4	15.0	2.8
Maine Non-Paranoid	13.4	2.4	12.7	3.6
Proverbs Test	24.8	11.1	32.0	9.4
Lovibond	18.2	16.0	--	--
GAS worst	--	--	27.4	7.1
GAS current	--	--	70.9	10.0
Premorbid	--	--	5.6	2.0
Dysth. States	22.3	11.9	25.8	13.8
Neurotic Sym.	28.6	18.9	27.3	19.9
Integ. Delusions	24.6	16.0	24.47	13.21
Disin. Delusions	8.6	6.3	6.8	13.21
Hospitalised currently?	all 10 subjects		9 of 15 subjects	

* Hospitalization/Age (x 100)

Schizophrenia and Paranoid Schizophrenia. The Schizoaffective category was avoided to minimise heterogeneity due to the potential inclusion of affective illnesses. Subjects were excluded if they had a history of substance abuse (e.g. alcohol, LSD, 'glue-sniffing' etc.) or if any mention was made in the hospital record of possible organicity (e.g., abberant EEG records, CAT scan abnormalities). Criteria for subject selection were a score of 12 or higher on the Paranoid Syndrome of the Maine Scale or, 10 or higher on the Non-paranoid Syndrome. These cut-offs were suggested by Magaro et al. (1981) to be capable of discriminating between schizophrenics and other psychiatric patients. These criteria showed a high concordance with the Research Diagnostic Criteria in selecting schizophrenics from other psychiatric patients (Magaro et al., 1981). Subjects were also selected if they were younger than forty years of age and a preference was given to the youngest of the available population. Finally, subjects were selected if they scored in the normal range or above on the WAIS Vocabulary subscale.

The descriptive information is presented in Table 4.7. As the Table indicates, only three variables appear to be different in the two groups, the Medication Index, the Proverbs Test score, and the rate of lifetime hospitalization. The large standard deviation of the Collection 1 group in the Medication measure suggests, as is indicated by the raw data, that a couple of the schizophrenics in that group were receiving very high medication levels in comparison to the rest of the group. Indeed the mean with these two subjects removed drops to 10.60 (SD = 10.53) and is comparable to the

Collection 2 mean. On the other hand, the Proverbs Test results, as noted earlier, do not seem to be an artefact ($t(23) = 1.74, p < 0.05$) suggesting that the Collection 1 subjects were more 'thought disordered' than Collection 2 subjects. Indeed, current 'mental health' status for this latter group, as rated on the GAS, is an average rating of approximately 72. This rating corresponds to the following description:

"minimal symptoms may be present but no more than slight impairment in functioning, varying degrees of 'everyday' worries and problems that sometimes get out of hand"

(Endicott et al., 1976, p. 768).

Comparatively, the rating of their worst condition was approximately 27. The corresponding description of this level of functioning is,

"Unable to function in almost all areas (e.g. stays in bed all day), OR behaviour is considerably influenced by either delusions or hallucinations, OR serious impairment in communication (e.g. sometimes incoherent or unresponsive) or judgement (e.g. acts grossly inappropriately)"

(Endicott et al., 1976, p. 768).

Regarding the Maine Scale (in Table 4.7) it appears that subjects of both Collections were rated to have displayed Paranoid and Non-paranoid symptoms and this concurs with the self reported pathology on the DSSI (e.g. scoring on both 'Integrated delusions' and 'Delusions of disintegration' scales), as well as the "GAS worst" description. This is also consistent with the original selection criteria which emphasised the presence of delusions, hallucinations and thought disorder.

On the Harris premorbid functioning score, which is scored in the direction of maladjustment, an average score of 5.57 places subjects in the middle of the range as scores can vary from 0 to 12. The actual range for the present sample was from a score of 2 to a score of 9, with five schizophrenics scoring 7 and over (i.e. in the 'poor premorbid' region). The sample then may be regarded as 'good premorbid' as reflected by the overall mean.

Table 4.7 also indicates that all schizophrenics in Collection 1 were hospitalised while in Collection 2 six subjects were recruited through the Community Centres. This is somewhat consistent with the lower group scores on the Proverbs Test for Collection 2 subjects relative to Collection 1 as it has been suggested above that the Proverbs Test scores might reflect current thought disorder.

All schizophrenics were receiving antipsychotic medication at the time of the study, regardless of whether or not they were living in the community.

With regard to diagnosis, all patients had received a hospital diagnosis of schizophrenia by their treating psychiatrist. Second, the Main Scale conforms with cross-sectional DSM III criteria and on this basis would probably classify all the patients into this class. However, three patients in the total sample may have not met the DSM III longitudinal criteria for schizophrenia (6 month duration) since they were first episode recent admissions. Alternatively, these patients would be classifiable in the Schizophreniform Disorder category by DSM III. The ambiguity cannot be resolved since prodromal information relating to

psychosocial deterioration was not collected in the present study. Finally, the concurrence between Research Diagnostic Criteria and Maudsley Scale criteria in selecting schizophrenics from other psychiatric patients suggests that the present samples are highly likely to receive a diagnosis of schizophrenia by the research criteria.

4.10 A general note on controls

In the Collection 1 all controls did Experiments 1 and 2. In the Collection 2, however, some controls did all tests (Experiments 2, 3, 4, 5) while others were involved in a circumscribed combination of experiments. This was forced into the design by time commitments of these subjects. In Collection 2 most control subjects drawn from the University were given credit points for their participation (those who did not receive points were not enrolled in the credit system and were attracted to the experiment by poster advertisements around campus). Relevant descriptive information of controls will be presented in the method section of each Experiment in the following Chapters.

4.11 Chapter summary

The present Chapter introduced the present work in a general fashion, providing a model of information processing derived from the literature on visual processing in normals, the general hypotheses to be investigated in each of the Experiments, and a description of the general orientation of the present work.

Second, the Chapter described the clinical variables and descriptive variables used in the present work. Broadly, these

included variables relating to the symptomatic state of the patient, their present level of thought disturbance, descriptor variables used previously in schizophrenia research (e.g., premorbid adjustment, medication levels, etc.).

In addition, the Chapter described the subject selection procedures along with the instruments used to assess the clinical state of the patients. The selection of subjects on the basis of the combined judgements of the treating psychiatrist and nurses proved to be successful as far as it detected people who reported themselves to have experienced psychotic symptoms associated with schizophrenia. Most of the patients can be described to be suffering from recurrent episodes of psychosis and to suffer a wide variety of pathological symptoms including 'neurotic' experiences. Patients presented with a picture of mixed Paranoid and Non-paranoid Syndromes of schizophrenia as measured by the Maine Scale. They were generally in the good premorbid functioning group as to be expected by the selection of subjects in the range of normal to above normal levels of intellectual functioning.

CHAPTER 5. THE EFFICIENCY OF ATTENTIONAL AND PREATTENTIVE VISUAL PROCESSING IN SCHIZOPHRENIA

The review of studies in Chapters 2 and 3 suggested abnormal visual processing in schizophrenia. However, it was unclear, from the review, why schizophrenics performed more poorly than controls on these tasks. A unifying concept was suggested to be a reduced ability of schizophrenics to achieve accurate figural synthesis. This notion would explain perceptual constancy disorders and it might also explain deviant eye-movement measures during input processing tasks. Studies concerned with the level of processing at which a dysfunction ought to occur, although not conclusive, have accumulated considerable evidence for the 'preattentive disorder' hypothesis. It appears from those studies that preattentive analysis might be the first processing level to be abnormal in schizophrenia. Subsequent processes depending on products from these early analyses might also be aberrant. This could explain distractibility phenomena in visual-processing tasks usually thought to be due to a reduction in 'attentional' efficiency in schizophrenia.

Several points will be argued in this Chapter. First, it will be shown that the adequacy of preattentive and attentional processing levels can be diagnosed by the types of errors an observer makes in the partial-report task. Secondly, if the processing levels are independent, they should be differentially responsive to variations of different parameters (e.g., luminance, stimulus onset asynchrony, processing load, etc.) of the visual event. This leads to the expectation that parametric variations, which influence either one or other of the processing levels, should be observable

through changes in the distributions of the types of report-errors that are diagnostic of the processing levels. Thirdly, if these above relations hold, then it should be possible to use analysis of report-errors to find out whether schizophrenics are disordered in preattentive, attentional, or both processing levels.

5.1 Types of errors in visual processing tasks

Two types of report-error are of concern in the present work - 'intrusion' errors and 'mislocation errors' (Butler, 1980, 1981; Butler & Currie, 1986; Irwin & Yeomans, 1986; Mewhort & Campbell, 1978; Styles & Allport, 1986). An intrusion error is the report of an unpresented letter in any particular trial. Generally, these are wrong 'guesses' of the target item made under a forced-response paradigm (e.g., Butler 1980, 1981; Irwin & Yeomans, 1986; Mewhort, Campbell, Marchetti & Campbell, 1981). Frequently intrusion errors tend to have similar physical features to the actual target (Townsend, 1971) suggesting that they are based on the reception of partial feature information from the target. A mislocation error, on the other hand, is a report of a letter which was presented but it was not the target. Since targets are letters indicated (usually) by a spatial cue, commonly presented before or after the onset of the stimulus display (e.g. Mewhort, et al., 1981), a 'mislocation' represents a confusion of items between the cued spatial location and another display location. When a mislocation is reported, it is as if the 'item-to-location' encoding (termed "localization", Butler, 1980, p. 119), has been inadequate while the stimulus was available prior to the arrival of the

mask. (An alternative explanation, that mislocations represent poor position processing of the spatial cue, is unlikely since mislocations have been demonstrated in the absence of direct spatial cueing (e.g. Prinzmetal & Millis-Wright, 1984; Treisman & Gelade, 1980). According to a number of analyses (Butler, 1980, 1981; Butler & Currie, 1986; Prinzmetal & Millis-Wright, 1984; Treisman & Gelade, 1980; Treisman & Schmidt, 1982) the incidence of mislocations depends on the direction and distribution of visual attention. Item-to-location encoding appears to be a general function of visual attention for the purpose of creating an accurate representation of the visual event (Butler & Currie, 1986; Rock & Gutman, 1981; Styles & Allport, 1986; Treisman, 1977; Treisman & Gelade, 1980). This will be discussed further below.

5.2 Intrusion errors are diagnostic of the adequacy of early processing of the visual stimulus.

Intrusion errors are considered to result from inadequate 'registration' and 'integration' of single information 'units' (e.g. letters, shapes). For items comprised of 'highly-learned' combinations of features both processes of 'registration' and 'integration' are relatively automatic (LaBerge, 1973, 1981; Prinzmetal & Millis-Wright, 1984), compared with the localization process (Butler, 1980, 1981; Butler & Morrison, 1984; Treisman & Gelade, 1980; Treisman & Souther, 1986; although some processing 'effort' seems to be expended, as is suggested by Paap & Ogden (1981) and by some of the results in Butler (1980, 1981)). LaBerge (1973), for example, observed that familiar and unfamiliar stimuli made different attentional-processing demands and that

with training, subjects learnt to respond to 'unfamiliar' shapes as rapidly as the 'familiar' ones under conditions where they did not expect to be presented with the particular stimulus. LaBerge (1973) concluded that familiar patterns must be organised as 'units' in perception whereas unfamiliar (and untrained) stimuli 'draw' processing 'effort' to the level of their features. 'Training' appears to serve the function of 'chunking' information, perhaps by setting up a 'perceptual readiness' for certain feature combinations (Dykes & Pascal, 1981; LaBerge, 1973, 1981; Prinzmetal & Millis-Wright, 1984; Regan, 1981). Preattentive grouping (Beck, 1966, 1967; Beck & Ambler, 1972, 1973; Olson & Attneave, 1970) and organization (Banks & Prinzmetal, 1976; Prinzmetal & Banks, 1977) of single letters, in an otherwise distinct background, may also subserve the automatic 'knowledge' of an item's identity by drawing attentional processing to 'objects' rather than their component features (Hoffman, 1980; Navon, 1977; Paquet & Merikle, 1984; Ward, 1982).

Consistent with the notion that intrusions represent processing failures at the preattentive-processing level are the following results:

1. reductions in display luminance (Butler, 1981, Treisman & Gelade, 1980) and/or the introduction of a random-noise mask (Butler, 1981; Mewhort & Campbell, 1978; Mewhort et al., 1981) reduce identification accuracy by increasing intrusion errors. Intrusion errors are more frequent at short 'stimulus onset asynchronies' (termed here the 'effective stimulus duration');

2. attentional direction and distribution, as indicated in comparing the effects of variations in 'physical' or 'functional' display sizes (Butler, 1980, 1981), play little role in the incidence of intrusion errors;
3. the incidence of intrusion errors is greater toward the periphery of fixation in selective masking experiments which used rows of letters as stimuli (e.g., Mewhort & Campbell, 1978), as would be expected from reduced acuity limiting the data registration process;
4. delays in post-stimulus cueing reduce accuracy but have little effect on the incidence of intrusion errors (Mewhort, et al., 1981). Pre-cueing also has little effect on the rate of intrusion errors compared with post-cueing conditions (Butler, 1981);
5. letter frequency information, in tasks utilising letter sequences of varying approximations to English orthography, reduces the incidence of intrusion errors rather than mislocations (Campbell & Mewhort, 1980; Mewhort et al., 1981; Mewhort & Campbell, 1981) suggesting a familiarity effect at the level of item registration and integration.

To summarise, the rate of intrusion errors is affected by retinal acuity, luminance, the effective stimulus-duration and stimulus frequency. The first three parameters limit the integrity of the stimulus representation entering the processing system (termed "data-limits", Butler, 1980, 1981; Norman & Bobrow, 1975, 1976; Treisman & Gelade, 1980) whereas stimulus frequency might influence the 'readiness' for one perceptual interpretation as opposed to another (see esp. Dykes & Pascal, 1981).

5.3 Mislocation errors are diagnostic of the adequacy of attentional item-to-location conjunction

Rock and Gutman (1981) investigated the effect of selective attention on subsequent recognition using overlapping figures as stimuli. They observed that recognition of whole figures was much poorer for the unattended than the attended figures. However, in contrast to the poor performance on whole-figure recognition, Rock and Gutman found that subjects could recall many of the stimulus properties of the unattended figure (e.g. curvature, type of contour, size). These results suggested that attention integrates stimulus properties to form 'perceptual objects':

"phenomenal shape entails an apprehension by the observer of exact spatial interrelationships of the parts of the figure to one another and of the relationships of these parts to the up-down, left-right spatial coordinates. It is this apprehension that requires higher level processing culminating in a cognitive description of the specific shape of the figure as a unique, organized whole."

(Rock & Gutman, 1981, p. 282).

Similar conclusions were drawn by Treisman and Gelade (1980) who regarded item-to-location conjunction as a special case of the general integrative function of attention:

"... the identity of features can be registered not only without attention but also without any spatial information about their location. The results suggest that focused attention may be necessary not only to ensure correct identification of conjunctions, but also to localize single features accurately. Feature localization is in fact a special kind of conjunction task - a conjunction of feature and spatial location - and our findings suggest that feature-location conjunctions may require the same conditions for accurate perception as seem necessary for conjunctions of other features."

(Treisman & Gelade, 1980, p. 130).

The following results of investigations of mislocation errors support the above view of the function of visual attention:

1. visual search for a target that shares features with noise items, such that noise items have features that, if mislocated, can form a representation of the target (conjunction condition), is slower than visual search in conditions where noise items cannot form the target (dysjunction condition). This is the case even when target-noise similarity is matched for the two background-noise conditions (Treisman & Gelade, 1980);
2. in tachistoscopic presentation, the probability of identifying an item is higher than the probability of locating the target if the item is presented in a dysjunction environment. In a conjunction environment this is not the case suggesting that the subject must locate the target before above-chance identification occurs (Butler, 1980, 1981; Treisman & Gelade, 1980; Treisman & Schmidt, 1982);
3. if attention is diverted by a concurrent visual task subjects experience perceptual illusions comprised of conjunction errors among the various properties of the stimulus items (Prinzmetal & Millis-Wright, 1984; Treisman & Schmidt, 1982; Treisman & Souther, 1986);
4. if attention is divided between a number of items the rate of mislocations increases in direct proportion to the number of items that the subject must attend to (i.e., a display-load effect, Butler, 1980, 1981). In fact, the display-load effect is only limited to items to-be-attended; additional items do not seem to have a pronounced influence on

mislocation errors (Butler, 1981);

5. if attention can be focussed, then the chances of mislocating an item to the target position is reduced from unfocussed conditions. This is usually observed as the advantage in performance in pre-stimulus cueing conditions over post-stimulus cueing conditions (Butler, 1980, 1981; Treisman & Gelade, 1980);

6. perceptual grouping contains the transposition of features within groupings rather than between groupings (Prinzmetal, 1981) suggesting that attention is directed to perceptual objects defined by similarity grouping and that, as predicted by Treisman and Gelade (1980), mislocations are most likely to occur within and outside the attentional 'spotlight' but not across its boundary;

7. familiarity of the information may also influence mislocation errors as suggested by a number of theorists (e.g. Butler & Morrison, 1984; Prinzmetal & Millis-Wright, 1984; Treisman & Gelade, 1980), however, evidence for this effect is variable (c.f. McLelland & Mozer, 1986 and Treisman & Souther, 1986). (The familiarity issue will be examined in Chapter 7);

8. reductions in the effective stimulus-duration with the addition of a masking stimulus has a relatively smaller effect on mislocation errors than on intrusion errors.

In summary, mislocation errors are produced during the misdirection of visual attention or by the division of attention over a number of objects that must be searched for the target. Spatial cueing or other, less direct, means of reducing the range of items to be searched (e.g. by the provision of opportunity for perceptual grouping) reduces the

rate of mislocation errors in comparison with non-cued conditions. The influence of the 'functional' display load on performance is to set limits on attentional processing (termed "resource limits", Butler, 1981; Norman & Bobrow, 1975, 1976). Attentional limits are present on the ability to encode multiple objects with reference to their correct spatial positions; only smaller effects on intrusion errors, by the misdirection of attention are observable, relative to mislocation errors (Butler, 1980, 1981; Mewhort et al., 1981).

5.4 EXPERIMENT 1: Intrusions and Mislocations in target reports of schizophrenics.

In the first Experiment letter displays of various sizes were presented at various stimulus durations. A target letter was indicated by a spatial cue. Subjects' reports were analysed in terms of 'correct identifications', intrusions and mislocations. Two cueing conditions were presented: pre-stimulus cueing and post-stimulus cueing. In the first cueing condition the spatial cue was available prior to the onset of the letter display allowing for attention to be focussed upon the target position. This condition (termed 'Focused Attention' Condition) allowed the examination of processing efficiency in the presence of distractor stimuli when selection strategy was provided by the experimenter. In the post-stimulus cueing condition the subject attended to the stimulus display first and at its offset the target-position cue was presented. In this condition (termed the 'Divided Attention' Condition), performance was expected to depend on the subject's own selection strategy and in the ability to process multiple, concurrent, sources of information.

Since the experiment was derived from Butler's (1980, 1981) work, the results were expected to replicate his effects of effective stimulus duration and display-size on performance. That is, reductions in the effective stimulus-duration were expected to result in a reduction of report accuracy and in a concomitant increase in intrusion errors. Mislocations were not expected to be influenced by duration. Secondly, increases in display-size were expected to reduce accuracy of report and to increase the rate of mislocation errors. Display-size was not expected to have any significant influence on the rate of intrusion errors. Moreover, the Focused Attention Condition, compared with the Divided Attention Condition, was expected to improve accuracy of report and, in particular, to reduce mislocation errors. This prediction was investigated by comparing the two cueing conditions in terms of a difference score (e.g. Focused Attention minus Divided Attention) termed the Pre-cueing Advantage Score (various scores were calculated for accuracy and error types).

Generally, there were two hypotheses about schizophrenics' processing dysfunction. If schizophrenics are disordered at the preattentive level, then the basic input to the processing system is expected to differ from controls. This should lead to a greater rate of intrusion errors compared with controls. Moreover, reductions in the effective stimulus-duration should increase intrusion errors in schizophrenics more than controls. This would be consistent with the Saccuzzo conclusions of an abnormal masking vulnerability in schizophrenia. If, on the other hand,

schizophrenics are disordered at the level of item-to-location conjunction, as predicted from an attentional dysfunction hypothesis, then schizophrenics should make more mislocation errors than controls and that display-size should lead to greater reductions in accuracy in schizophrenics compared with controls. Furthermore, a comparison of the Pre-cueing Advantage Score should give an indication whether processing under experimenter- or subject-directed selection strategy differs in schizophrenia. Since error analysis has indicated an increase in mislocations in the Divided Attention Condition compared with the Focused Attention Condition (Butler, 1981), it was expected, from an attentional deficit hypothesis, that schizophrenics would show a greater Pre-cueing Advantage Score than controls for the accuracy measure. Moreover, this should be reflected in a greater incidence of mislocation errors in the Divided Attention Condition than in the Focused Attention Condition for schizophrenics compared with controls.

In this experiment the probability of a target occurring was held constant over the display positions. Similarly the probability of a display position being occupied by a letter was held constant over any block of stimuli. This allowed an analysis of the distribution of errors over the display positions and an assessment of whether or not selection strategy differs in schizophrenia. For example, it is possible that schizophrenics would select accurately only in the central fixation position because of reduced scanning (recall, Chapter 2). On the other hand, it is possible that schizophrenics would select information more randomly than controls over the display positions.

Finally, correlational analysis of accuracy and the

TABLE 5.1 Means and standard deviations of the descriptive data.

	CONTROLS		SCHIZOPHRENICS	
	mean	s.d.	mean	s.d.
AGE	26.2	4.9	30.0	7.4
VOCAB.	12.1	1.3	11.1	2.3
PROVERBS *	38.1	5.1	24.8	11.1

* Significant diff.
p < 0.01 (two-tailed)

clinical variables was conducted to assess whether any particular dimensions of schizophrenia were associated with poor performance. Briefly, it might be expected that pathology variables would show negative correlations with performance. These variables included indices of both current and past psychosis. Dosage of medication might lead to poorer performance resulting from, for example, sedation side-effects (Hirsch, 1982). On the other hand, Braff and Saccuzzo (1982) found positive correlations of medication and accuracy in a similar tachistoscopic task and they suggested that medication might have a positive influence on information processing.

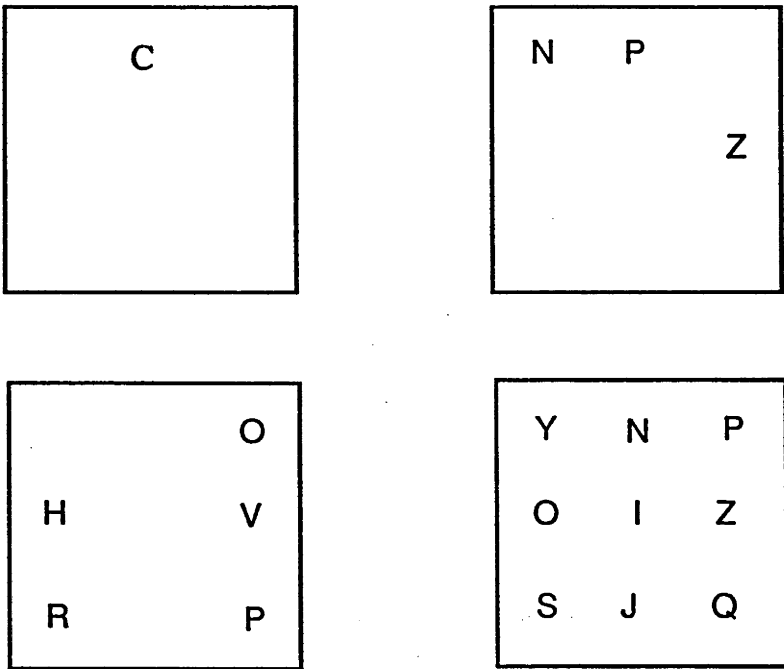
5.41

METHOD

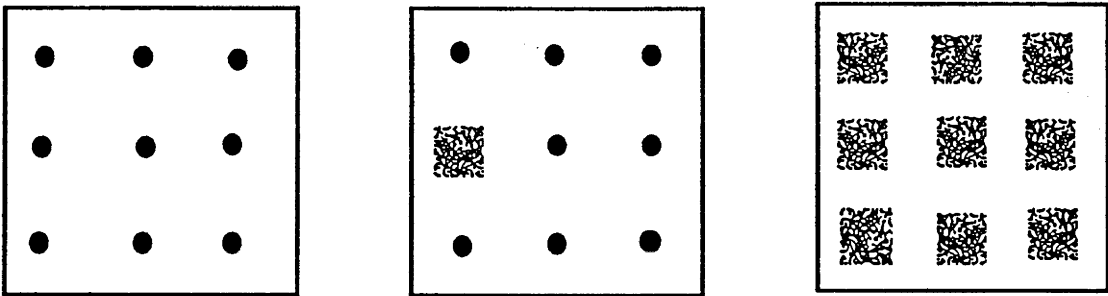
Subjects

Ten schizophrenics and ten controls served as subjects in the experiment. Details of the selection criteria, procedure of selection and mean scores on the clinical variables were presented in the previous chapter. Table 5.1 summarises the biographical information common to the two groups. Mean age and scores on the Vocabulary subscale of the Weschler Adult Intelligence Scale did not differ between the groups. As to be expected, schizophrenics had significantly lower scores on the Proverbs Test than controls ($t(18) = 3.44$, $p < 0.01$), suggesting a reduced tendency to think abstractly. This is consistent with the idea that at least some of the schizophrenics in the sample were experiencing psychosis at the time of testing. The groups were matched on sex (5 of each sex in each group).

FIGURE 5.1 : Examples of stimulus, masking, and pre-stimulus displays.



STIMULUS DISPLAYS



**PRE-STIMULUS AND MASKING
DISPLAYS**

Apparatus and Materials

Three kinds of display were constructed: stimulus displays; mask displays; and, pre-stimulus displays. Examples of these are reproduced in Figure 5.1.

Stimulus displays consisted of a square frame containing letters in a 3 by 3 square matrix. Displays contained 1, 3, 5, or 9 letters selected at random from the alphabet without replacement (i.e., no letter was repeated in a display). Letters were black capitals (Letraset, 24 point, Helvetica light) of approximately 7 mm in height and 6 mm in width. The distance between any two neighbouring letters was approximately 15 mm. Two Blocks of 40 letters (ten examples of each display-size) were prepared. Twelve additional displays were used as Practice displays. For each Block an attempt was made to equate the probability of a letter appearing in the nine display positions. Figure 5.2 indicates the frequency of a letter occurring in a particular position for each Block as presented in the experiment.

Masking displays were of the following two types:

1. complex masks: these acted both to mask and cue the subject with reference to the target letter (see Figure 5.1). These comprised a square frame, eight black dots (diameter 3 mm) and a 12 by 12 mm square of 'visual noise'. Dots and masking square were arranged in the 3 by 3 matrix positions corresponding with the letter positions. Visual noise consisted of a random dot pattern photocopied from Gregory (1966, p. 59). The probability that a position was cued was approximately equal over the display positions. Figure 5.3 shows the frequency that each display position was cued in each Block of trials.

FIGURE 5.2 : The frequency of occurrence of letters in the display positions for each stimulus block.

BLOCK 1			BLOCK 2		
20	20	19	20	19	21
21	21	19	21	19	21
20	20	19	20	19	20

FIGURE 5.3: The frequency occurrence of cues in the display positions for both stimulus blocks.

5	4	5
4	4	4
5	4	5

2. simple masks: these consisted of nine visual noise squares arranged in the 3 by 3 matrix in the corresponding letter positions.

The pre-stimulus displays consisted of a 3 by 3 matrix of black dots, again, superimposed on the letter positions.

All displays were prepared on white paper and then photographed. The negatives were mounted onto slides and were used as the actual displays for the experiment. These slides were projected onto a back-projection screen which was covered with black cardboard except for a centred, square, fixation-region (80 by 80 mm). Three projectors were arranged with transparent mirrors so that all three projected the stimuli onto the fixation region. Depending on the experimental condition, one projector contained either the pre-stimulus displays or the cue displays. The other projector contained the letter displays. Again depending on the experimental condition, the last projector contained either the cue displays or the 'simple mask' displays. That is, when the pre-stimulus display was shown in the first projector the third projector contained the cue displays (i.e., Divided Attention Condition). When the first projector contained the cue displays the third projector contained the 'simple mask' displays (i.e. Focused Attention Condition). All displays were projected so that the frame of each display subtended an approximate visual angle of 2.34 degrees at a viewing distance of approximately 110 cm.

Relative luminances of the displays were regulated by placing darkened filters in front of a projector. The average luminance for the letter displays was 15 cd/m² (averaged over

several estimates on the five letter display), for the pre-stimulus display, 18 cd/m², and for the mask displays, the luminance of each visual noise square was 34 cd/m². When a mask and the letters were projected in a superimposed manner the letter was not readily apparent from the visual noise under normal viewing conditions. The stimulus duration of the displays was controlled by fitting each projector with a tachistoscopic shutter (Gebrands, Model G1166). Shutters were driven by a Gebrands 'digital integrated circuit' millisecond timer (300 series, Model G1176). Effective stimulus durations (50, 100, and 150 msec) were determined through prior pilot work in the University sample.

Procedure

The procedure was divided into three parts: instructions and familiarization; practice; and, testing. Each subject was introduced to the experimental room and familiarised with the testing equipment. The subject was asked to sit comfortably against the back of the chair and to refrain from moving. Each subject received instructions about the types of displays and the order of their presentation. The sequencing of the displays was demonstrated using, at first, long stimulus exposures and then with speeded exposures. The subject was instructed to fixate in the centre of the fixation region and to report only the letter which was indicated by the spatial cue. As in previous experiments (e.g. Butler, 1981) subjects were asked to give their best guess if they were not sure of an answer. The training instructions and procedure of instruction are detailed in Appendix 1.

After training subjects were given 10 practice trials of which the first few may have been repeated if the subject indicated a lack of understanding of the task. Following the practice trials the test trials were presented. The trials were interrupted in the middle of experiment by a three to five minute rest. After the rest subjects were re-instructed about the task since the first half of the experiment was of a different cueing condition to the second half. Practice was again given before the test trials.

Each trial was begun with a warning ("ready") and ended with the subject's report. Between trials the experimenter recorded the subject's response and advanced the projector carousels (for the cue and letter displays). Specific feedback was not given but the experimenter encouraged task-attendance periodically (e.g. "you are doing fine").

Half the subjects were started with the Divided Attention Condition and then proceeded with the Focussed Attention Condition. Within each condition the pairing of the stimulus Blocks with each of the three stimulus exposures was randomised over the subjects. The order of their presentation of the combinations of Blocks and stimulus exposures was also randomised over the subjects. Display-size was randomised within a stimulus Block.

Scoring

Two types of responses were given by subjects: a letter report and "don't know" responses. Despite instructions subjects responded with the latter responses rather than guessing at the targeted letter. "Don't know" responses were treated as extra-list intrusions since both types of responses

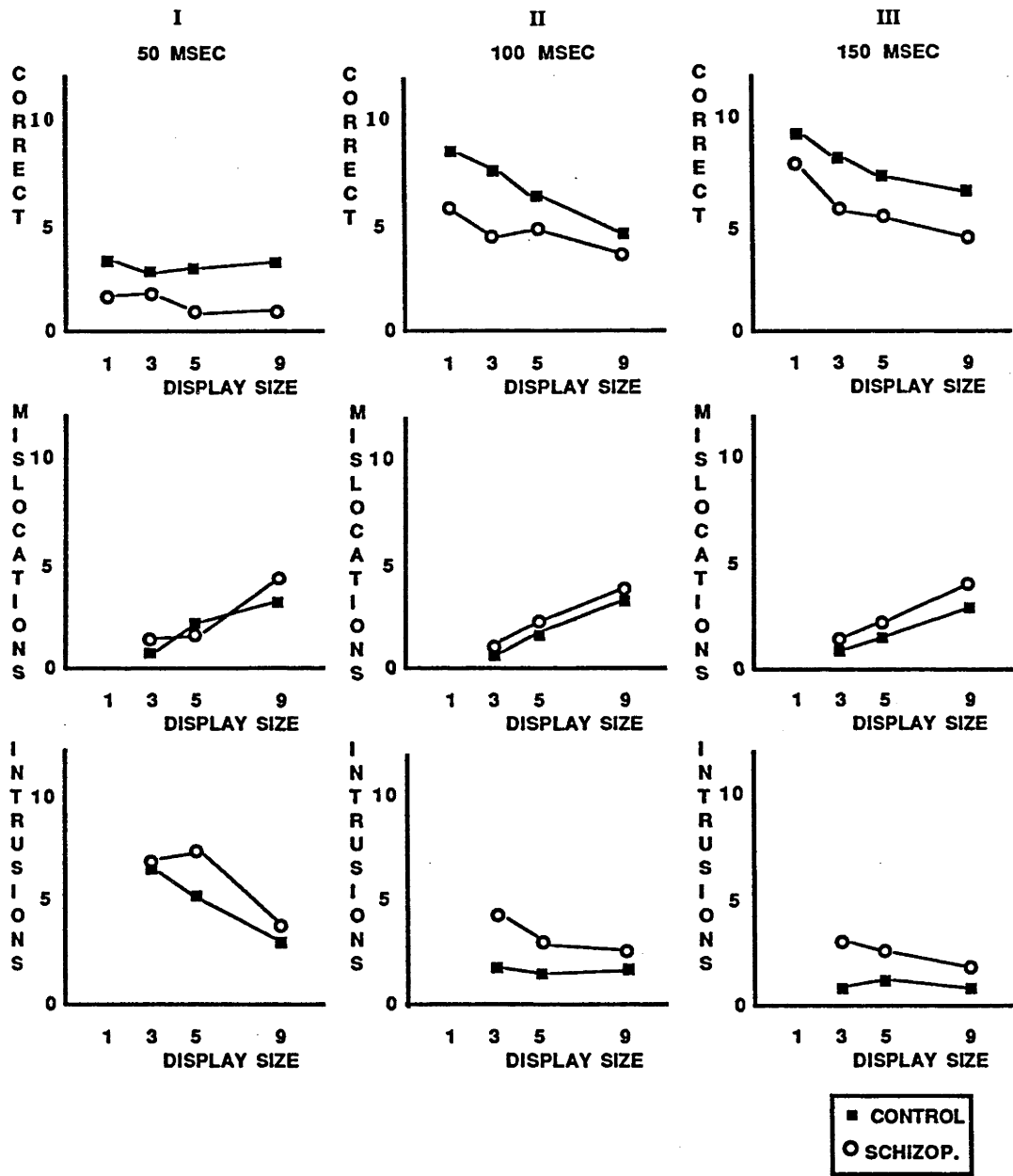


FIGURE 5.4: The distribution of correct responses, mislocations and intrusions, as a function of exposure duration (I, II and III) and display size (abscissa of each graph), in the Focused Attention Condition.

reflect the absence of appropriate information about the identity of the target. All reports then, were separated into 'correct responses', 'mislocation errors' and 'intrusion errors'. A subject's scores were simply the number of correct responses, mislocations and intrusions per condition.

As noted earlier, the scores were also analysed as a difference score between a subject's Focused Attention and Divided Attention performances (Pre-cueing Advantage Score) to assess the additional processing demands of the post-cueing condition.

Design and Analysis

There were two conditions: Focused and Divided Attention conditions. Separate analyses of variance were conducted for each condition and for each response-type. That is, each condition contained three analyses corresponding to the three response-types. The general design was a 'mixed' design (Keppel, 1973, p. 433) with two independent levels of the 'groups' factor and repeated-measures over the 'display-size' and the 'effective stimulus-duration' factors. For 'correct responses' the design was a 'groups' (two levels) by 'display-size' (four levels) by 'stimulus duration' (three levels). Analyses of errors were limited to the display sizes of 3, 5 and 9 letters since mislocations are not possible in the remaining displays.

5.42

RESULTS

Performance analysis

Figure 5.4 shows the results for the Focussed Attention Condition. The top panel in the figure indicates the accuracy of each group over the experimental conditions. The

distribution of errors for the corresponding conditions are indicated in the lower panels.

For 'correct responses', analysis of variance revealed significant main effects of 'groups' ($F(1,18) = 14.61$, $p < 0.01$), 'effective stimulus-duration' ($F(2,36) = 119.18$, $p < 0.001$), and 'display-size' ($F(3,54) = 24.45$, $p < 0.001$). A significant interaction was found between stimulus duration and display-size ($F(6,108) = 6.31$, $p < 0.001$). As is indicated in the top panel of Figure 5.4 the effect of display-size differs across the levels of the effective stimulus-duration. For example, the display-size effect is not evident in the 50 msec duration contrasting the other two duration conditions. Although the flat function of display-size and performance at 50 msec might reflect a 'floor effect' for the schizophrenics, this does not appear to be the case for controls who performed well above the level expected from pure guessing (guessing probability is expected to be $1/26$ based on the random selection of a letter from the alphabet).

None of the other two-way interactions were found to be significant but the three-way interaction, between groups, display-size and the effective stimulus duration, was significant ($F(6,108) = 2.58$, $p < 0.05$). Description of the three-way interaction was carried out using two-way analyses of variance for groups and display-size at the various levels of effective stimulus duration. These analyses indicated a significant interaction between groups and display-size only at the 100 msec duration ($F(3,54) = 3.59$, $p < 0.05$). Consistent with this, inspection of Figure 5.4 (top panel) suggests a faster rate of improvement in the performance of controls with

reductions display-size compared with schizophrenics. It should be noted a similar effect might have been found at 150 msec where the interaction might have been obscured by a 'ceiling effect' in the performance of controls.

Analysis of variance on the mislocations data indicated, as is obvious in Figure 5.4 (middle panel), a significant main effect of display-size ($F(2,36) = 37.98$, $p < 0.001$). Mislocations increased with display-size. No other significant effects were found. Similar analysis of variance for intrusion errors indicated results corresponding with the pattern of 'correct responses'. That is, the main effects for groups ($F(1,18) = 14.05$, $p < 0.01$), effective stimulus-duration ($F(2,36) = 174.90$, $p < 0.001$), and display-size were significant ($F(4,72) = 5.37$, $p < 0.001$). None of the two-way interactions were significant, but the three-way interaction of groups, effective stimulus-duration, and display-size was significant ($F(4,72) = 2.64$, $p < 0.05$). Further two-way analyses of variance of groups and display-size at each of the levels of stimulus duration did not indicate any significant effect. It should be noted that the 'trade-off' of mislocations and intrusions may have contributed to the interaction by reducing intrusion errors with increases in display-size. Analyses of the two-way interaction of groups and stimulus duration at each of the levels of display-size indicated a significant effect at display-size of 3 letters ($F(2,36) = 2.91$, $p < 0.05$). Inspection of Figure 5.4 (bottom panel) suggests that the interaction is due to a greater increase in the rate of intrusions of controls with decreasing stimulus duration, and particularly at the 3-letter display-size, compared with schizophrenics.

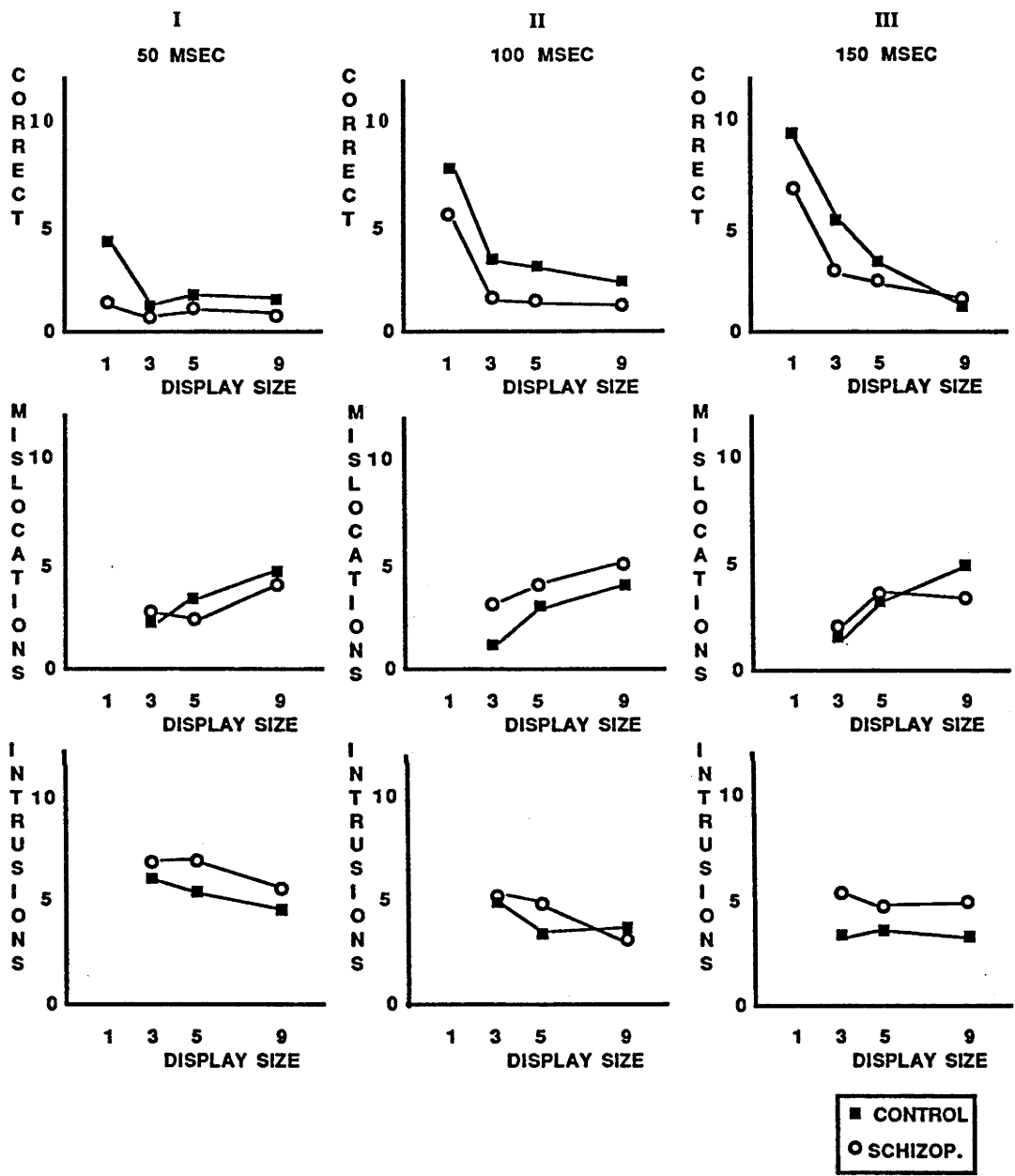


FIGURE 5.5: The distribution of correct responses, mislocations and intrusions, as a function of exposure duration (I, II and III) and display size (abscissa of each graph), in the Divided Attention Condition.

In summary, in the Focussed Attention Condition schizophrenics were found to report less information from the display than controls. The rate of mislocation errors was similar in the two groups and so the relative inaccuracy of schizophrenics was due to different rates of intrusions in the groups. The results suggest a faster rate of improvement in performance for controls than schizophrenics as the display-size is reduced and as the effective stimulus duration increases.

Figure 5.5 shows the performance measures for the Divided Attention Condition. In the top panel of the figure correct responses can be seen to reduce with increasing display-size and with decreasing effective stimulus duration. Schizophrenics performed more poorly than controls. Analyses of variance confirmed this description. Significant main effects of groups ($F(1,18) = 11.74$, $p < 0.01$), stimulus duration ($F(2,36) = 96.39$, $p < 0.001$), and display-size ($F(3,54) = 89.62$, $p < 0.001$) were found. The two-way interaction of stimulus duration and display-size was found to be significant ($F(6,108) = 13.09$, $p < 0.001$) but it is likely that a 'floor effect' on performance contributed to this finding. A significant interaction of groups and display-size was found ($F(3,54) = 4.59$, $p < 0.01$) and inspection of the top panel of Figure 5.5 suggests that controls improved more than schizophrenics with display-size reduction.

Analysis of mislocation errors indicated a significant display-size effect ($F(2,36) = 23.83$, $p < 0.001$). The interaction of groups and stimulus duration was also found to be significant ($F(2,36) = 4.06$, $p < 0.05$). Inspection of the

middle panel of Figure 5.5 suggests that schizophrenics made more mislocation errors at 100 msec stimulus duration than controls, compared with the other duration conditions. However, two-way analyses of variance of groups and display-size at each stimulus duration indicated only that the interaction of groups and display-size approached significance within the 150 msec duration condition ($F(2,36) = 2.92$, $0.05 < p < 0.1$). This is apparent in Figure 5.5 (middle panel), in the 150 msec duration, as a faster rise in mislocation errors for controls as the display-size increases. (Of course, display-size main effects were significant at each of the duration levels.) Intrusion errors, shown in the bottom panel of Figure 5.5, were found to increase significantly with reductions in stimulus duration ($F(2,36) = 16.38$, $p < 0.001$) and to reduce significantly with increases in display-size ($F(2,36) = 5.46$, $p < 0.01$). As in the Focused Attention Condition the latter effect is likely to be due to the 'trade-off' of mislocations and intrusions. No other effects were found to be significant.

In summary, the results for the Divided Attention Condition confirm the finding that controls improve in performance much more rapidly than schizophrenics with reductions in display-size and increases in the effective stimulus duration. In this condition, however, there was no indication that schizophrenics made more intrusion errors than controls. Again, mislocation errors were not found to be more frequent in the performance of schizophrenics. In fact, there was a slight tendency for controls to increase in mislocation errors at a greater rate than schizophrenics with increases in display-size. However, this was only apparent in the 150 msec

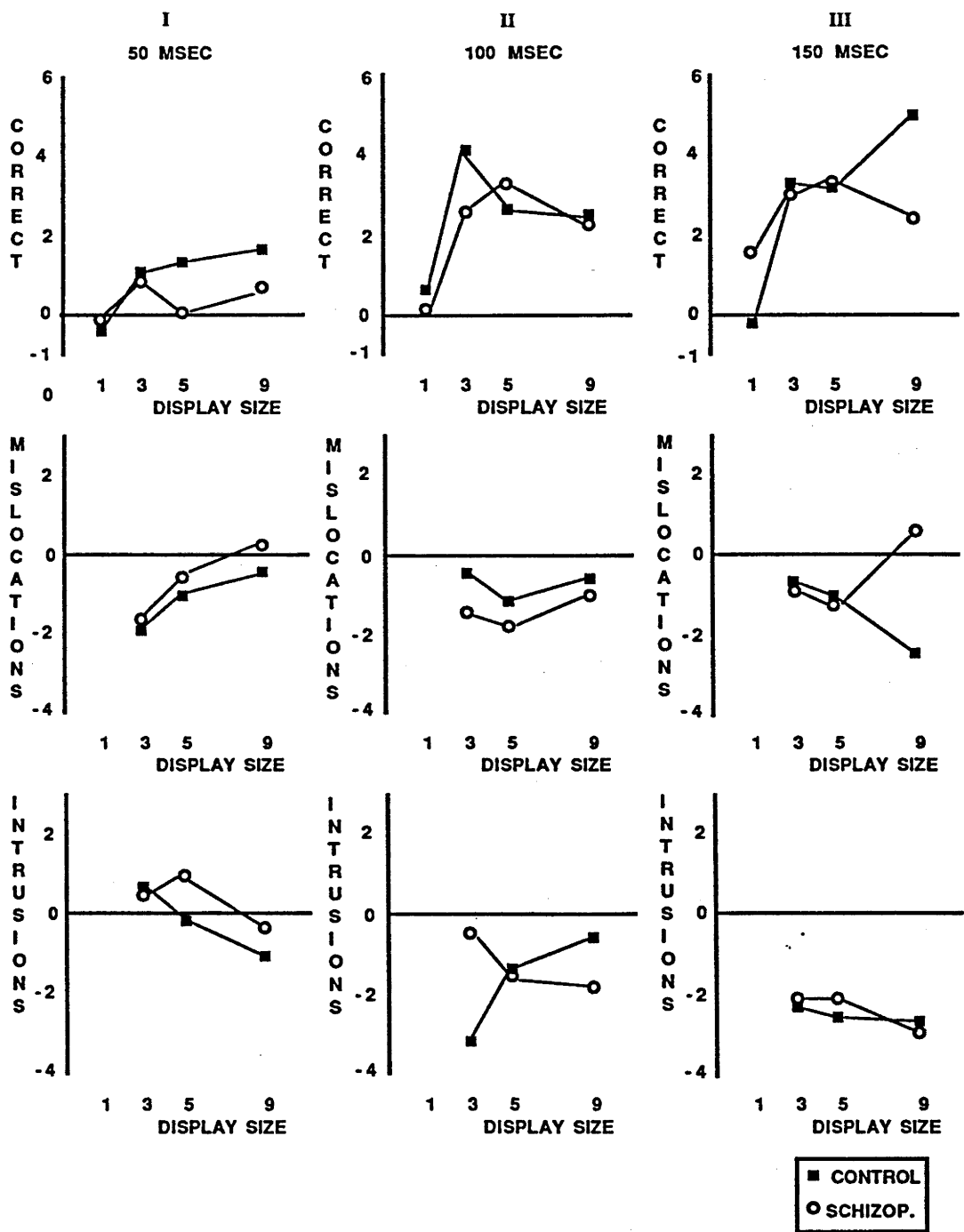


FIGURE 5.6: The distribution of Pre-cueing Advantage Scores for correct responses, mislocations and intrusions, as a function of exposure duration (I, II and III) and display size (abscissa of each graph).

duration condition and the result did not attain the 0.05 level of significance.

Next, the analysis of performance concentrated on the Pre-cueing Advantage Scores. These appear, for each response type, in Figure 5.6. In the top panel of the figure a positive score indicates better performance in the Focused Attention Condition than in the Divided Attention Condition whereas in the lower panels positive scores indicate poorer performance. First, it is apparent in the top panel that Focussed Attention improves performance over Divided Attention since the scores are generally positive. It is also apparent that the improvement increases with increasing duration and display-size. There are no apparent differences between the Pre-cueing Advantage Scores of the two groups. This description was confirmed with analysis of variance. Only, significant effects of display-size $F(3,54) = 16.41, p < 0.001$ and stimulus duration ($F(3,54) = 15.36, p < 0.001$) were found.

In the analysis of Precueing Advantage Scores for mislocations no significant effects were found at the 0.05 level. As can be seen in Figure 5.6, however, there is a tendency for these errors to be more frequent in the Divided Attention Condition than in the Focused Attention Condition. Similar analysis for intrusion errors indicated a significant stimulus duration effect ($F(2,36) = 21.54, p < 0.001$). In Figure 5.6 (bottom panel) this effect appears to be a reduction of intrusions in the Focussed Attention Condition compared with the Divided Attention Condition as the stimulus duration increases. In summary, analysis of the Pre-cueing Advantage Scores did not indicate any differences between the two groups. It was verified that focused attention reduces

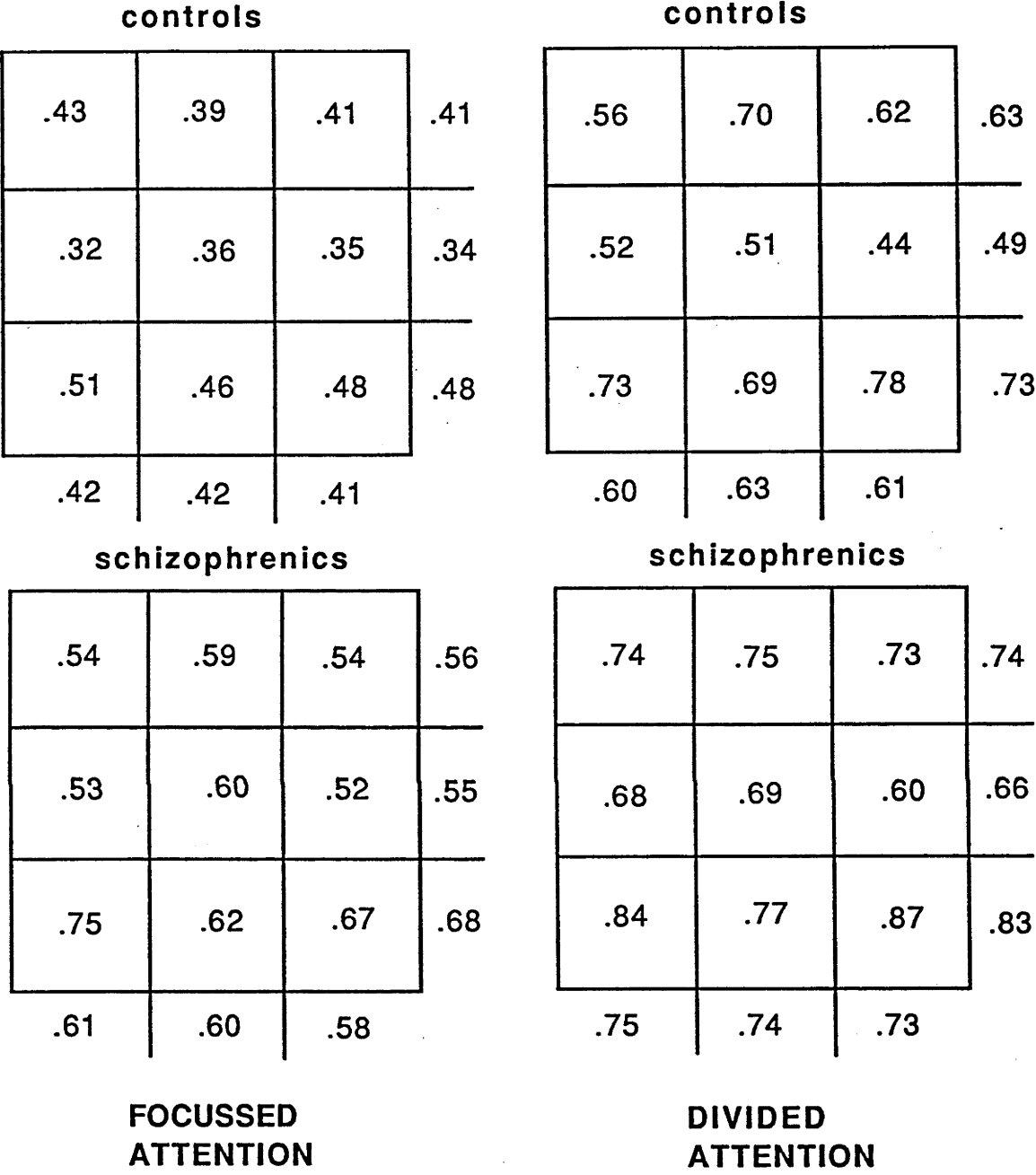


FIGURE 5.7 : Error probability mapped onto the display positions (collapsed over stimulus onset asynchrony and display size).

mislocations generally and reduces intrusions only at long effective stimulus durations, compared with distributed attention.

The final analysis of performance was conducted on the error distribution over the various display-positions for each group. The various error probabilities were mapped onto the positions where targets appeared and this is represented in Figure 5.7. The two figures on the left represent the results for the Focused Attention Condition while the two on the right are for the Divided Attention Condition. Marginal means of the error probabilities are also presented with the figures. In all figures the horizontal marginal means appear to be relatively constant for both groups. The vertical marginal means show a tendency for greatest accuracy for the central positions, followed by the top positions and poorest accuracy in the lowest positions. This pattern is indicated in both groups. The results suggest similar attentional distribution during the task for the groups.

Correlational Analysis

For the purposes of the correlation analysis a total score for each subject was derived under each attention condition as well as a sum score for the two conditions. Spearman correlations were conducted between these scores and the clinical variables. The results are presented in Table 5.2. There were two main findings. First, as is indicated in the figure, medication was found to be correlated with the 'total correct' score and particularly with performance in the Focused Attention Condition. The result indicates better performance in patients with higher doses of neuroleptic

TABLE 5.2: Correlations of letter identification performance in the two attention conditions and total score with the clinical variables.

	Focused Attention	Divided Attention	Total Correct
Age	.07	-.28	-.11
Voc IQ	.19	.01	.11
Hosp/Age	-.23	-.08	-.13
Medication	.74 **	.54	.70 **
Maine Paranoia	-.02	-.28	-.21
Maine Non-Par.	.07	-.31	-.10
Proverbs	-.17	.29	.05
Lovibond	.29	-.14	.18
Dysth. States	.33	-.06	.22
Neurotic Sym.	.37	-.30	.13
Integ. Delusions	.56 *	.00	.40
Disin. Delus.	.48	-.07	.30

One-tailed signif. levels, (N=10)

* $p < 0.05$

** $p < 0.025$

medication compared with those on lower doses. The second finding was a correlation between symptom severity in the DSSI illness-class of Integrated Delusions and performance in the Focused Attention Condition. This result suggests that those patients reporting these experiences performed better than those patients who did not report such experiences.

5.43

DISCUSSION

The experiment was successful in replicating previous findings that mislocations increase with increases in display-size and intrusions increase with reductions in the effective stimulus duration. However, the display-load effect on mislocations was evident in both of the attention conditions suggesting a distractibility effect in the Focused Attention Condition. This is inconsistent with Butler's (1981) 'functional load' effect since in the present experiment the functional load was always one letter. Nevertheless, in the Divided Attention Condition there was a general increase in mislocation errors over the Focussed Attention condition confirming previous observations (Butler, 1981). Intrusion errors were found to increase with reductions in the 'stimulus onset asynchrony' in both attention conditions. Moreover, focusing attention reduced intrusion errors, given sufficient stimulus duration, compared with the Divided Attention Condition. Thus it appears that in the present experiment stimulus integration at the level of letters was dependent both on the distribution of visual attention (consistent with Paap & Ogden, 1981) and on the effective stimulus duration (Butler, 1980, 1981).

Comparisons of schizophrenics and controls in both

attention conditions confirmed previous findings (reviewed in Chapter 3) of poorer tachistoscopic letter-detection in the patients. However, in both attention conditions there was no evidence to suggest that the relatively poor performance of schizophrenics was due to poor item-to-location encoding, as would be expected from the attentional deficit hypothesis. Moreover, in comparisons of the two attention conditions, it was expected, from the attentional deficit hypothesis, that distributing attention over a number of items would increase mislocations in schizophrenics more so than controls. This was not found.

In the Focused Attention Condition, some evidence for the preattentive deficit hypothesis was found in that schizophrenics made more intrusion errors than controls. Confirming evidence for the hypothesis would have been if schizophrenics increased in intrusion errors more so than controls with reductions in the stimulus duration. However, this effect was not evident in the results. Furthermore, the rate of intrusion errors was not different between groups in the Divided Attention Condition. In this condition reduction in accuracy was apparently due to a 'trade-off' between intrusions and mislocations which varied unsystematically across the experimental conditions.

In summary, although the experiment proved successful in demonstrating previously discovered effects of display-load and effective stimulus-duration in regulating partial-report performance, the level of processing dysfunction in schizophrenics still remains unclear. Only some of the predictions of the preattentive-dysfunction hypothesis but none of the predictions of the attentional-dysfunction

hypothesis were supported. Furthermore, group differences could not be attributed to different patterns in the distribution of visual attention during the task since the error-probabilities across the display positions showed similar patterns for the groups.

Explanation of the general performance difference between the groups might be sought outside the processing model. For example, schizophrenics might have been more reluctant to guess the target than controls, or they may have not attended to as many trials as controls over the duration of the experiment (i.e., reduction in vigilance). Both these non-processing explanations would partly predict the observed pattern of results since they predict more intrusion errors for schizophrenics. To investigate these hypotheses the results were rescored according to the number of "don't know" intrusions and letter-report intrusions. The rescoring (collapsed over the attention conditions) indicated that for schizophrenics 51 percent of intrusions were "don't know" responses whereas 40 percent were similar responses for controls. However, since the intrusions were found to differ between the groups in the Focused Attention Condition, rescoring limited to this condition indicated "don't know" responses accounted for 46 percent of intrusions for schizophrenics and 42 percent for controls. These rates appear to be comparable and do not explain the rate of intrusions differing between groups in the Focused Attention Condition.

In the correlation analysis it was found that medication correlated with letter-identification performance and particularly with performance in the Focused Attention

Condition. The result is consistent with Braff and Saccuzzo's (1982) finding suggesting that neuroleptic medication 'normalises' perceptual processing. On the other hand, patients on higher levels of medication might have been more psychotic than those on lower levels and this would suggest that better performance is associated with psychosis. Unfortunately, measures sensitive to psychosis in the present study, such as the Lovibond Object Sorting Test and Proverbs Test, did not correlate with performance so that it is difficult to interpret the medication result. Consistent with the 'illness-better performance' association is the finding of a correlation between Integrated Delusions and performance. This can be explained by assuming that those who reported more symptoms were also less psychotic at the time of testing and therefore provided better performance on the partial-report task. However, it will be recalled from the previous Chapter (Table 4.5) that a positive correlation was found between Integrated Delusions and the Lovibond Sorting Test suggesting that those reporting more of these symptoms were also characterised by 'over-inclusive' thinking at the time of testing. Given the present sample-size the issue of medication effects is best left to a larger study. Suffice it to say here that medication was not responsible for the poorer performance of schizophrenic group on the task relative to controls.

CHAPTER 6. PREATTENTIVE GROUPING IN SCHIZOPHRENIA

The previous Chapter provided some support for the preattentive deficit hypothesis. However, although schizophrenics reported more intrusion errors than controls during the partial-report task, their rate of intrusions did not surpass that of controls with reductions in the stimulus onset asynchrony. In this Chapter the preattentive deficit hypothesis will be re-examined with an investigation of perceptual grouping in schizophrenia.

6.1 Physical attributes, similarity grouping and selection

Beck (1962, 1966, 1967, 1972; Beck and Ambler, 1972, 1973) suggested that preattentive processing operates to group together 'similar' objects that might be dispersed throughout the visual field. Perceptual segregation of regions in the visual field appears to depend on "simple" (Beck, 1982, p. 287) or "separable" (Garner & Felfoldy, 1970, p. 225) stimulus properties such as brightness, colour, and orientation. Such attributes of stimuli "not only give strong similarity grouping but also underlie the primary segregation of a visual field into regions of uniform visual texture" (Beck, 1972, p. 15). Olson and Attneave (1970) suggested that the process of grouping by similarity resembles an 'analysis of variance' procedure. If the variance (i.e., the physical difference) of objects between two regions of the visual field is smaller than the variance within the regions, then the two regions are grouped into one region. If the 'between' region variance exceeds the 'within' region variance then the visual field becomes perceptually segregated.

Von Wright (1968, 1970, 1972), using the partial-report

task, showed that 'simple' attributes of stimuli are effective cues for the selection of information from the display. Von Wright (1968) showed that location, colour, brightness and size differences, among the elements of the display, are all effective as partial report cues, suggesting that the analysis of these attributes might be carried out earlier than the selection process itself. In contrast, selection by categories (letters versus numbers, consonants versus vowels, and letters versus their mirror images) is less effective than by physical attributes (Sperling, 1960 ; Von Wright, 1970).

Harms and Bundensen (1983) investigating the effect of segregation by colour (see also, Carter, 1982; Farmer & Taylor, 1980; Wolford and Chambers, 1983) suggested that perceptual segregation improves selection from the display rather than enhances performance through 'other' factors. These 'other' factors might be, for example, an overall increase in the rate of segregation of the display items. It is also possible that changing the colour of some items may remove lateral masking effects and hence improve target detection. Consonant with their suggestion, Harms and Bundensen's results showed that when attention was divided during the task among a number of display-locations subjects did not gain from colour cueing. In contrast colour cueing improved performance when attention could be focused.

To summarise, perceptual segregation of a display occurs on the basis of the detection of similarity or difference in the physical attributes of the objects. Presenting displays containing objects with globally distinct features can aid in the selection of particular items. Perceptual segregation of a display allows the subjects to focus attention more precisely

on items.

6.2 EXPERIMENT 2: Perceptual segregation by colour and visual search in schizophrenics

In this Experiment visual search of schizophrenics was compared with normal controls' using a card-sorting task. In some conditions visual search could be aided by colour cueing compared to the condition where there was no colour-cueing. It was expected that the greater the number of noise items in the display that shared the target's colour the less the ability of the subject to localise the target from the processes of early perceptual segregation and organization, and consequently, there would be a greater requirement for serial, attentional processing of the items (Farmer & Taylor, 1980).

If schizophrenics have a deficit at the level of preattentive analysis then it was expected that serial search would occur in all conditions - colour cueing should not improve performance. In contrast, the performance of controls was expected to improve with colour cueing and their performance was expected to show a serial decrease in sorting time as the number of display elements having the target's colour was decreased. Schizophrenics, if they are unable to utilise, or they 'prefer' not to utilise information that is available from preattentive analysis, were expected to show a flat sorting time function across the conditions, approximating the sorting time of the condition lacking colour cues.

Since total card sorting time involves processing time for response selection and motor movement, along with the

TABLE 6.1 : Means and standard deviations of the descriptive data.

	CONTROLS		SCHIZOPHRENICS	
	mean	s.d.	mean	s.d.
AGE*	24.5	3.1	29.4	6.4
VOCAB.	12.5	1.7	11.7	2.2
PROVERBS**	41.4	4.1	28.7	10.7

* $p < 0.05$

** $p < 0.001$

(two-tailed tests)

stimulus processing time, subtractive methodology was used to remove the contributions of the first two components. The residue time was assumed to reflect the speed of perceptual analysis of the display.

As in the previous Chapter, correlation analysis was used in the present experiment to indicate whether any of the clinical variables were associated with performance deficit.

6.21

METHOD

Subjects

Twenty three schizophrenics and 23 controls served as subjects in the experiment. Patients were obtained from the hospital wards as well as from community centres (as described in Chapter 4). Two patients from the total pool were excluded because they reported that they were red-green colour blind. As noted earlier, all schizophrenics were medicated with antipsychotic drugs. Controls included a mixture of hospital staff and university students. Table 6.1 shows the details on measures common to the two groups. A t-test revealed a significant difference in the mean age of the groups ($t(44) = 2.51$, $p < 0.05$) indicating that controls were younger than schizophrenics. However, the difference between the means was approximately five years and this difference is not expected to have major effects on the processing variables. Similar statistical analysis revealed a significant difference in the Proverbs Test scores between the groups ($t(44) = 5.34$, $p < 0.001$). As in the previous Chapter, schizophrenics were found to be less 'abstract' in interpreting proverbs compared with controls. There were no significant differences between the group in the WAIS vocabulary scores.

Stimulus materials

Four decks of twenty cards (65 mm x 75 mm) were prepared. Letters were stencilled onto the cards with either green or red ink pens. The size of each letter was approximately 7 mm in height and 4 to 5 mm in width. The first deck contained a single letter which was either green or red. When the letter was green it was always an X. When it was red it was any of the other letters of the alphabet except X. This deck was used to assess motor speed and response decision time (Deck 1). All other decks contained two rows of 4 letters. Letter spacing was approximately 2 mm between columns and 3 mm between rows. Deck 2 cards contained one green letter which could be either the target, X, or another letter. The rest of the letters were red. The green letter occurred unpredictably in any of the eight positions in the rows. Deck 3 cards contained four green letters and four red letters. In half the cards the four green letters appeared in the first and third column of letters, and the other half in the second and fourth columns. The rest of the columns were occupied by the green letters. Only half of the cards contained a green X. Thus ten cards in this deck contained either a green X or another green letter, together with three green non-X letters and four non-green and non-X letters. Deck 4 simply contained eight green letters on each card. Half of these cards contained an X.

Procedure

Subjects held the deck of cards face up and were asked to sort when they were signaled by the experimenter ("ready, go"). A stop watch was begun when the subject began to move the first card. The stop watch was stopped when the subject

placed the last card on a sorted pile. Subjects were instructed to sort as fast as possible but to "take care" not to sort so fast that they would make an error. They were also instructed to continue sorting if on occasion they detected that an error was made (i.e. the subject was not to spend time correcting errors) or if a card was dropped. (These incidents were relatively rare.) No error scoring was made. Before each sorting the cards were shuffled. The decks were sorted in the order of Deck 1 to Deck 4 and this sorting sequence was repeated five times. This order of presentation was expected to maximise practice effects on the most difficult of the decks where colour is least predictive of the position of the target.

Scoring and Design

The mean sorting-time for each deck was calculated over the five trials for each subject. Then, for each subject, the mean time for sorting Deck 1 was subtracted from the means of Decks 2, 3, and 4. The residue intervals were assumed to reflect 'stimulus processing time' for each of three search conditions:

1. Condition 1: searching for the target in seven red letters and one green letter;
2. Condition 2: searching for the target in four red and four green letters;
3. Condition 3: searching for the target in eight green letters (i.e., no colour cueing).

A 2 Groups by 3 Conditions analysis of variance with repeated measures over the Conditions factor was used to analyse the results.

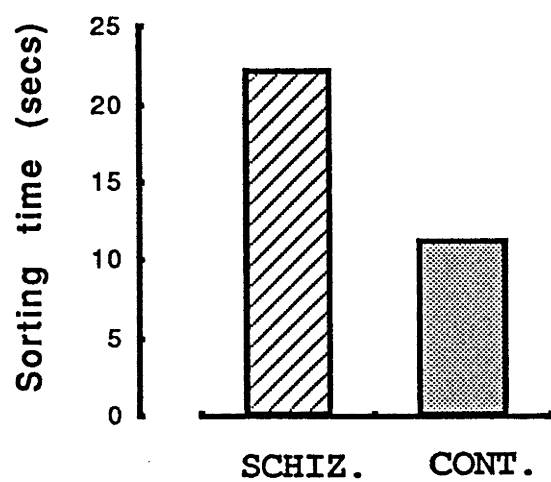


FIGURE 6.1 : Mean sorting time for 'deck 1'.

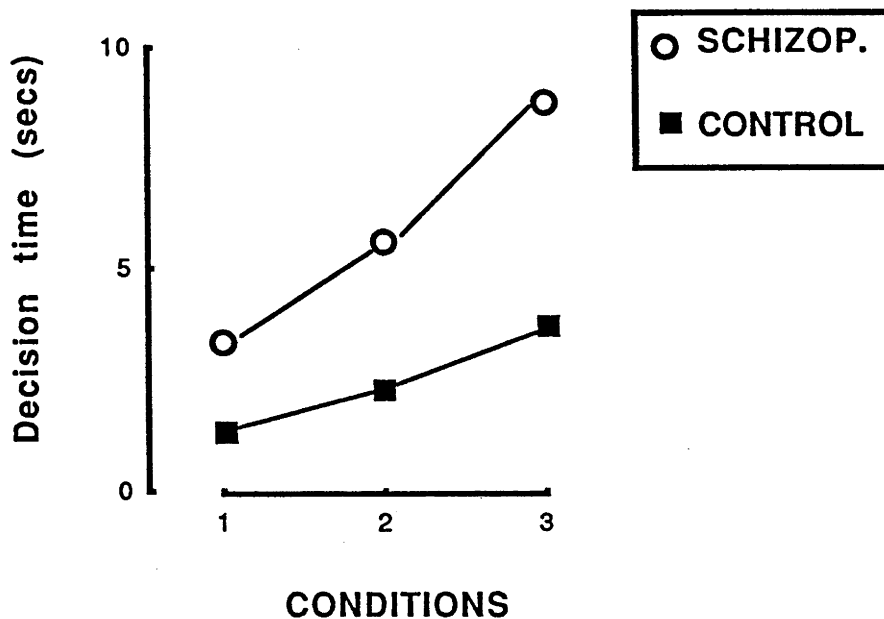


FIGURE 6.2 : Mean decision time for sorting in Conditions 1, 2 and 3.

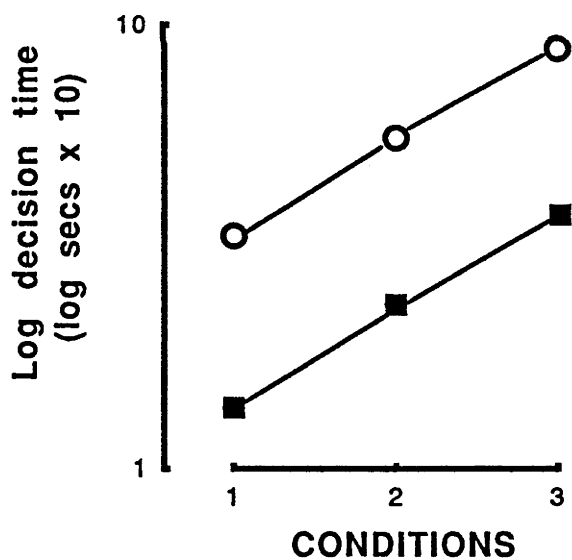


FIGURE 6.3 : Mean log decision time for sorting in Conditions 1, 2 and 3.

Performance analysis

First, Figure 6.1 indicates that schizophrenics were significantly slower in sorting deck 1 than controls ($t(44) = 4.66$, $p < 0.001$). This measure can be expected to include time for perceptual integration of target letters, response decision-time (i.e., 'target-present' versus 'target-absent' decisions) and movement-time in sorting. The 'stimulus processing time' data, with the above decision-time removed by subtraction, were analysed in two forms, as raw data and as logarithmic transformations. The means are represented in graphic form in Figures 6.2 and 6.3. Analysis of variance with the raw data indicated that the effects of Conditions ($F(1,44) = 20.02$, $p < 0.001$) Groups ($F(2,88) = 53.14$, $p < 0.001$), and the interaction of Groups and Conditions were all significant ($F(2,88) = 8.44$, $p < 0.001$). Since the means were found to increase with the standard deviation in the scores, it was possible that the interaction was due to a violation of the assumptions of the analysis of variance (Bartlett, 1947; Cochran & Cox, 1950) - namely, the homogeneity of error variance across the conditions.

Investigation of a number of transformations (Ferguson, 1976; Howell, 1987) indicated that the logarithmic transformation reduced the relation between the means and variances. Reanalysis logarithm-transformed data indicated no interaction effect between groups and processing-time ($F(2,44) < 1$) but significant main effects of Groups ($F(1,44) = 20.12$, $p < 0.001$) and of Conditions ($F(2,88) = 54.54$, $p < 0.001$) were obtained. The resultant additivity of the Groups and Conditions factors verifies the original interaction in the

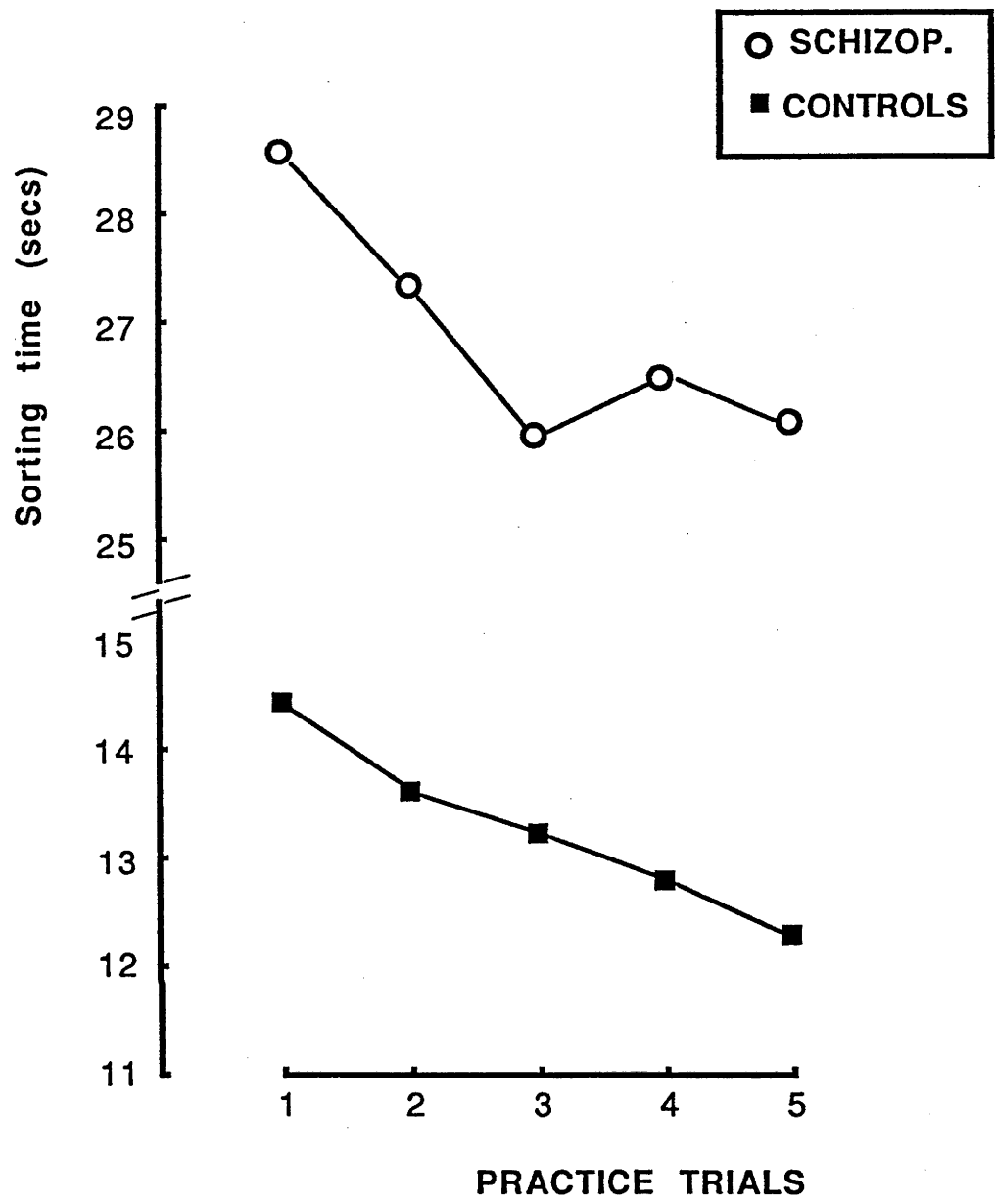


FIGURE 6.4 : The effect of practice on sorting time.

raw data analysis (Lubin, 1961; Smith, 1976) and further suggests that the ratio in stimulus-processing time between the groups is a constant (Cochran & Cox, 1950; Colquhoun, 1971). That is, as can be ascertained from Figure 6.2, schizophrenics were, on average, 2.4 times slower than controls in processing any display. The finding suggests that there are equivalent effects of display-size in the two groups and that there is a processing operation which takes longer to complete in schizophrenics. Display-size merely influences the number of repetitions of this operation. This will be discussed further below.

Figure 6.4 shows performance on each trial collapsing the data across the decks. This indicates the degree of 'gain' in performance due to practice regardless of the stimulus condition. To compare the size of the practice effect between the groups a two-way analysis of variance with repeated measures on trials was conducted. Effects of groups and trials were found to be significant ($F(1,44) = 25.17$, $p < 0.001$ and $F(4,176) = 12.18$, $p < 0.001$, respectively) but there was no interaction between the two factors. Therefore the previous results cannot be attributed to differential practice effects in the groups.

Correlation analysis

Table 6.2 summarises the correlation analysis between clinical variables and performance measures. The figure indicates Spearman correlations of the clinical variables with the total decision-time in the three Conditions and with the change in decision-time from Condition 1 to Condition 3. Of special interest is the correlation between Age and

TABLE 6.2: Correlations between the sorting latency measures and the various clinical measures.

	Number of subjects	Total sorting time	Change in time
Age	23	.01	-.15
Voc IQ	23	-.28	-.16
Hosp/Age	23	.06	.33
Medication	23	.36 *	.38 *
Maine Paranoid	23	.38 *	.32
Maine Non-par.	23	.20	.28
Proverbs	23	-.37 *	-.18
Lovibond	10	.29	.60 *
GAS worst	13	-.13	-.11
GAS current	13	-.30	-.39
Premorbid	13	.17	.28
Dysth. States	23	.01	.13
Neurotic Symp.	23	.12	.29
Integ. Delusions	23	.11	.27
Disin. Delus.	23	-.21	-.05

One-tailed signif. level

* $p < 0.05$

performance since the groups were found to differ significantly in mean age. As the Table indicates, there is no correlation between these variables for the schizophrenics. Similar analysis using the data from the controls also indicated no correlation between Age and performance (i.e., for Total Sorting Latency, $r(22) = 0.17$, $p > 0.05$; and, for the Change in Latency, $r(22) = 0.18$, $p > 0.05$). It appears that performance differences between the groups can not be attributed to the effects of age. Medication, on the other hand, was found to be correlated with both of the performance variables (Figure 6.6). The Maine Scale Paranoia score was found to be correlated with the Total Sorting Latency score while a negative correlation was found between the Proverbs Test and this measure (i.e. reduced 'abstraction was associated with longer decision-time'). Lovibond scores (of 'overinclusive thinking') were found to be correlated with the Change in Latency Measure.

6.23

DISCUSSION

The results indicated that schizophrenics limited their visual search to items colour-congruent with the target just like controls did thus disfavours the preattentive-deficit hypothesis. Furthermore, it was found that display-size and diagnostic groups interacted with a greater difference between the groups' processing-times in the larger displays. However, investigation of the nature of the interaction indicated that the increase in processing time due to the increase in display-size was of a fixed ratio between schizophrenics and controls suggesting that display-size had an equivalent effect on processing in the two groups. Schizophrenics were found to

take 2.4 times longer than controls to process any display. The nature of the interaction becomes apparent in the following example. If controls take, say, one second to conduct a single processing operation in the task, schizophrenics can be expected to take 2.4 seconds; if controls take 2 seconds, schizophrenics can be expected to take 4.8 seconds, and so on. This would lead to the observed interaction effect between groups and display-size since display-size can be expected to increase the number of such processing operations.

It is difficult to specify clearly what might have led to the longer processing-time in schizophrenics. However, it was thought that the subtractive methodology used in the study removed the contributions to total processing-time of such operations as perceptual integration of the target, response decision-time and response execution time. It is possible that inter-letter scanning (Farmer & Taylor, 1980) or 'perceptual analysis and rejection' of non-target items (Farmer & Taylor, 1980; Neisser, 1963) might be slower in schizophrenia. Alternatively, schizophrenics may conduct adequate inter-letter scanning and noise-rejection but they may also conduct some additional processing operation(s) compared with controls. The present experimental design cannot distinguish between these possibilities.

Can the model presented in Figure 4.1 account for the present findings with a 'weaker' version of the preattentive deficit hypothesis. In this version, the slower decision time in schizophrenics might have been due to the products of preattentive processing being available over a longer

Perceptual Segregation
and Search Conditions
(Experimental)

Target Integration
and Response Decision
Condition (Control)

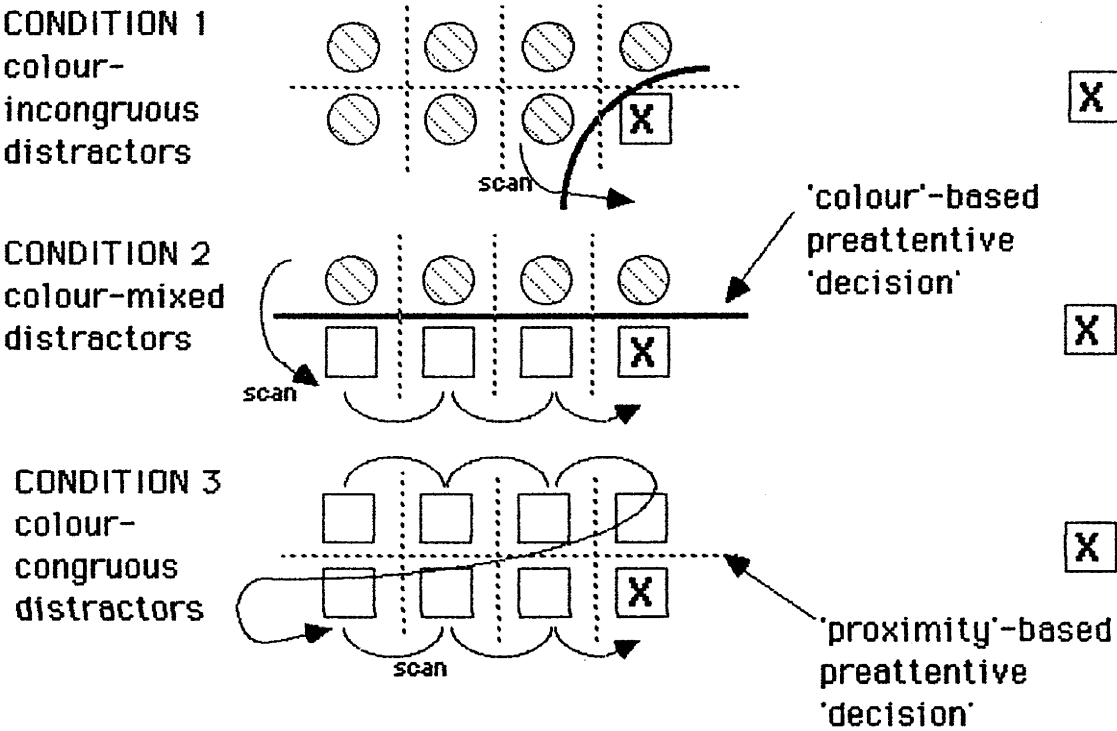


FIGURE 6.5 : The conditions and proposed preattentive products.

processing period than controls. To clarify this point consider Figure 6.5 which represents the products of preattentive processing, as would be expected from the model, for each condition in the Experiment. Two types of boundaries are represented in Figure 6.5. Solid lines represent boundaries expected by colour differences between elements while dotted lines represent boundaries between elements based on grouping principles of good continuation, proximity and so on. An arrow in the Figure is used to represent the possible direction and focusing of attention. Attentional focus in Condition 1 is expected to be directed across the colour boundary. In Condition 2 there is focussing across the colour boundary and then a serial scan of the elements that are colour congruent with the target (each colour congruent element represents an aggregation of features which are searched in parallel while each aggregate is searched by serial/attentional processing). This description fits with Treisman's (1982) demonstration that elements of a group could be scanned in parallel in that colour incongruent elements could be eliminated from serial search in parallel. Moreover, Treisman (1982) showed that serial processing occurred across perceptual groups.

Accordingly, although schizophrenics have been shown to benefit from colour cueing in the Experiment indicating that perceptual grouping does occur, it remains possible that the boundaries between elements depicted in Figure 6.5 become available over a longer processing period. Attentional focusing, which might be normal in schizophrenia both in speed and direction, might have to be delayed until the products of preattentive processing become available. This 'weaker'

version of the preattentive deficit hypothesis can not be distinguished from the slow scanning hypothesis or a slow noise-rejection process given the present results.

The slow-scanning hypothesis suggested above is not entirely consistent with the results of Experiment 1. Slow scanning should have led to less item-to-location conjunctions and therefore to a greater rate of mislocations in the schizophrenic group compared with controls in the Divided Attention Condition. This was not found. On the other hand, this expectation relies on the theoretical notion that information about letter identity is activated automatically and that the task of attention is solely to mediate item-to-location conjunction (as proposed by Butler, 1980, 1981). Contrary to this position, it was noted that the allocation of attention to a region also reduced the rate of intrusion errors in Experiment 1, especially as the stimulus onset asynchrony increased, suggesting that single letter integration is also dependent on attentional focus (see also, Paap & Ogden, 1981; Prinzmetal, Presti & Posner, 1986). This view suggests that slow scanning of a display can be expected to increase intrusion errors in the probed location (in addition to mislocations) in the Divided Attention Condition - since a target embedded in a number of other items is less likely to be encoded. This possibility renders difficult any specific prediction of the error types in the Divided Attention condition. On the other hand, in the Focussed Attention Condition, slow scanning should have led to less encoding of items beyond the probed target position (assuming that cueing was equally effective in directing attention in

the groups) and this should have been reflected in less mislocations in schizophrenics compared with controls. Alternatively, if cueing was less effective for the schizophrenic group it can be expected that focussing attention to the probed location would tend occur when the actual stimulus display was presented for the schizophrenics. This would be less the case in controls. This should have led to more mislocation errors in this group than in controls since attentional focus is comparatively more distributed. Neither of these results were obtained (Experiment 1).

Thus the slow attentional scanning hypothesis is not a sufficient explanation of the combined results of Experiments 1 and 2. Alternatively, it is possible that poor early processing of information, as suggested by the greater rate of intrusion errors in schizophrenics in the Focussed Attention Condition of Experiment 1, could lead to 'slower scanning' and to slower 'rejection of noise' items in the present visual-search task. This would fit the 'weaker' version of the attentional deficit hypothesis presented in explanation of Experiment 2. However, objections to this hypothesis were raised in the previous Chapter.

Turning to the correlation analysis, the absence of a correlation between Age and performance suggests that the initial difference between the groups in mean age may not have had any bearing on the performance differences between the groups. Neither can the results be attributed to differential practice effects between the groups across the successive trials of the task. On the other hand, medication may have retarded performance in schizophrenics as is suggested by the positive correlation of medication-level and both of the

response-time measures. Furthermore, the experience of psychosis near or at the time of testing may have increased decision-time as is suggested by the correlations of the Proverbs Test and the Lovibond Test with the performance measures.

6.3 EXPERIMENT 3: Effects of discrimination difficulty on detection performance in schizophrenics.

In the previous experiment schizophrenics were found to be normal with respect to their use of colour cues for limiting visual search. Alternatively, the results favoured the hypothesis of slower processes of attentional scanning and rejection of non-targets in schizophrenics, and the weaker version of the preattentive deficit hypothesis. The failure to find a preattentive processing deficit as represented by the stronger version of the hypothesis, however, may have been due to the high saliency of the colour cues. It was noted in Chapter 3, for example, that schizophrenics performed normally in 'preattentive tasks' when the target was salient but they failed in conditions of poor target discriminability (e.g., Cox & Leventhal, 1978). However, not all studies indicated this effect (e.g., Davidson & Neale, 1974). In the next experiment the susceptibility of schizophrenics to the effects of reduced target discriminability was investigated. Stimuli consisted of large letters comprised of smaller letters (termed 'bilevel' stimuli). Examples, are shown in Figure 6.6 which also indicates the three levels of target discriminability used in the experiment. Subjects were asked to identify either the global letter-form or the local letter on each trial. According to the preattentive deficit hypothesis schizophrenics were expected to be poorer in target

detection than controls as the level of discriminability was reduced.

A second aim of the experiment was to investigate processing precedence in the level of stimulus structure in schizophrenics. Navon (1977) presented results suggesting that information from the global level of stimulus structure is available prior to information from the local level. However, a number of exceptions have been noted to this 'rule' (Kinchla & Wolfe, 1979; Martin, 1979; Pomerantz, 1981; Pomerantz & Sager, 1975; Ward, 1982) and it appears that stimulus discriminability partially determines the level of structure that is analysed first (Paquet & Merikle, 1984; Pomerantz, 1981). For example, Paquet and Merikle (1984) showed that global precedence occurred at short masking delays (e.g. 10 msec) but there was no precedence at long effective stimulus durations (e.g. 100 msec). They argued that global precedence at the shorter delays was caused by the relatively superior conspicuity of the global level over the local level. Secondly, precedence of processing appears to be influenced by the direction of attentional focus. For example, Ward (1982) showed that if a subject had just processed a particular level of structure, the probability of correct report from the same level was higher than if the next target occurred in a different level of structure. Consistent also with the attentional influence Grice, Canham and Burroughs (1983) indicated that location precueing eliminated the global precedence effect while Kinchla, Solis-Macias and Hoffman (1983) showed that increasing the target probability in a particular level of structure reduced response latency and

improved target detection in that structural level.

In the present experiment global precedence was expected to decline with conditions of reduced discrimination and perhaps to reverse to a local precedence under the poorest conspicuity condition. In line with Paquet and Merikle's (1984) results reductions in effective stimulus duration were expected to reduce global precedence. If schizophrenics are normal with respect to early registration of information and preattentive processing then they were expected to follow the same pattern of precedence as controls. Alternatively, if there is an early processing deficit in schizophrenia no changes in processing precedence were expected compared with controls. A weaker version of this deficit predicts that there would be a delay in the change of precedence in schizophrenics. That is, while controls have switched to local precedence schizophrenics would still be displaying global precedence.

A third aim of the experiment was to verify the masking-delay effect in schizophrenics. It was noted in Chapter 3 that schizophrenics were thought to be abnormally vulnerable to masking effects but the results of Experiment 1 did not support this contention. In the present Experiment the effective stimulus duration was again reduced to observe whether target detection would decline excessively in schizophrenics compared with controls. A significant methodological change from Experiment 1 was the limitation of the number of response alternatives to four potential targets and the presentation of a visual aid to help the subject in choosing the target. In the present experiment, therefore, only minimal information about the shape of the target was required for its identification with the visual aid. Since the

TABLE 6.3 : Means and standard deviations of the descriptive data.

	CONTROLS		SCHIZOPHRENICS	
	mean	s.d.	mean	s.d.
AGE	24.3	7.3	28.0	6.0
VOCAB.	12.6	1.6	12.1	2.0
PROVERBS*	40.9	4.1	32.0	9.4

* $p < 0.01$
(two tailed test)

potential targets remained the same accross trial the task examines detection under priming conditions. According to the model depicted in Figure 4.1 (and Butler's findings summarised in Chapter 5) it is expected that letter detection would be accomplished automatically.

6.31

METHOD

Subjects.

Fifteen schizophrenics and fifteen normal controls participated in the experiment. Common measures for the groups are summarised in Table 6.3. As before, schizophrenics were found to be less 'abstract' on the Proverbs Test than controls ($t(28) = 3.34$, $p < 0.01$). The groups did not differ significantly on age or in WAIS Vocabulary scores.

Apparatus and Materials

Three kinds of displays were prepared. Each display contained a single bilevel stimulus as shown in Figure 6.6 presented with one of three background conditions. The three discrimination conditions were labelled Easy, Intermediate and Difficult. A PDP-11 computer with a high quality dot matrix printer was used to generate each display to ensure uniformity in the contrast of the local elements. Bilevel stimuli were centered in a 20 (height) by 30 (width) matrix. Local characters were approximately 2.5 mm while global characters were approximately 31 mm in height and 20 mm in width. Local letter characters were from the set of T, A, V, and N while global characters were from the set of K, P, O, and H. The combination of different global, local and background conditions resulted in 48 different displays. Displays were

separated into two blocks of 24 displays. Masking displays were of a similarly sized square as the stimulus display but consisted of a random dot pattern as used in Experiment 1. The whole stimulus display was covered if the mask was superimposed upon it. All displays were photographed and the negatives used as stimuli.

When presented, a local element subtended a vertical visual angle of 0.26 degrees while global letters subtended a similar angle of 3.35 degrees at a viewing distance of approximately 65 cm. All displays were projected on to a back projection screen through a rectangular aperture of dimensions 6 cm (height) and 8 cm (width). Luminance levels for masking displays were 10 ftL while for stimuli it ranged between 1.25 and 1.85 ftL for the various discrimination conditions. Stimulus durations were 30, 60 and 90 msec determined by preliminary piloting.

Procedure

The subject was familiarised with the equipment and then seated in front of the back-projection screen. He was asked to refrain from moving during the presentation of a stimulus. The subject was introduced, first, to the stimuli on an instruction sheet (Appendix 1), and then, to slow presentations of actual (but non-test) stimuli. Briefly, the instruction sheet informed the subject that a bilevel letter would appear in the viewing region and that he was to attend to either the local or global level of the stimulus on any trial. He was instructed that he would be told which level to attend to prior to the trial. Last, the subject was introduced to the response choices, and was given a sheet which he was to

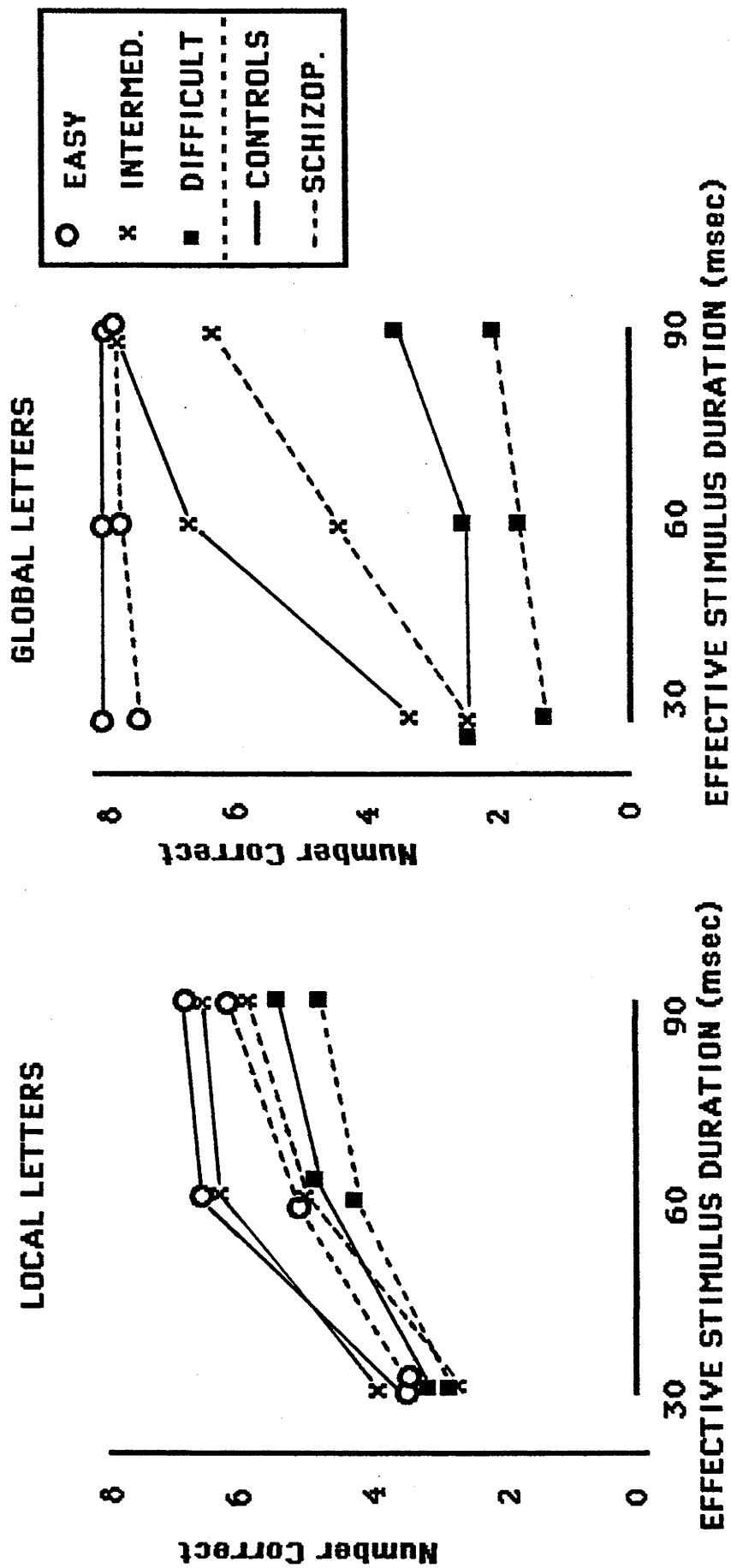


FIGURE 6.7: Detection of local and global level targets as a function of discrimination difficulty and effective stimulus duration.

study and to use subsequently in choosing a response (Appendix 1). Training was given on slowed presentations at first, so that the subject understood the use of the pre-trial instruction and the response sheet. This was followed by fast practice trials. Usually, about five or six presentations were sufficient for the procedure to be understood.

Each of the two blocks of stimuli were shown three times to each subject at three stimulus durations. The order of presentation of the blocks and the effective stimulus duration were randomised across subjects. Discrimination difficulty and report type (i.e., global versus local letter-form) was randomised within each block.

Design and analysis

Three-way analyses of variance were used to assess performance for each response-type. The three factors were, 'groups', 'effective stimulus duration' by 'discrimination difficulty', with repeated measures in last two factors. There were three levels of discrimination difficulty and three stimulus durations. The subject's data comprised of the number of correct detections for each combination of stimulus duration and discrimination difficulty.

6.32

RESULTS

Performance Analysis

Local letter detection : The results are presented in Figure 6.7 (left graph) which shows detection accuracy as a function of effective stimulus duration for each of the three levels of discrimination difficulty. As can be seen in the figure, performance on the detection of local level letters declined with increases in discrimination difficulty ($F(2,56)$

= 8.74, $p < 0.001$) and with reductions in stimulus duration ($F(2,56) = 75.44$, $p < 0.001$). The interaction between these two factors was not significant. It is apparent in the figure that schizophrenics were less accurate than the controls in detection, however, this effect only approached significance ($F(1,28) = 4.02$, $0.05 < p < 0.10$). No other effects were found to be significant. Both groups showed similar performance variation with effective stimulus duration and 'discrimination difficulty'.

Global letter detection : These results are also represented in Figure 6.6 (right graph). Performance in this condition fluctuated between 'floor' and 'ceiling' levels rendering interpretations of the interactions among the variables difficult. Using the original three factor design, a two way interaction was found between 'groups' and 'discrimination difficulty' ($F(2,56) = 3.39$, $p < 0.05$), among other findings. However, this interaction reflects a ceiling effect performance in the Easy Discrimination Condition. A more limited analysis of variance was conducted with the data for the Intermediate and Difficult Discrimination Conditions. In this analysis, the interaction between groups and discrimination difficulty failed to reach significance. Other results were significant main effects for groups ($F(1,28) = 38.08$, $p < 0.001$), discrimination difficulty ($F(1,28) = 136.62$, $p < 0.001$), and stimulus duration ($F(2,56) = 101.68$, $p < 0.001$); and, a significant interaction between discrimination difficulty and effective stimulus duration ($F(2,56) = 37.33$, $p < 0.001$). In addition, performance in the most difficult discrimination condition was found to be

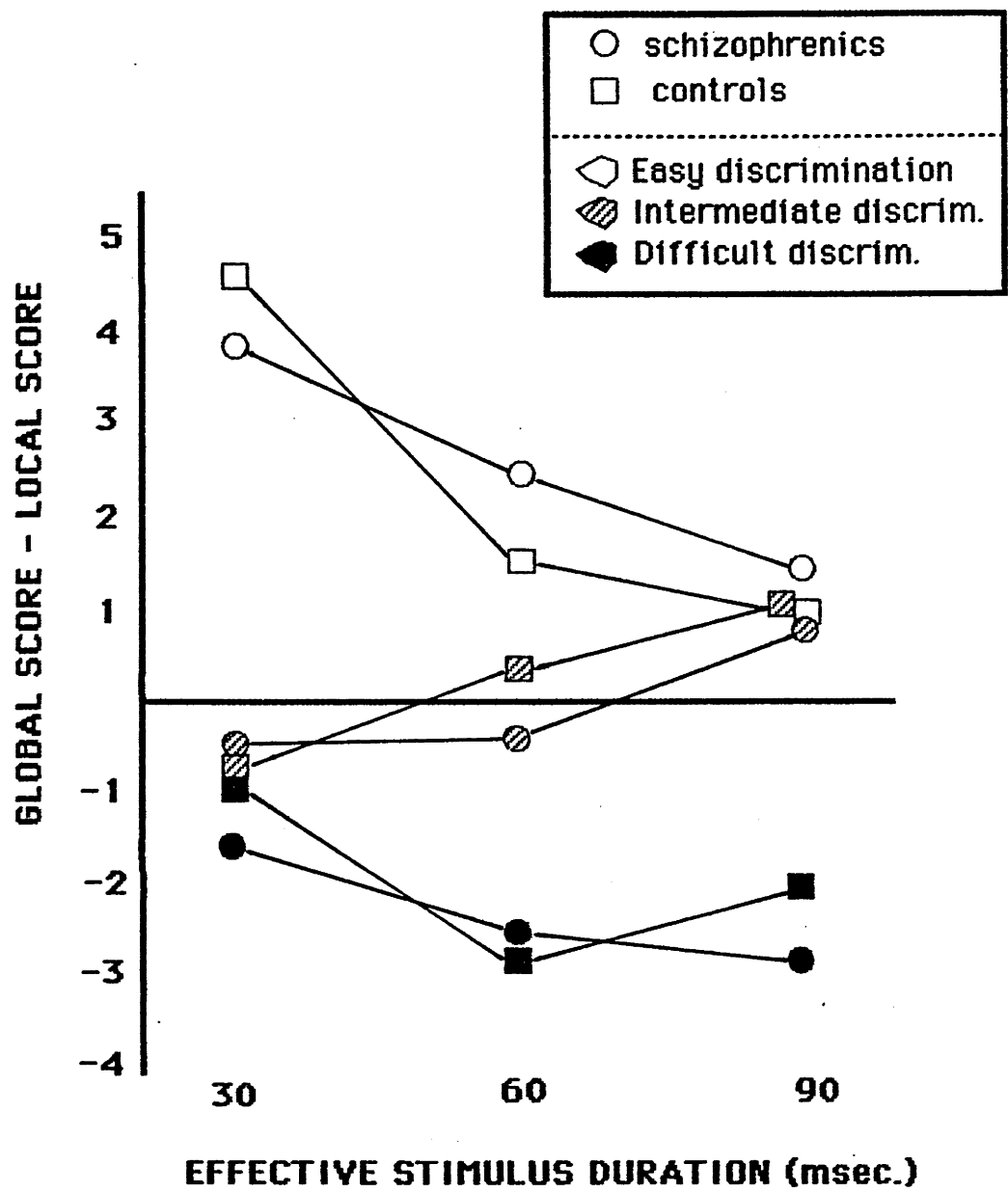


FIGURE 6.8 : Processing precedence as a function of groups, discrimination difficulty and effective stimulus duration.

reduced to levels expected by chance. Chi-squared analyses revealed that only controls surpassed theoretical chance levels at the 90 msec exposure duration ($\chi^2(14) = 24.5$, $p < 0.05$).

Processing precedence : To investigate the processing precedence effect a difference score was calculated for each subject between performance in the global and local conditions (i.e., global score minus local score). The group means of the scores are represented in Figure 6.8. A three-way analysis of variance of 'groups', 'discrimination difficulty' and 'effective stimulus duration' with repeated measures over the last two factors was conducted on the data. The analysis revealed significant main effects for discrimination difficulty ($F(2, 56) = 121.49$, $p < 0.001$), and effective stimulus duration ($F(2, 56) = 9.11$, $p < 0.001$). The interaction between discrimination difficulty and effective stimulus duration was also significant ($F(4, 112) = 18.33$, $p < 0.001$). As can be discerned in Figure 6.8, global precedence reduced with effective stimulus duration in the Easy Discrimination Condition replicating Paquet & Merikle's (1984) findings. In the Intermediate Discrimination difficulty condition global precedence became reversed to local precedence with reductions in the effective stimulus duration. Finally, local precedence evident in the Difficult Discrimination condition was also reduced by reductions in effective stimulus duration, suggesting an overall reduction in the perceptibility of both global and local levels of stimulus structure. It is evident that the processing precedence of schizophrenics did not differ from controls across any of the conditions of the experiment.

TABLE 6.4: Correlations of performance with the clinical measures.

	Local letter Condition	Global letter Condition	Combined Conditions
Age	.03	.02	.00
Voc IQ	-.27	.15	.12
Hosp/Age	-.13	-.62 **	-.60 **
Medication	-.45 *	-.01	-.27
Maine Paranoid	.21	-.01	-.09
Maine Non-par.	.05	.32	.20
Proverbs	.45 *	.08	.10
GAS worst	-.11	-.23	-.10
GAS current	.24	.35	.41
Harris Premorbid	-.58 **	-.26	-.37
Dysth. States	-.03	-.12	-.17
Neurotic Symp.	.07	.11	-.04
Integ. Delusions	.12	-.03	-.06
Disint. Delus.	.72 ***	.14	.31

One-tailed signif. level, (N=15)

* p < 0.05

** p < 0.025

*** p < 0.005

Correlational Analysis

The results are presented in Table 6.4 which shows the correlations of performance for each report-type and for the combined report-type conditions with the clinical variables. A significant negative correlation was found between medication level and performance in the local letter detection condition suggesting the possibility of a negative influence of medication on performance. There was a significant correlation between Proverbs Adjusted scores and local-letter detection suggesting that poor performance was associated with reduced 'abstract thinking' while poor premorbid adjustment was associated with poorer local-letter detection as evidenced in a negative correlation between this performance and scores on the Harris Premorbid Adjustment scale. Global-letter performance was found to be negatively correlated with the rate of hospitalization (corrected for age). Combining performances in each condition resulting in a single significant correlation with the rate of hospitalization measure. Noteworthy is the unexpected positive correlation between reported pathology on the Disintegrated Delusion subscale of the DSSI and performance on the local-letter condition.

6.33

DISCUSSION

Consistent with the previous results it was found that schizophrenics tended to perform more poorly than controls in the presnet detection task (particularly in the 'global structure' condition). However, their performance was not abnormally vulnerable to the effects of increased

discrimination difficulty, nor was it attenuated abnormally by reductions of effective stimulus duration. The second finding supports that of Experiment 1. Precedence of processing stimulus structure was found to be similar between the two groups and to be influenced, as expected, by discrimination difficulty and effective stimulus duration. Indeed, the processing precedence analysis revealed equal performances in the groups as the stimulus representation changed, due to variations in stimulus onset asynchrony and discriminability, from imperceptible levels through to a level of local feature precedence and finally to a level of global precedence. The present findings support those of Experiment 2 in suggesting that there is no abnormality in preattentive processing in schizophrenia.

The reduced ability of schizophrenics to report targets as indicated in Experiment 1 was replicated in the present results but in the present study correlational analysis indicated that schizophrenics' performance may have been hindered by medication. Poor detection in the present sample of patients was also found to be characteristic of those with poor premorbid adjustment, those who had a history of a high rate of hospitalization, and those with reduced 'abstract thinking' at the time of testing. The present results suggest that chronic schizophrenics are more likely to report less information from a tachistoscopic display than controls and that the reason for the poor performance is not likely to be poor target discriminability. Finally, the anomalous finding of better performance in subjects scoring higher on psychotic pathology (i.e., on the Disintegrated Delusions subscale) on the DSSI replicated the findings of Experiment 1. In the

present sample of patients correlations of Disintegrated Delusions and measures of current psychological health were not found to be significant. The results suggest that the interrelations between current psychosis, medication effects, history of symptoms during psychosis, and visual search performance are worthy of further study.

CHAPTER 7: THE ATTENTIONAL-DEFICIT HYPOTHESIS AND THE INFLUENCE OF STIMULUS FAMILIARITY IN SCHIZOPHRENIA.

Although schizophrenics were found to be generally poorer in visual processing tasks than controls in Experiments 1, 2 and 3, their performance did not deteriorate abnormally with reductions in the effective stimulus duration (Experiments 1 and 3) nor with reductions in stimulus discriminability (Experiment 3). There was little evidence for a specific processing disorder in the present samples of schizophrenics. The results of Experiment 2, however, suggested slower attentional scanning in schizophrenics compared with controls. This finding, however, was not consistent with the results of Experiment 1 since this hypothesis should have led to a differential display-size effect in schizophrenics compared with controls. Furthermore, contrary to the results, the attentional-deficit hypothesis predicted that in Experiment 1 schizophrenics should have made more mislocation errors than controls during tachistoscopic detection.

The attentional-deficit hypothesis was therefore re-examined in Experiment 4 in the present Chapter. In addition, the present Chapter will be concerned with the effects of stimulus familiarity on processing. Specifically it will address the question of whether schizophrenics take advantage of stimulus familiarity to accelerate processing as normal controls have been shown to do (La Berge, 1973; Mason, 1982; Mewhort et al., 1981; Prinzmetal & Millis-Wright, 1984). A failure to find normal stimulus-familiarity effects in schizophrenics would suggest an explanation of the generally poorer performance of schizophrenics on the previous task.

Since other aspects of processing appear to be normal, such a failure can be expected to lead to more intrusion errors as indicated in Experiment 1 or to lead to increased need to employ attentional strategy (e.g. increased stimulus scanning) in otherwise automatic processing operations.

7.1 Expectancy and Familiarity Effects on stimulus-processing

A number of familiarity effects have been suggested involving processing levels of short-term verbal memory rehearsal, response-selection bias (Goldiamond & Hawkins, 1958) and perceptual processing effects (Mewhort, et al., 1981; Mewhort & Campbell, 1980). The concern here is with the intra-perceptual effects of 'expected' stimulus configurations (Dykes & Pascal, 1981; LaBerge, 1973; Rummelheart & McClelland, 1982) - that is, the facilitation of the integration of the stimulus representation due to such factors as stimulus familiarity and stimulus probability. For example, Rummelheart & McClelland (1982) indicated that detection of a letter within a word was better in conditions where the non-target letters (context) were presented prior to, or concurrently with the target-letter than in delayed presentation conditions. A response-bias hypothesis predicts no superiority for the first two of these conditions, since the subject is equally likely to use the delayed context in response selection. Furthermore, presenting digits as the context prior to the target letter did not lead to improved performance suggesting that the results were not due to effects of increased readiness for processing (i.e., an alerting effect).

The results of Rummelheart and McClelland suggest that the content of prior or concurrent stimulation leads to

processing advantage perhaps by setting-up a perceptual readiness for receiving and processing certain stimulus configurations in preference to others. This is consistent with the findings of Dykes and Pascal (1981), who indicated that target processing was influenced both by the probability and the physical similarity of prior stimulation. They found that targets were processed more efficiently if they contained physical features similar to those of a high probability non-target stimulus than if they were different. Dykes and Pascal concluded that the observer modifies visual search according to the 'schema' of probable stimuli. LaBerge (1973) came to similar conclusions. He found that when subjects expected certain stimulus configurations, regardless of whether they were familiar or unfamiliar characters, there was no processing advantage for the familiar characters. On the other hand, when an unexpected stimulus appeared, processing speed for familiar stimuli was much faster than for unfamiliar stimuli. The processing difference between the types of stimuli, however, was shown to be reduced with repeated exposure to the stimuli over a number of experimental sessions. That is, subjects could be trained to respond to the unfamiliar stimuli as rapidly as the familiar stimuli. LaBerge concluded that familiar patterns must be processed as units and that unfamiliar configurations may come to be 'unified' by training.

Familiarity effects appear to influence perception by influencing attentional focus. Mason (1982), for example, indicated that serial position curves for the detection of a target within a linear sequence of items varied according to stimulus-familiarity. She found that letter sequences produced

a typical (Butler, 1975) 'M-shaped' serial-position function indicating shorter detection latency for items in the middle and at the edges of the letter sequences. If the sequences comprised of unfamiliar objects, however, a 'U-shaped' serial position function was obtained showing inferiority for processing the end items. Consistent with the influence of attentional focus, location pre-cueing removed differences in the serial position functions across the types of stimuli.

Congruent with both Mason's (1982) and LaBerge's (1973) results, Prinzmetal and Millis-Wright (1984) found that familiar letter sequences were attended to as wholes more than unfamiliar sequences. Prinzmetal and Millis-Wright argued from feature-integration theory (Treisman & Gelade, 1980) that if familiar letter-sequences were processed as units, then any incidental information, such as the colour of each letter, was more likely to be mislocated, whereas in unfamiliar sequences attention was allocated to individual letters. This is similar to Butler's (1981) findings that divided attention conditions lead to more mislocations than do focused-attention conditions and that the frequency of mislocations increases with increases in the number of items subjects must attend to. Prinzmetal and Millis-Wright's results confirmed their expectations by indicating a higher incidence in colour mislocations between letters of familiar trigrams compared with unfamiliar trigrams.

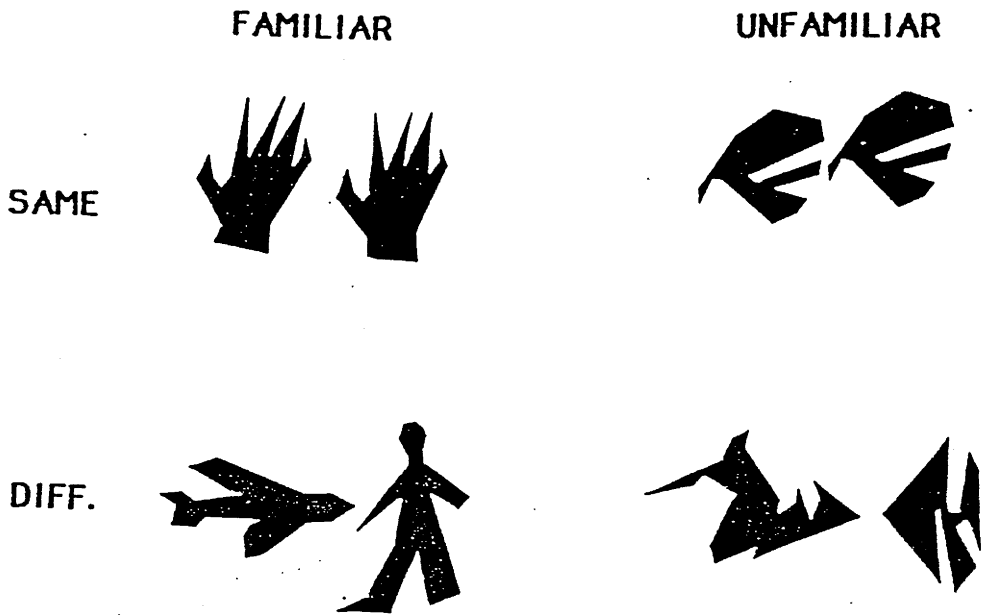
7.2 Stimulus familiarity effects in schizophrenia.

The suggestion that schizophrenics do not use expectancies in processing information is not new. As noted in Chapter 2, Weckowycz and Blewett's (1959) description of the

experience of psychosis as a cortical flooding of sensations and impressions included a failure to use 'experience and the anticipation of the future' in filtering out irrelevant information. However, experimental investigation of stimulus-familiarity effects in perceptual tasks have been rare in the schizophrenia literature. Only two studies in the recent information-processing literature have contributed relevant results. First, Russell and Knight (1977) compared accuracy and response latency measures for paranoid, non-paranoid, and normal controls, using a stimulus-matching task. Subjects were presented with letter strings which were words or random strings. Although familiarity effects were demonstrated, the groups did not differ in the degree of facilitation afforded by the familiar over the unfamiliar stimuli. In the second study, Pharr and Connor (1980) compared chronic schizophrenics with normal controls, in a visual and memory search task. They found that normal controls tended to show the usual facilitation effect of familiar letter strings over the less familiar. In chronic schizophrenics, however, this pattern was reversed; that is, they displayed processing advantage for random strings rather than the word stimuli. It was also found that acute schizophrenics did not show any sensitivity to stimulus familiarity.

7.3. EXPERIMENT 4: The attentional deficit hypothesis and effects of stimulus familiarity in schizophrenia.

In the present experiment a 'simultaneous' matching task was used to assess the stimulus familiarity effect and to reassess the attentional deficit hypothesis. The stimuli were shapes rather than linguistic stimuli in an attempt to



'ATTENTIONAL' CONDITION

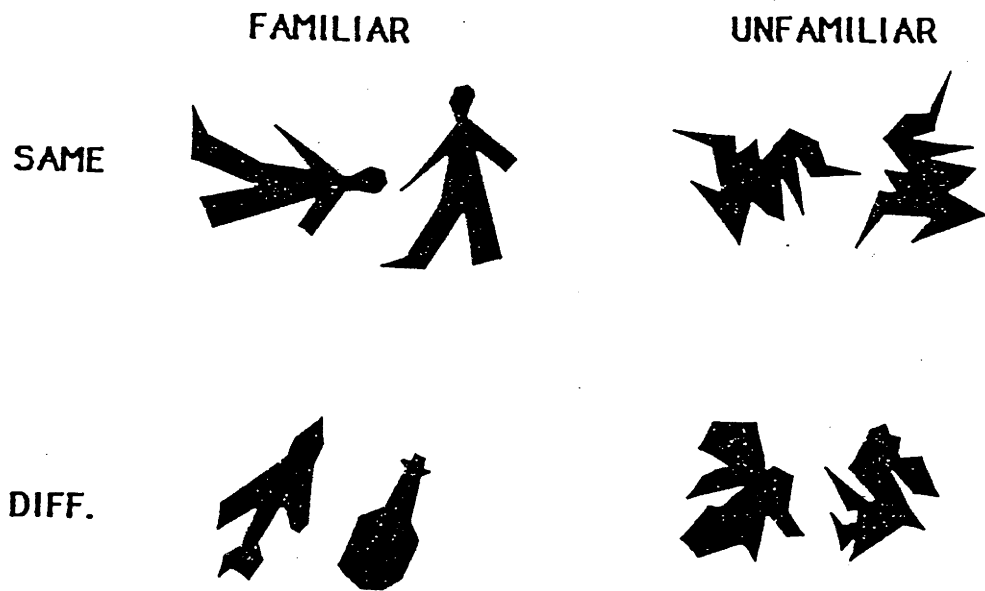


FIGURE 7.1 : Examples of the shape pairs presented in the different conditions.

generalise previous results. Subjects were shown two shapes simultaneously and were asked to judge whether the shapes were the 'same' (i.e. a replication of a single shape) or 'different' (i.e. two different shapes altogether). Examples of the stimuli are presented in Figure 7.1. Shapes were either 'familiar' or 'unfamiliar'. Familiar shapes were defined as those which were easily nameable with good inter-observer agreement about the identity of the shape. Unfamiliar shapes were those which elicited a range of names from observers (i.e., there was little agreement in naming the shape) and confidence ratings for each name given was 'low'.

Two 'attention' conditions were presented. First, in the 'non-attention' condition subjects were required to make their judgements based on the 'global' attributes of the objects. In this condition, termed the 'global processing' condition, objects were arranged in the same orientation and had the same identity when the response was 'same'. When the response was 'different' two different identities were presented and in orientations which maximised the physical difference between the objects (i.e., the general orientation of the objects did not match). Subjects were instructed about this arrangement prior to the commencement of the trials. Global processing, then, involved judgements which could be based on the physical attributes of stimuli (e.g. size, orientation) and the speed of processing in this condition was thought to reflect processing at the preattentive level.

In the 'attentional' condition when a response was 'same' the two objects, which had the same identity, were presented in different orientations. When the response was 'different', the identities were different but the orientation

of the object pairs was similar. The aim, in this condition, was to induce subjects to use an analytical 'feature by feature' verification process. It is possible, however, that subjects might have simply learnt that when the objects 'look' different they must be the 'same' and consequently, subjects might have, once again, used a global analysis along with response switching. To discourage this, subjects were informed that the identity/orientation contingency would occur only on some of the trials in this condition. Of course, if the instructional manipulation was ineffective, the performance under attentional and global conditions was expected to be similar. Alternatively, if it was effective, attentional processing should have been slower (i.e., longer response latency) and less accurate than global processing.

Within the framework of the distinction between global and attentional processing it is possible to ask what level of processing familiarity has its facilitation effect. It is possible, for example, that familiarity acts within global processing (e.g. by mediating the chunking of features in 'unit' formation), or it acts within attentional processing (e.g. by speeding up feature verification). The distinction is important because of the hypothesis that information processing disorder in schizophrenia resides within attentional processing only.

The effective stimulus duration was also varied in this Experiment for two reasons. First, the two processes, global and attentional, might be expected to proceed at different rates and thus the selection of a single stimulus duration might 'capture' the effect of one but not of the other

TABLE 7.1 : Means and standard deviations of the descriptive data.

	CONTROLS		SCHIZOPHRENICS	
	mean	s.d.	mean	s.d.
AGE *	23.3	2.9	28.0	6.0
VOCAB.	12.9	1.5	12.1	2.0
PROVERBS* *	41.8	4.4	32.0	9.4

* $p < 0.05$

* * $p < 0.01$

(two-tailed tests)

process. Second, it is necessary to verify, once again, whether or not schizophrenics are abnormally vulnerable to masking, since this has been a reliable result in the Saccuzzo studies but not in the present studies. To summarise, it was expected that a failure in attentional processing in schizophrenia would involve a group difference only within the attentional processing condition. Earlier processing deficits on the other hand, can be expected to result in poorer performance compared with controls in both the global and attentional processing conditions. If schizophrenics fail to utilize familiarity constraints to aid processing, similar processing time and accuracy for both familiar and unfamiliar stimuli would be expected in their performance whereas controls should experience facilitation.

7.31.

METHOD

Subjects

Fifteen schizophrenic subjects and 15 normal controls participated in the study. Descriptive data are presented in Table 7.1. T-test analysis indicated significant differences in age and Proverbs Adjusted scores as in previous experiments ($t(28) = 2.70$, $p < 0.01$, and $t(28) = 3.65$, $p < 0.005$, respectively). Controls were approximately five years younger than the patient population. Since age effects were not found to be correlated with performances in the previous tasks the difference between the groups was not expected to affect the present results.

Apparatus and Materials

Each stimulus contained two shapes which differed in identity or were the same. Pairs of shapes were classified as

either 'familiar' or 'unfamiliar' as will be defined below. Ten unfamiliar shapes were obtained from Hamid (1972, unpublished dissertation) and from Vanderplas and Garvin (1959). These were selected for their low probability for activating semantic associations. The association value for each shape was defined in these studies as the percentage of subjects who responded that a shape reminded them of an object, or, who responded by actually naming the shape (Vanderplas & Garvin, 1959). These shapes are presented along with the familiar shapes constructed by the author in Appendix 1. The mean percentage association for the unfamiliar shapes was 23.6 (standard deviation (SD) = 3.89). In addition to a low value of association, the shapes were selected to be within a particular range of complexity. The range was arbitrarily selected so that the shape did not look (to the author) too complex or too simple. Shape complexity (Hamid, 1972; Vanderplas & Garvin, 1959) was represented by the number of angles in the shape. The average complexity of the unfamiliar shapes was 19.1 (SD = 2.69) angles. Familiar shapes were drawn by the author so that the average complexity matched that of the unfamiliar material. For familiar objects the mean complexity was 19.8 (SD = 2.15).

A test that the familiar materials could generate consistent naming responses was carried out using seven subjects (university students) who took no further part in the experiment. Each subject was given a mixed list of the familiar and unfamiliar shapes along with instructions to provide three names for each of the shapes. Next to each name the subject was asked to indicate how confident he was that

the name represented the judged shape. It became obvious from the first subject's responses that, once a name was elicited for a familiar object, the subject had difficulty in arriving at another name for the object. The initial procedure was modified by instructing each subject to attempt to provide at least two names and associated confidence ratings.

Confidence ratings were made on a visual analog scale with one point of reference at 'zero confidence'. The confidence, for each item, was taken to be the length of the line (in millimetres) from the 'zero' point to the centre of the subject's response mark. For each shape the most confident response was obtained and used for further comparisons. A score ('the naming stability' score) was derived for each shape reflecting both confidence and inter-observer agreement for a shape over all the subjects' responses:

$$\begin{aligned} \text{Naming} & \\ \text{Stability} & \\ \text{Score} & = \sum_{i=1}^n (c_i) / [(K)(n)] \\ & \text{range } \{0 < \text{score} < 55\} \end{aligned}$$

where c_i is the confidence for the name provided by the ' i 'th subject, K is the number of concepts used by all subjects in naming a shape, and n is the total number of subjects. The highest score is 55 representing complete reliability in the naming of an item (i.e. all subjects used the same name to describe the item) with the highest possible confidence that the name represents the shape (i.e. all subjects put their mark on the highest point on the visual analog scale).

The means and standard deviations of the Naming Stability Score and the number of concepts used to describe a shape are shown in Table 7.2. As can be seen in the figure familiar and unfamiliar shapes are clearly separated on both

Table 7.2. Comparisons of 'naming stability scores' and number of concepts used to describe familiar and unfamiliar shapes.

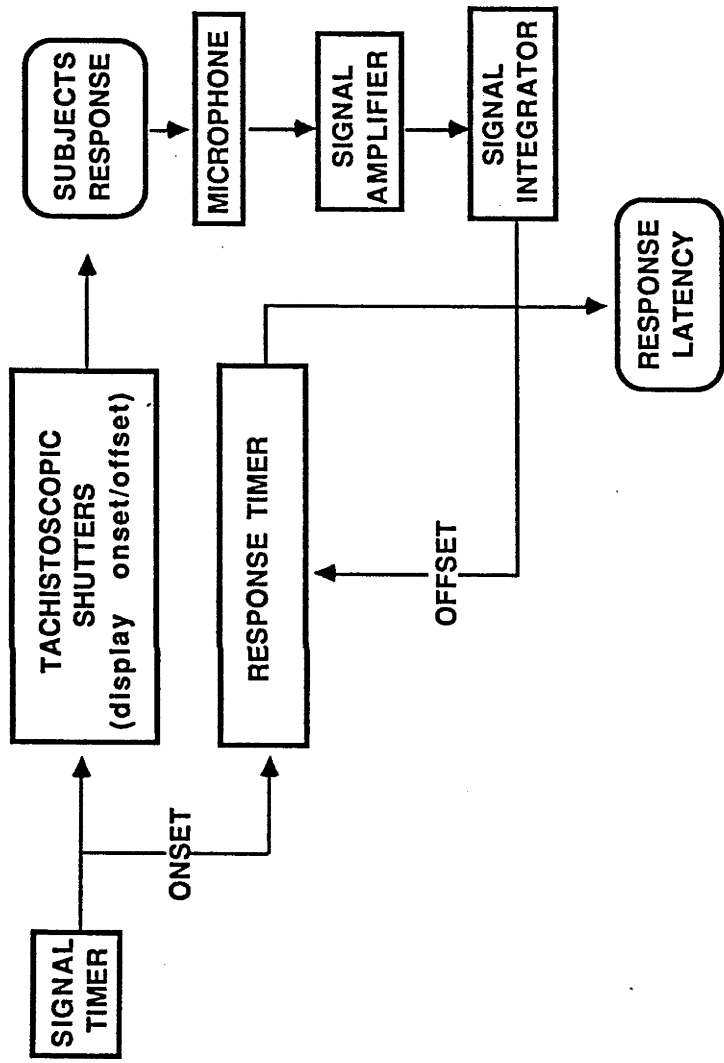
	familiar		unfamiliar	
	score	K	score	K
mean	45.3	1.1	4.7	5.2
SD	10.9	0.3	2.1	1.1

measures indicating that subjects were more likely to provide singular names with confidence that the name described the shape for the familiar shapes than for the unfamiliar. Indeed, within the judgements of the ten familiar shapes only one disagreement occurred in naming a shape.

Shapes were paired and arranged according to the conditions of the experiment (to be described below). The shapes were then photographed and the photographic negatives were mounted onto slides. Four blocks of 20 slides were prepared, each block containing 10 'same' and 10 'different' stimulus types. Half of the slides were constructed with familiar and half with unfamiliar shapes as shown in Figure 7.1 (i.e., no heterogeneous display contained both familiar and unfamiliar shapes). Within each familiarity condition, no pair of shapes was repeated although a single shape could be repeated within a block. There were four blocks of stimuli - two for the 'global' condition and two the 'attentional' condition. Examples are shown in Figure 7.1.

Slides were presented onto a back projection screen, as in the previous experiments, followed by a visual noise mask which covered the whole display. Luminance of a single shape was on average 3.8 ftL and background luminance was 0.6 ftL. The mask luminance was 10 ftL. Mask duration was 150 msec

FIGURE 7.2 : The sequence of events for the voice-onset latency measurement.



while the stimulus duration was varied according to the experimental conditions (either 30 or 100 msec). Both objects appeared within a rectangle which subtended a visual angle of 5.7 degrees in height and 7.6 degrees in width.

Measures of response accuracy and latency were collected. For the latter, the onset of the display began a 'milliseconds' timer which was stopped by the onset of the subject's voice. The sequence of events leading to the latency measure and equipment used are shown in the diagram in Figure 7.2.

Procedure

Each subject was familiarised with the equipment and asked to sit back against the chair, facing the back-projection screen. Standard instructions and training were then administered. The subject was instructed that pairs of shapes would be presented and that he was to determine whether the two shapes were the same object replicated or two different objects altogether. If they were judged to be the same, the subject was to respond loudly with the word "same"; if they were different, he was to respond with the word "different". Both speed and accuracy were stressed - the subject was asked to respond quickly but to try to avoid making errors. Between trials the experimenter noted the latency and accuracy measures. Subjects were asked to refrain from making sounds other than the responses during any trial. A trial began with the experimenter's warning, "here is another one ... ready", and then he pressed the switch which initiated the stimulus-display and mask combination. Before the commencement of the test trials several practice trials

and training were given. Training continued until the subject understood the nature of the task and until an adequate voice amplification was found (e.g. amplified 'enough' to detect the subject's voice but not so high as to detect the various other sounds such as, the clicking of the tachistoscopic shutters). The subject was reminded to maintain a loud voice level throughout the experiment.

Stimuli were presented in blocks of 20 trials. After the presentation of four blocks, subjects rested for several minutes before the second half of the stimuli were shown. Blocks were either of the 'global' or 'attentional' stimuli. When a subject was presented with each of these blocks for the first time, he was given the relevant description of the stimuli. For the 'global' condition he was told that when the objects were the 'same' (i.e. when response was to be "same") then the objects would be exactly alike - both in identity and in orientation. If the objects were 'different' then they would differ in their identity and their orientations and size. Furthermore, he was asked to respond based on his immediate and initial impression of the display. For the 'attentional' condition, subjects were told that when the objects were the 'same' they might be oriented in different ways and if they were 'different' they might be oriented in the same way. They were then instructed that they would have to pay 'close attention' to the objects because the above contingency was not always true. When the two conditions, global and attentional were displayed subsequently, subjects were informed of the kind of block they were to be shown.

The levels-of-processing conditions appeared in blocks

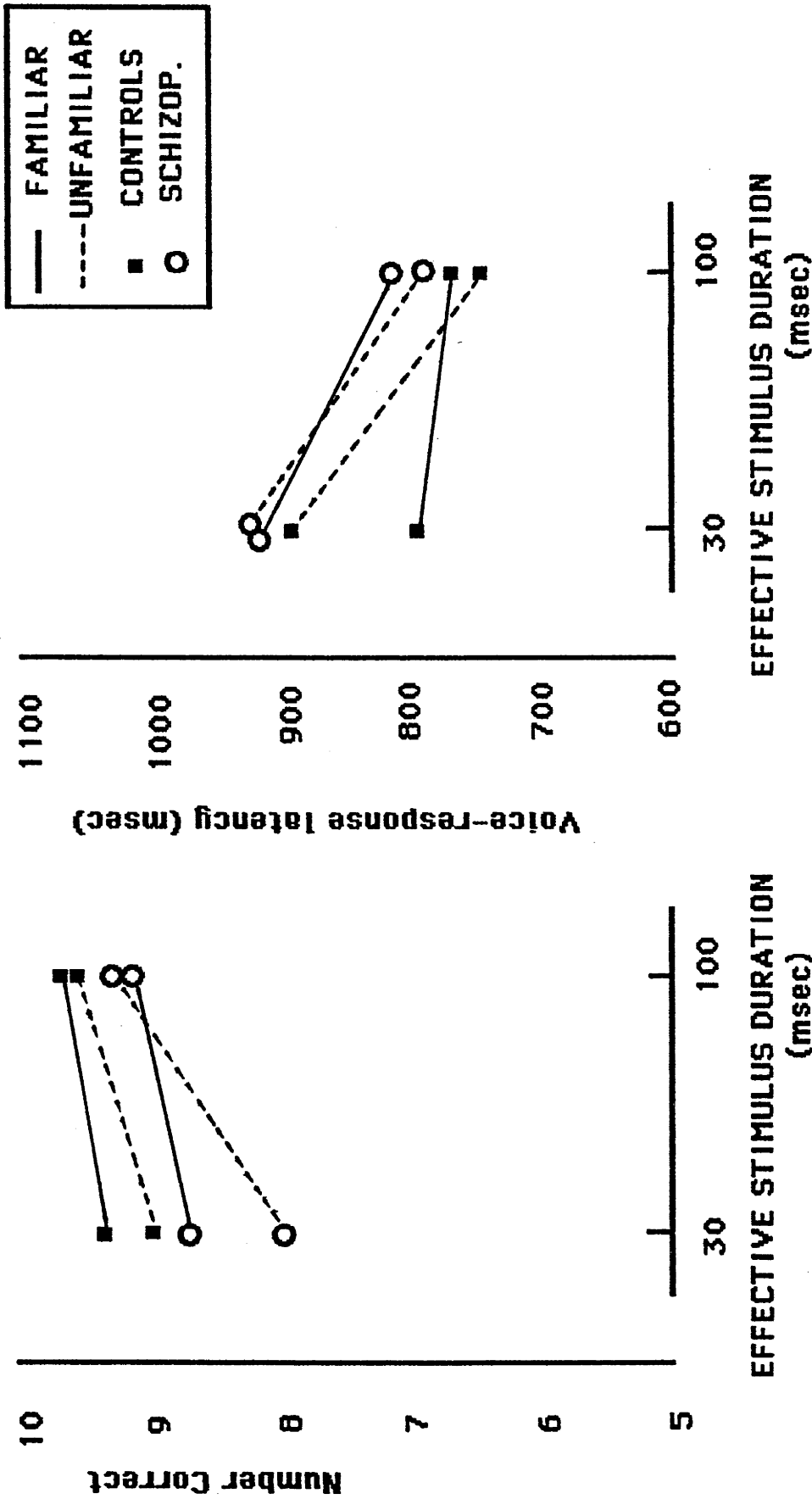


FIGURE 7.3 : Accuracy and reaction-time measures for same stimuli in the global processing condition.

containing same and different, familiar and unfamiliar stimuli, in a random order over trials. Stimulus durations and presentation order of the levels of processing was randomised across subjects. Schizophrenics and controls were matched with regard to the presentation order of the conditions.

Design and Analysis

As noted earlier, there were two groups, two levels of stimulus duration, two familiarity conditions, and two levels of processing (attentional and global). Furthermore, there were two measures, accuracy and voice response latency to be considered. Separate analyses were conducted for each of the measures (accuracy or latency) the kinds of stimuli (same or different), and levels of processing (global or attentional). The resulting analyses were of 2 groups x 2 stimulus durations x 2 levels of familiarity. This analysis draws out the effects of stimulus duration and familiarity. No special predictions were made regarding processing differences between same and different judgements although there is some evidence that, in some conditions, 'same' responses are carried out globally while 'different' responses undergo sequential feature verification (for discussions see, Bamber, 1969; Cunningham, Cooper & Reaves, 1982; Eriksen & O'Hara, 1982; Farrell, 1985; Kroll & Henderson, 1980; Krueger, 1978; Proctor & Rao, 1983).

7.32

RESULTS

Performance Analysis

Global processing 'Same' stimuli. The results are presented in Figure 7.3. Accuracy is represented in the left panel and latency in the right panel. Each point represents

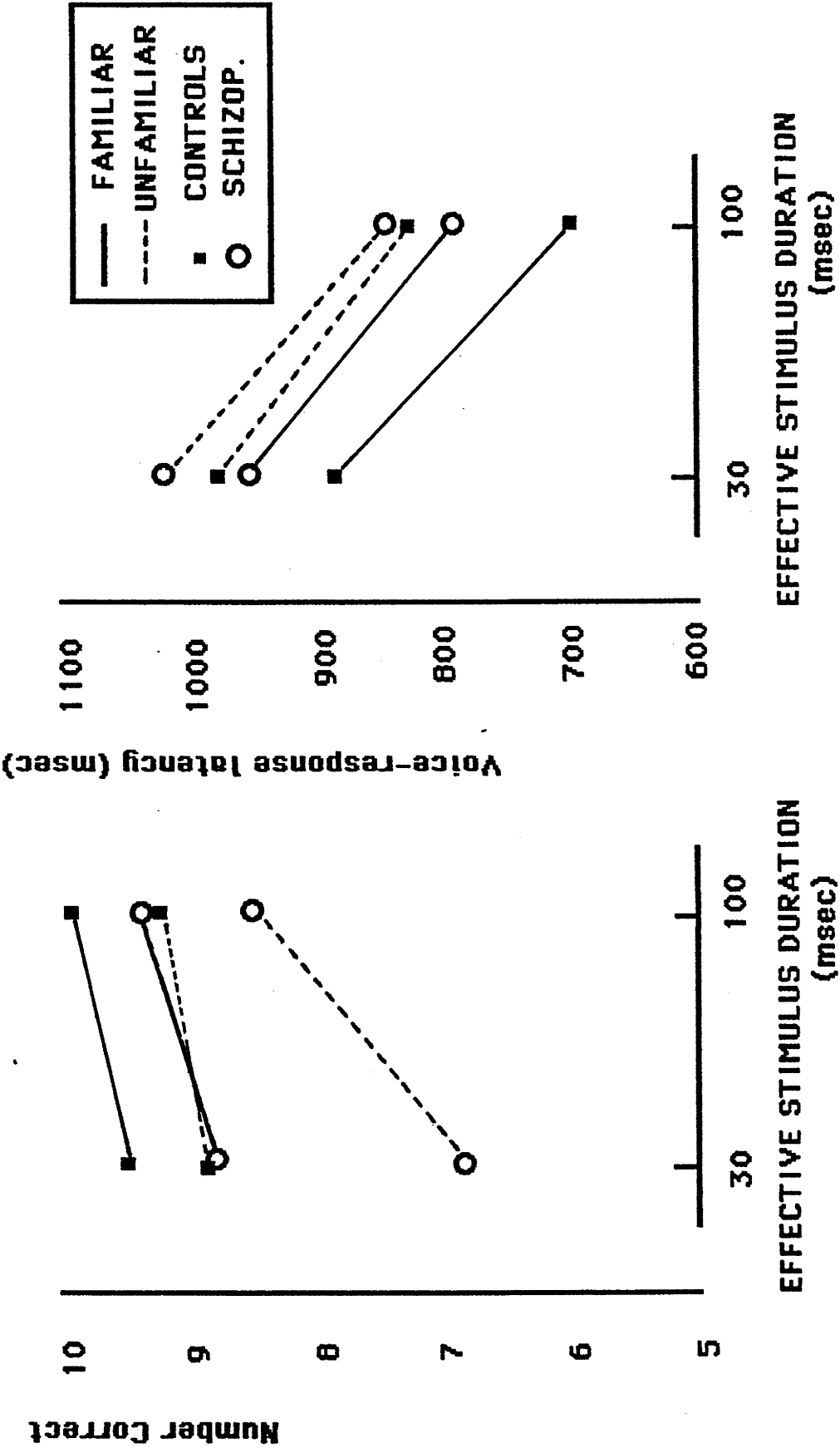


FIGURE 7.4: Accuracy and reaction-time measures for different stimuli in the global processing condition.

the mean of ten responses for that condition, over the 15 subjects of each group. Schizophrenics were found to be less accurate than controls ($F(1,28) = 5.93$, $p < 0.025$). The main effect for stimulus duration was significant ($F(1,28) = 11.32$, $p < 0.05$) and this was evident in a significant interaction of stimulus duration and familiarity ($F(1,28) = 5.18$, $p < 0.05$). It is apparent in Figure 7.3 that as the stimulus duration is reduced, the accuracy for unfamiliar objects is reduced much more than for familiar objects. Schizophrenics were found not to be less accurate than controls due to reductions in stimulus duration or familiarity.

In the latency data, the only apparent difference involving groups appears to be a familiarity effect for controls at 30 msec. However, this three way interaction failed to reach significance. Again, the stimulus duration main effect was significant ($F(1,28) = 11.92$, $p < 0.01$) and this was evident in the interaction between familiarity and stimulus duration ($F(1,28) = 4.29$, $p < 0.05$). The groups $\times$ familiarity interaction approached significance ($F(1,28) = 3.06$, $0.1 < p < 0.05$). In the latency measure (Figure 7.3, right panel) the interaction appears as a differential gain in response speed for the controls over that of schizophrenics for familiar materials.

Global processing 'Different' stimuli. Figure 7.4 contains the results for different judgements. As is apparent in the left panel, accuracy was higher for controls ($F(1,28) = 13.26$, $p < 0.01$), stimulus duration altered accuracy ($F(1,28) = 16.11$, $p < 0.001$) and the familiarity main effect was also significant ($F(1,28) = 33.27$, $p < 0.001$). In this condition the

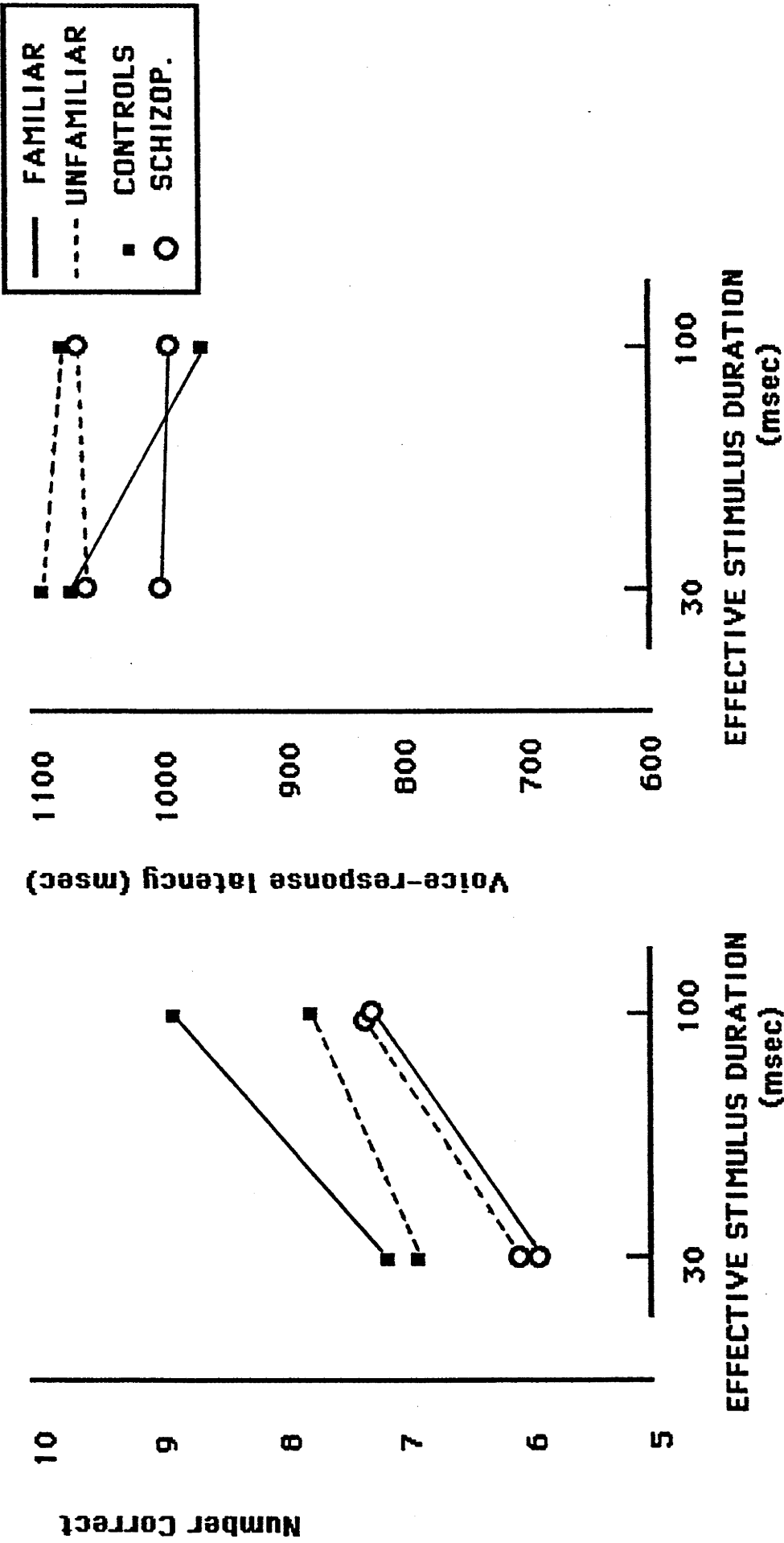


FIGURE 7.5: Accuracy and reaction-time measures for same stimuli in the attentional processing condition.

stimulus duration x familiarity interaction only approached significance ($F(1,28) = 3.09$, $0.05 < p < 0.1$). No other effects were significant.

The latency data indicated only significant main effects for stimulus duration ($F(1,28) = 25.41$, $p < 0.01$) and for familiarity ($F(1,28) = 21.71$, $p < 0.01$). All other effects failed to reach significance despite the apparent difference between groups, generally, and the differential familiarity gain of controls over schizophrenics (see, Figure 7.4, right panel).

Attentional processing 'Same' stimuli. These results appear in Figure 7.5. Schizophrenics were found to be less accurate than controls ($F(1,28) = 5.22$, $p < 0.05$). The only other significant effect was the main effect for stimulus duration ($F(1,28) = 20.31$, $p < 0.001$). In the latency data the only significant effect was that of familiarity ($F(1,28) = 8.60$, $p < 0.01$). This is apparent in Figure 7.5 (right panel) showing that the familiar objects were processed quicker than the less familiar objects.

Attentional processing 'Different' stimuli. Figure 7.6 shows the results for different judgements. As is apparent from the left panel, accuracy varied with effective stimulus duration ($F(1,28) = 27.36$, $p < 0.001$) and familiarity ($F(1,28) = 62.67$, $p < 0.001$). The interaction of these two factors approached significance ($F(1,28) = 3.00$, $0.05 < p < 0.1$). The only effect involving groups was an interaction effect of groups and familiarity but this only approached significance ($F(1,28) = 3.05$, $0.05 < p < 0.1$). As is apparent from the left

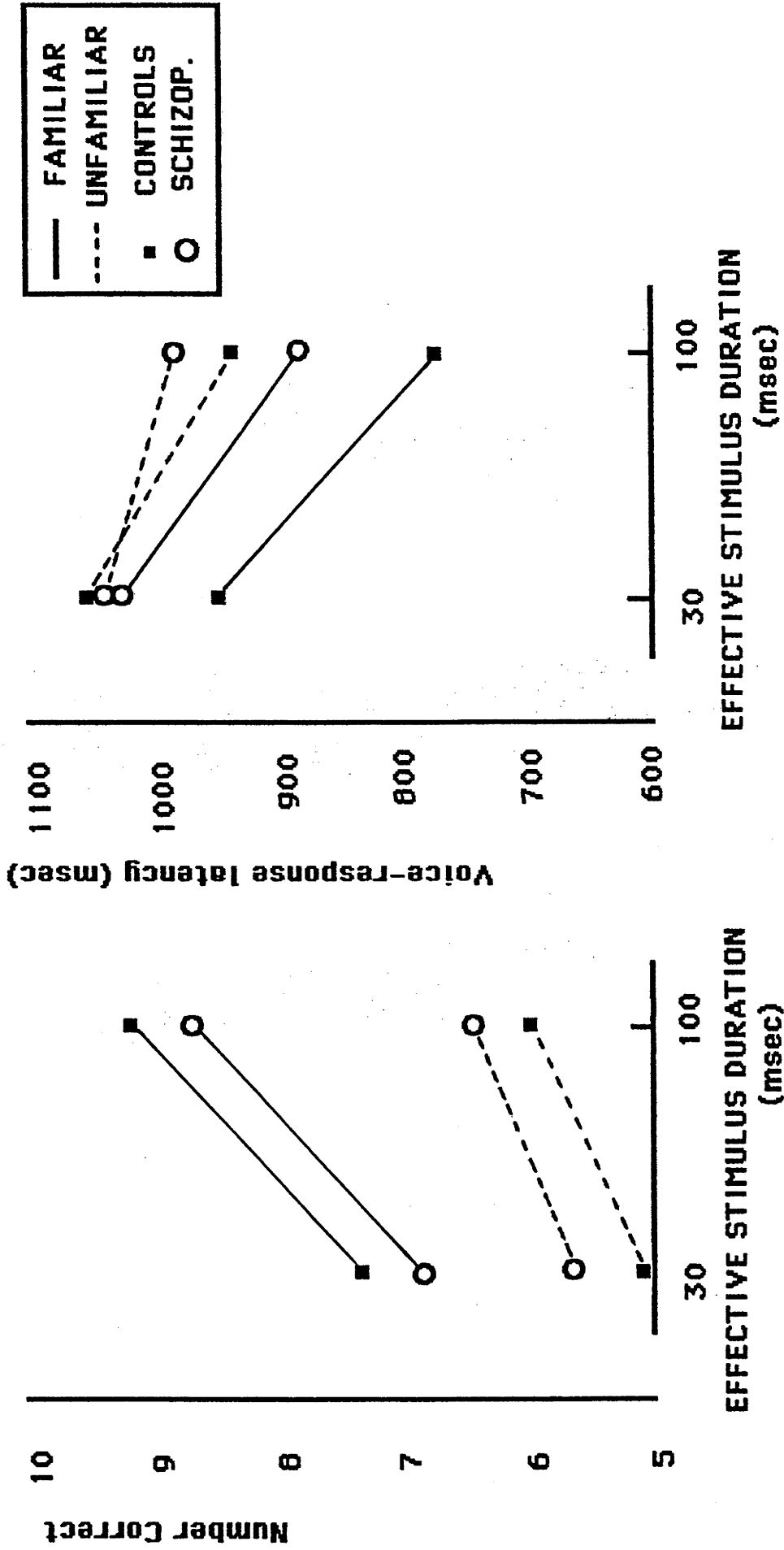


FIGURE 7.6: Accuracy and reaction-time measures for different stimuli in the attentional processing condition.

panel in Figure 7.6 this interaction involves a slightly poorer accuracy of controls for the unfamiliar objects and a slightly higher accuracy for the same group for the familiar objects in comparison to the schizophrenics. This pattern of results cannot be interpreted as a failure of schizophrenics to utilise familiarity constraints.

The panel on the right in Figure 7.6 indicates an effect of stimulus duration ($F(1,28) = 20.49$, $p < 0.001$) and an effect of familiarity ($F(1,28) = 18.31$, $p < 0.001$). The interaction of these two factors was significant ($F(1,28) = 4.95$, $p < 0.05$). In Figure 7.6 (right panel) there appears to be a greater gain in response speed for controls than schizophrenics as a function of familiarity, however, this interaction did not approach significance.

Correlational Analysis

Table 7.3 shows the correlations of the accuracy and response latency with the clinical variables. Each correlation represents combined performance in 'same' and 'different' judgements. The findings suggest that the poorer accuracy of schizophrenics compared with controls in the global processing condition might be associated with the effects of medication and a reduction in 'abstract thinking' as measured by the Proverbs test. The first order partial correlation between accuracy and Proverbs scores, partialing out the effects of medication was 0.51 ($t(12) = 2.06$, $p < 0.05$, one-tailed test), suggesting independent effects of reductions in abstract thinking and medication. Within the attentional processing condition response latency was correlated positively with the rate of hospitalization corrected for age (Table 7.3).

TABLE 7.3: Correlations of performance with the clinical measures.

	GLOBAL PROCESSING		ATTENTIONAL PROCESSING	
	accuracy	latency	accuracy	latency
Age	-.09	-.04	-.26	.14
Voc IQ	-.35	-.03	-.09	-.09
Hosp/Age	-.07	.42	-.41	.59 **
Medication	-.51 *	.24	-.12	.01
Maine Paranoid	.40	-.28	.16	-.36
Maine Non-par.	.06	-.37	.27	-.63 ***
Proverbs	.59 **	.25	.14	-.03
GAS worst	.08	.17	-.21	.40
GAS current	.27	.24	.37	.26
Harris Premorbid	-.31	.34	-.12	.40
Dysthymic States	.20	-.39	-.01	-.37
Neurotic Symp.	-.05	-.25	.32	-.38
Integ. Delusions	.35	.55 **	-.03	-.42
Disin. Delus.	.60 **	-.36	.51 *	-.26

One-tailed signif. level, (N=15)

* $p < 0.05$

** $p < 0.025$

*** $p < 0.005$

As in the previous experiments patient-reported delusional pathology measured with the DSSI was associated with better performance - greater accuracy and reduced latency in the global processing condition and greater accuracy in the attentional processing condition (Table 7.3). The finding has been difficult to explain yet appears to be consistent across the experiments. Moreover, in the present results doctors and nurses ratings on the Maine Non-Paranoid subscale were found to be correlated with negatively with latency in the attentional condition thus supporting the unexpected association between a history of psychotic symptoms and better performance.

7.33

DISCUSSION

Generally, accuracy and response speed were greater in the global than the attentional condition. In the global-processing condition, performance was generally reaching plateau level (i.e., toward 100 percent accuracy) by 100 msec stimulus duration, so that familiarity effects tended to be observable only in the 30 msec condition. At 30 msec, performance in the attentional condition reached 'floor' levels (i.e., toward the chance response selection) so that performance differences between the conditions were better observed at the 100 msec duration. In the global condition differences between groups were found in the accuracy measures for both 'same' and 'different' judgements. Only tentative evidence was found for a differential stimulus-familiarity effect between the groups and this was only evident in the latency measure for 'same' judgements. Effective stimulus duration altered the performance of the groups in a similar

way. Generally the evidence is not convincing to suggest that schizophrenics fail to utilise familiarity constraints when judgements are based on the global attributes of the objects (e.g., size, orientation). In the attentional condition differences between groups were less apparent than in the global condition - only one of the measures yielded a groups effect, and in only one case did familiarity tend to differentiate between the groups. This result, however, can be best described as a poorer accuracy of controls than schizophrenics for unfamiliar objects combined with better accuracy for familiar objects. Again, it does not appear, from these results, that schizophrenics failed to gain from stimulus familiarity. Contrary to the expectations from the attentional-deficit hypothesis, accuracy deficits were observed within the global-processing condition and the group difference in performance did not become pronounced by the attentional verification requirement in the attentional condition.

Correlational analysis indicated that reduced performance in the global-processing condition was associated with increased medication levels and with reduced 'abstract thinking' attitude. The latter effect is as expected from a possible association of thought disorder with processing deficit. The present results, in contrast to those of Experiment 1 suggest a negative effect of medication on stimulus detection. The result replicates the findings in Experiment 3, where local-letter detection was negatively correlated with medication. Differences between the two sets of results might be due to subject selection suggesting positive effects in more psychotic groups (as in the

Collection 1 subjects), whilst negative effects in remitted schizophrenics (as in most of the Collection 2 subjects). Importantly, the negative correlation in Experiments 3 and in the present experiment between performance and medication suggests stability in the processing deficit, at least over the week or so of testing.

7.4 EXPERIMENT 5: Inhibitory effects of Familiar Distractors on target detection.

The next experiment re-investigated the stimulus familiarity effect in schizophrenia. There have been several demonstrations of inhibitory effects on target processing from familiar distractors since these can activate recognition responses relatively automatically. For example, Hoffman (1980) found that familiar global letter-forms, in bilevel stimuli, interfered with processing of local targets but if the distractor stimulus (e.g. the global letter) was distorted this removed much of its ability to inhibit the processing of target letters. Similarly, Regan (1981), using response time as a measure of the interference effects of the global form on the local, showed that not only did the familiar global letters interfere more than the unfamiliar with local letter detection, but unfamiliar letter forms interfered more than a rectangular grouping of letters. Therefore, the interference effect seemed to be due to the actual letter-like organization of the global form leading to the conclusions that familiar stimuli probably exerted an inhibitory effect on target processing by activating incompatible response codes to the target (i.e. alternative recognition responses). The results, however, also favour a perceptual-interference hypothesis that performance deficit was due to the attraction of attentional

FAMILIAR
DISTRACTOR

```
HHHHHH
HHHHHHH
HH      HH
HH
HH
HH
HH
HH      HH
HHHHHHH
HHHHHH
```

UNFAMILIAR
DISTRACTOR

```
EEE      EE
EE      EE
EE      EE
EEEE
EEE
EE
EE      EE
EE      EEE
EEEEEE
EEEEEE
```

RANDOM

```
Y Y Y      Y
Y Y Y Y Y
Y      Y
Y      Y Y
Y Y Y YYY
Y Y Y
Y      Y Y
Y Y Y Y
Y Y Y Y
Y Y Y Y
```

FIGURE 7.7 : Examples of the stimulus displays showing the three kinds of distractors.

resources to the global structural level (and hence, away from the local level).

The present experiment investigated similar inhibitory effects of familiar noise in a re-test of the hypothesis that stimulus processing in schizophrenia is not influenced by stimulus familiarity. The present study was fashioned after the Regan experiments, but it measured accuracy rather than latency. Three types of bilevel stimuli were presented where the global form was either : a familiar letter; an unfamiliar form; or, a random pattern containing the same number of small letters as the other patterns. Examples are shown in Figure 7.7. The subject was asked to select, as in Experiment 3, from a limited set of responses, which of the local letter was presented. (In contrast to Experiment 3, the task was always to detect the local letter.) It was expected that, if schizophrenics failed to process according to the familiarity of the stimulus, then there would be no difference in target detection between familiar, unfamiliar and random noise conditions. That is, schizophrenics should not have experienced interference effects for the familiar distractor condition in contrast to controls. In contrast controls were expected to be more distracted by the familiar and perhaps the unfamiliar global form compared to the random noise condition.

The effective stimulus duration was also varied to observe its effect on processing. It is possible, for example, that with prolonged stimulus duration the differences between the materials will not be evident since attentional resources may be re-allocated to the targets than to the distractors (Paquet & Merikle, 1984).

TABLE 7.4 : Means and standard deviations of the descriptive data.

	CONTROLS		SCHIZOPHRENICS	
	mean	s.d.	mean	s.d.
AGE *	23.3	6.6	28.0	6.0
VOCAB.	12.5	1.7	12.1	2.0
PROVERBS* *	42.4	5.0	32.0	9.4

* $p < 0.05$
* * $p < 0.025$
(two tailed tests)

Subjects

Fifteen schizophrenics and 15 controls participated in the present experiment. Their descriptive data are represented in Table 7.4. As in previous experiments t-test analysis revealed a significant differences in the age of the groups and in the Proverbs Adjusted scores ($t(28) = 2.05$ $p < 0.05$ and $t(28) = 3.78$ $p < 0.025$, two-tailed tests, respectively).

Apparatus and materials

The same equipment was used as in Experiment 3. Displays were constructed as were those for that experiment by using a PDP11 computer to generate the stimuli. Examples of these stimuli were presented in Figure 7.7. Presentation dimensions, masking displays and luminance values for all displays were similar to those of Experiment 3. Five blocks of stimuli were constructed, each with five displays of each distractor type.

Procedure

The subject sat facing the back-projection screen. Examples of the stimuli were shown and the subject was told which of the objects would be the targets (e.g. 'the small letters'). Preliminary stimuli were introduced in slow presentation times and the subject was asked to simply state what the small letter was in each display. About five (rapid) practice trials were required on average since the task was simple to understand. No response selection sheet was given in this task (c.f. Experiment 3). There were five blocks of stimuli but in the experiment one block was shown twice. This was randomised in the course of randomising the order of

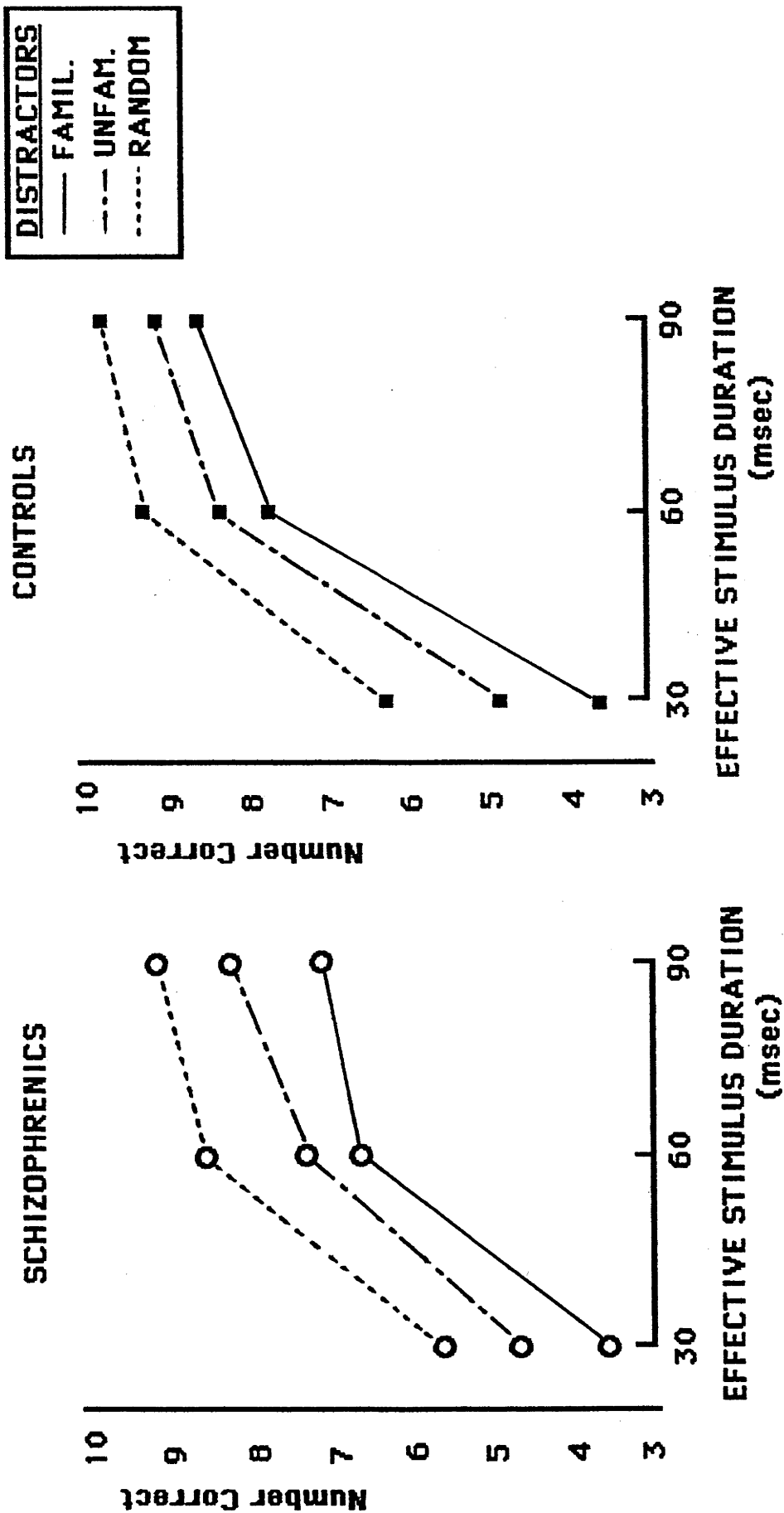


FIGURE 7.8 : Performance in the three distractor conditions.

presentation of the blocks. The order of the exposure durations were also randomised for the subjects but for each subject the first half of the experimental trials (45 trials) contained the same order of exposure durations as the second half.

Design and Analysis

The results were analysed using a 2 (groups) x 3 (distractors) x 3 (exposure durations) analysis of variance with repeated measures on the last two factors.

7.52

RESULTS

Performance Analysis

The results are presented in the two graphs of Figure 7.8 which shows the mean accuracy of each group as a function of effective stimulus duration and the distractor variables. As can be seen in the graphs reductions in stimulus duration reduced accuracy and this was evident as a significant main effect for effective stimulus duration ($F(2,56) = 88.33$, $p < 0.001$). The main effect for the distractor-type was also significant ($F(2, 56) = 29.85$, $p < 0.001$). No other effects were found to be significant. As can be seen in the graphs, the distractor effect of familiar distractors is consistently greater than that of the unfamiliar distractor which is, in turn, greater than that of the random pattern distractor. It is also evident that the two groups experienced similar levels of distraction.

Correlational Analysis

The results of the correlational analysis are shown in Table 7.5 which represents the correlations of performance

TABLE 7.5: Correlations of performance with the clinical measures.

	familiar	unfamiliar	random
Age	-.54 **	-.56 **	-.43
Voc IQ	.07	.00	-.06
Hosp/age	-.57 **	-.54 **	-.31
Medication	.27	.23	.24
Maine Paranoid	.15	.08	.12
Maine Non-par.	.43	.36	.24
Proverbs	-.23	-.24	.02
GAS worst	.24	.13	.19
GAS current	-.15	-.12	-.06
Harris Premorbid	.00	-.18	-.30
Dysthymic States	-.03	-.31	-.45 *
Neurotic Symp.	.13	-.27	-.40
Integ. Delusions	-.32	-.42	-.40
Disintegrat. Delus.	-.07	-.34	-.20

One-tailed signif. level, (N=15)

* $p < 0.05$

** $p < 0.025$

with the clinical variables in each of the distractor conditions. The results suggest that age differences between the groups may have influenced the performance of schizophrenics adversely. Furthermore, the rate of hospitalization corrected for age was found to be negatively correlated with accuracy on the task. Finally, those subjects scoring higher on Dysthymic States in the DSSI were found to score more poorly on the task. It should be recalled, however, that in the present task schizophrenics were not significantly poorer than controls on the task suggesting only a minor contribution of these variables.

7.43

DISCUSSION

The main result in this experiment was that schizophrenics showed similar performance to controls across the distraction conditions; the interference expected from familiar distractors and from the organization of the global stimulus into a letter-like, but unfamiliar form, was similar for the groups. These results resemble Regan's (1981) results which were based on reaction-time measurements. Interestingly, the groups were not found to differ in their overall performance - a finding that is unique in the present series of experiments. The familiarity effects were consistent with the findings of Experiment 4 and with those of Russell and Knight (1977) indicating that schizophrenics are sensitive to familiarity with regard to stimulus processing.

7.5 Chapter Summary

It was thought that schizophrenics might not have utilised familiarity constraints for processing visual

information and that this may have been the cause of the performance deficit observed in the previous experiments. However, two experiments investigating this hypothesis failed to provide evidence for a processing difference between the groups. First, using an object matching task, familiarity was shown to influence performance within global processing but the performance of both groups were similarly influenced by this variable. In the second task, familiar distractors had similar effects on target processing for schizophrenics and controls.

Experiment 4 also investigated the hypothesis that schizophrenics would perform more poorly in the attentional-processing condition rather than in the global-processing condition compared with controls. This would have supported the results of Experiment 2 which suggested slow attentional scanning in schizophrenia. However, the results did not favour the attentional-deficit hypothesis and in fact indicated poorer performance of schizophrenics relative to controls in the global-processing condition.

CHAPTER 8. REVIEW OF THE DEFICIT HYPOTHESES AND CONCLUSIONS

8.1 Synopsis of Previous Findings

The central aim of the present work was to investigate whether visual information-processing disorder in schizophrenia could be attributed to a dysfunction within a particular level of processing. It was clear from the review of studies using general measures of visual-processing in schizophrenia, including phenomenological reports, measures of perceptual constancy, and voluntary eye-movement measures, that schizophrenics both in acute and chronic phases of the illness can experience aberrant perception. Other evidence suggested that even when perceptual distortions were not subjectively evident schizophrenics were less adept than controls at processing information within the first few hundred milliseconds of its presentation. Although other explanations of these disorders are possible, for example the eye-movement disorder in schizophrenia might be due to physiological impairments in the frontal-lobe eye-fields (see, Levin, 1984a, 1984b) and not necessarily related to perceptual processing (c.f., Cegalis & Sweeney, 1981; Mather & Putchat, 1986), the disruption of 'figural synthesis' was proposed as a unifying construct.

Evidence from the phenomenological reports described in Chapter 2 suggested that the processing dysfunction in schizophrenia involves disruptions at the level of both focal attention and a failure at preattentive processing. In the perceptual constancies literature, explanations of the disorder ('underconstancy' and 'overconstancy') revolved around a breakdown selective mechanism which was supposed to be 'primed' by experience and responsible for the responding

to relevant cues in the stimulus field (Weckowycz & Blewett, 1959). However, it was suggested in Chapter 2 that this notion was only reasonable for explaining the 'overconstancy' judgements, since normal subjects make such judgements in conditions where size-distance cues are fully available. Furthermore, the explanation dealt sufficiently with the relative failure of schizophrenics to perceive 'embedded figures' and their abnormal susceptibility to the Muller-Lyer illusion. Underconstancy judgements, however, could not be explained through the same process. Since non-schizophrenics make such judgements when size-distance cues are absent, schizophrenics, especially chronic non-paranoid patients, might simply be insensitive to the available visual cues.

The second objection raised in Chapter 2 was to the mechanism thought to underly the deficit as proposed by Weckowycz and Blewett (1959). This concerned the notion that the processing failure was in an 'active-search' mechanism for scanning the visual field. Instead, it was suggested that the process of constancy might involve an 'automatic' calculation of the size-distance relation and not be subject to processing effort (Kahneman, 1973). This would suggest a failure at the level of activating an automatic level response as depicted in the information processing model presented in Chapter 4 (Figure 4.1).

Eye-movement studies indicated that schizophrenics, and particularly chronic patients, suffer from voluntary visual-tracking disorders which seemed to be linked to measures expected to indicate the adequacy of 'figural synthesis'. Increasing the attentional demand of the task improved the

performance of schizophrenics suggesting an improvement in 'figural synthesis' (Cegalis and Sweeney, 1981). However, it was pointed out in Chapter 2 that these results were ambiguous with regard to the mechanisms involved. It remained unclear whether, in the original, low-demand visual-tracking task, controls allocated attention to the task more often than schizophrenics or whether controls were more accurate than schizophrenics in 'calculating' the stimulus position by preattentive analysis.

In Chapter 3 studies that could provide direct information about the processing levels were reviewed. Most of these studies were influenced by the model of 'iconic processing' and post-iconic selection. The generalization of this model to schizophrenia in the literature suggested some new hypotheses about the nature of the visual processing deficit based on the possibility that the time course of iconic processing was disordered. The two specific hypotheses were that the icon of schizophrenics either decayed abnormally slowly, or that it decayed abnormally fast. Both conditions would result in a reduction in the amount of information received. In Chapter 3 it was concluded that there was no evidence for the 'rapid decay' hypothesis, but there was some support for the 'slow decay' hypothesis. However, it was argued that this hypothesis was indistinguishable from the notion that iconic processing (i.e., the development of the icon) was deficient. It was seen that one major conceptual problem was the idealization of iconic decay as invariable with respect stimulus parameters. Moreover, it remained possible that the slow decay hypothesis was reducible to a hypothesis that schizophrenics had poor feature registration,

poor figure-ground resolution, or failed to gain from familiarity constraints, as depicted in the model in Chapter 4. Any of these processes could be responsible for the performance failure of schizophrenics relative to controls.

The rest of the literature in Chapter 3 was classified according to the model presented in Chapter 4. This model did not accept the simple notion of the icon but stressed that sensory registration and preattentive processing were two processes within the formation of the icon while post-iconic selection and organization involved the process of item-to-location conjunction. Based on this elaborated model the literature was grouped into three types of studies measuring: 'simple' thresholds (sensory registration); 'complex' thresholds and studies of preattentive organization (preattentive processing); studies of the effects of display-load on processing efficiency and 'masking vulnerability' (post-iconic selection). Studies of stimulus familiarity were analysed separately in Chapter 7 since these were very few and this issue was largely unexplored in the schizophrenia literature.

Briefly, studies of 'simple' thresholds, with the exception of the unreplicated work of Collins et al. (1978), failed to find differences between schizophrenics and controls. This would suggest that sensory registration is adequate in schizophrenics. On the other hand, the first level of information-processing disturbance was suggested in Chapter 3 to be in preattentive processing since schizophrenics exhibit higher 'complex' thresholds for detection (Cox & Leventhal, 1978; Pharr & Connor, 1980; Stilton & Koppell,

1964) and reduced utilization of gestalt organization in the stimulus (Frith et al., 1983; Place & Gilmore, 1980; Wells & Leventhal, 1984). Indeed, the effects of orthogonal variations in stimulus 'gestalt-organization' and display-size, indicated a normal response in schizophrenics to increased stimulus display-load suggesting that preattentive-processing is specifically impaired (Place & Gilmore, 1980). The preattentive-deficit hypothesis also explained the effects of visual masking found by Knight et al. (1985) by a failure in schizophrenics to separate the target features from the features of the mask, the two having become perceptually integrated due to the rapid succession of the target display and the mask. However, in Chapter 3, it was also noted that not all studies supported the preattentive deficit hypothesis despite ostensibly similar stimulus variations of target-noise discriminability - notably, Davidson and Neale (1974) - suggesting the need for further exploration of this variable.

Display-load effects found by Place and Gilmore (1980) cast doubt on the hypothesis of a failure in the focal-attention process since they demonstrated a normal response in schizophrenics to variations in display-size. However, the display-load effect on schizophrenics' performance has been inconsistent and all possible outcomes of display-load have been reported, including a positive effect on target-report (Davidson & Neale, 1974). Post-iconic selection deficit was also suggested by the work of Saccuzzo and colleagues using masking on single-letter stimuli. They suggested that showing the target displays at the subject's own critical stimulus duration should 'equalise' subjects with respect to icon-formation variables. Post-iconic selection could then be

observed through masking at various stimulus-onset asynchronies. Saccuzzo and colleagues found, in general, that schizophrenics were poorer than control groups in reporting targets under masking conditions supporting the hypothesis of 'slow' post-iconic selection mechanisms.

8.2 Synopsis and Integration of the Present Experiments

In view of the disagreements in the literature about the level of processing that is impaired in schizophrenia, the first study concentrated on the distinction between the two major levels using an error analysis of letter-identification performance. Two types of errors, intrusions and mislocations had been used in the literature (Butler, 1980, 1981; Butler & Currie, 1986; Styles & Allport, 1986; Treisman & Schmidt, 1982) to indicate, respectively, the failure of an early process of 'identification' and the later process of selection and item-to-location conjunction.

Intrusion errors were seen as reflecting a failure of sensory registration and preattentive processing which normally leads to an automatic activation of stimulus identity information. In terms of the information processing model presented in Figure 4.1, a trade-off of correct responses with intrusion errors would indicate a failure to elicit an automatic level response. In contrast, mislocation errors were seen as reflecting the failure in focal attention - either in selection conditions (as when the selection cue occurred prior to the presentation of the stimulus) or in selection and organization conditions (as when the cue appeared after the stimulus). Selection and organization were thought to be functions of focal attention (Figure 4.1). Stimulus onset

asynchrony and display-size have been shown to limit each processing-level selectively - intrusions increased with reductions in the effective stimulus duration (i.e., stimulus onset asynchrony) and mislocations increased with increases in display size.

In Experiment 1, in the Focused Attention Condition, schizophrenics were found to make more intrusion errors than controls, lending some support to the preattentive deficit hypothesis. This finding is generally consistent those studies suggesting either that input registration (e.g., Collins et al., 1978; Saccuzzo & Braff, 1981) or that perceptual organization (Cox & Leventhal, 1978; Place & Gilmore, 1980) is deficient in schizophrenics. It is also consistent with the notion that perceptual cues are unavailable leading to reduced visual tracking ability (Cegalis & Sweeney, 1981). Thidly, it is consistent with the findings that some schizophrenics make underconstancy judgements in size-distance constancy tasks (Weckowycz & Blewett, 1959) since this was suggested in Chapter 2 to be due to an absence of available information at an automatic processing level.

However, the performance of schizophrenics did not deteriorate beyond the level of the controls' with reductions in stimulus onset asynchrony, suggesting that the limitation in processing might not have been in preattention. According to the explanation based on a preattentive deficit, as the trailing mask approaches the onset of the stimulus the two events should become integrated in perception (Hellige et al., 1979). As a result the rate of intrusion errors would be expected to increase since the features of the target would

not be distinguishable from the mask. (Notably, under normal, unspeeded presentations the stimulus was arranged to be indistinguishable from the mask when the two were superimposed). Although the intrusion error rate did increase as predicted with reductions in the effective stimulus duration, the expected interaction effect between groups and effective stimulus duration was not evident.

It was suggested, alternatively, that a greater rate of intrusions could be expected simply based on variables such as poor motivation or general inattention to the task. This would also suggest that the results of other studies reviewed above might possibly be attributed to this idea. However, further analysis of the constitution of intrusion errors by segregating them into reported letters and "don't know" responses did not seem to support the motivation or inattention explanations since the number of "don't know" responses did not differ appreciably between schizophrenics and controls. Despite the lack of the expected interaction (between groups and stimulus onset asynchrony for intrusion errors) the general group effect tentatively supports the preattentive deficit hypothesis.

In addition, in Experiment 1 it was found that in the Focused Attention condition the rates of mislocation errors were similar for the two groups. This indicates that selection by focal attention was within normal limits in the schizophrenic sample. It seems that the present sample of schizophrenics was not abnormally distracted by additional non-targets in the display. This finding contradicts the results of Broga and Neufeld (1981) who noted that both paranoid and non-paranoid schizophrenics failed to perform as

well as controls in a pre-stimulus cueing condition similar to the present conditions. Their interpretation of the result was that there is a selection failure in schizophrenics (Broga & Neufeld, 1981). However, in that study the advantage that controls had over schizophrenics might have been due to maintaining the display size constant over trials so that the result may reflect a comparatively better adaptation of controls to the constant mapping of items to display positions. That is, controls improved over schizophrenics with the number of trials because they were able to learn a strategy for allocating attentional focus to the target position over the duration of the task. The present experiment used various display sizes presented randomly and this could have precluded such an advantage. Unfortunately no other studies utilised this paradigm and practice effects were not analysed by Broga and Neufeld (1981) to further clarify this point. Nevertheless, the present results do suggest that in a single act of selection, with little possibility for inter-trial practice in focusing attention, schizophrenics are not more distractible than normal controls.

In the Divided Attention condition of Experiment 1 accuracy generally reached chance levels. Somewhat contradictory to the conclusion of a preattentive deficit, no consistent difference in the pattern of errors was observed between the two groups.

Analysis of the error probability over the positions in the display revealed similar error distributions suggesting similar patterns of attending to the display in the two groups. The latter result, considering the Focused Attention

condition, contradicts the pattern of limited scanning of a display by chronic schizophrenics as found in some of the eye movement studies which concurrently investigated the breadth of attentional focus (Cegalis et al., 1975; Cegalis & Tegmeyer, 1980). In the present experimental conditions schizophrenics seemed to scan the display as broadly as controls, and generally with the same biases for particular display positions over others. The random distribution of targets in the nine locations of the display in the present Experiment as opposed to the conditions in the Cegalis work where attentional focus could be expected, across trials, to be shifted to generally predictable locations might have led to the different findings. In the Cegalis work, in contrast to chronic schizophrenics, controls might have utilised broader scanning by learning over trials where the stimulus would appear. The findings of Kojima et al., (1986) which indicated that such scanning modification was possible through direct verbal instruction suggest that this is a plausible explanation. In the present task the unpredictability of targets and distractors in the vertical and horizontal planes may not have allowed controls to scan broadly, but may have restricted them to multiple, small-focused processing actions, just like the schizophrenics. Further experiments are required to investigate the possibility of different inter-trial effects between schizophrenics and controls since such effects have been evident in similar visual processing tasks in normals (Schneider & Shiffrin, 1977).

Experiment 2 tested the hypothesis that preattentive processing is abnormal in schizophrenia using a visual search task. It was expected that if the preattentive process of

similarity-grouping by colour was deficient in schizophrenia then they should show no difference in decision-time between sorting cards that contained colour cueing and those that did not (serial search should have been obtained regardless of colour-cueing). In contrast, controls were expected to improve in sorting time in the colour-cued displays and their performance was expected to show a 'display-size' effect reflecting restricted visual search of letters that were colour-congruent with the target. This was considered a strong version of the theory of preattentive deficit since, in contrast to controls, it maintains that there is no preattentive analysis in schizophrenics.

Contrary to these expectations, it was found that both groups improved with the presence of colour cues. In addition, it was found that display-size had proportionally similar effects on decision-time in the two groups. Schizophrenics simply appeared to take longer to make decisions about the presence of the target compared with controls in all of the displays. It was suggested that this deficit reflected slower inter-letter scanning or slower noise rejection mechanisms in schizophrenics compared with controls. These proposed mechanisms made similar predictions to a weaker version of the preattentive deficit hypothesis which maintained that preattentive processing simply took longer to provide products to focal attention in schizophrenics than controls. This mechanism in combination with an adequate attentional mechanism could well account for the discovered pattern of results in Experiment 2. It is also consistent with the tentative evidence for a preattentive deficit in Experiment 1 in contrast to either the 'slow-scanning' hypothesis or the

'slow noise rejection' hypothesis. The latter mechanisms would predict generally a greater rate of mislocation errors in schizophrenics compared with controls in Experiment 1 which was not evident in the results. In Experiment 2 practice effects were also analysed finding that the performance difference between the groups could not be attributed to this variable.

It remained possible that colour-cueing in Experiment 2 was so salient that even a deficient process might have been capable of similarity-grouping to some degree. Moreover, target-noise discrimination was suggested in Chapter 3 to be the basis of the masking effect as well as the demonstrated failures in performance in the preattentive tasks (e.g., Cox & Leventhal, 1978). Experiment 2 was conducted using only a single level of target-noise discriminability so that performance variance due to discriminability could not be assessed. Therefore, target-noise discrimination was varied in Experiment 3.

It was found that schizophrenics were not more vulnerable to the effects of reduced target discriminability than controls failing to confirm the expectations from the preattentive deficit hypothesis. Nevertheless, schizophrenics were found to perform more poorly than controls in this task, particularly in the global processing condition, replicating the general finding of the previous Experiments. The possible difference in difficulty level (based on acuity) between the two conditions could account for the differential deficit found between the global and local level of analysis, consonant with Chapman and Chapman's (1973) concerns (see Chapter 4). The

effect in the local condition, however, did approach significance suggesting that there might be a similar performance deficit in this condition compared with the global level condition. That is, the results suggest a general deficit in target detection regardless of level of stimulus structure, discriminability and effective stimulus duration.

In addition to these findings, the results of Experiment 3 suggested that the processing advantage of global over local levels of stimulus structure, as determined by target discriminability and stimulus onset asynchrony, was equal in the two groups. According to the model presented in Figure 4.1, attentional allocation based on figure ground resolution occurring at the first processing stage was found to be normal in schizophrenics. These results do not support the preattentive deficit hypothesis, nor do they fit with the notion that the attentional mechanism is dysfunctional in schizophrenia. Furthermore, it suggests that the 'balance' between preattentive and attentional strategies adopted in the task was the same in the groups. (The notion of 'balance' will be discussed below.)

The discriminability findings directly contradict the results of Cox & Leventhal (1978; and more tentatively, Russell & Knight, 1977) but fit well with those of Davidson and Neale (1974). In the latter experiment Davidson and Neale observed an equal effect of target-noise discriminability in the groups and an additional improvement in performance due to massed practice. Since preattentive mechanisms are by definition automatic the improvement observed by Davidson and Neale most probably reflects a practice effect in focusing attention. In any case, no differences between schizophrenics

and controls were observed as a function of either target discriminability or practice by Davidson and Neale, comensurate with the results of Experiment 3.

The failure to find a differential effect for discriminability across the two groups calls into question the tentative support of Experiment 1 for a preattentive deficit based on intrusion errors. Furthermore, it suggests that the weaker version of the preattentive deficit hypothesis suggested as an explanation for the findings of Experiment 2 might not be appropriate. The weaker version of the preattentive deficit hypothesis would predict the same pattern of results in Experiment 3 as those of Cox and Leventhal (1978) - that is, an interaction effect between groups and discrimination difficulty - which was not apparent.

The deficit hypotheses were re-examined in Experiment 4 using an object-matching task. In one condition object-matching judgements could be made based on a global representation of the stimulus shapes, which were exactly the same when 'same' responses were correct and differed in general orientation and size when 'different' responses were correct. In another condition judgements were expected to be based on an attentional feature-by-feature verification process. In this case, same stimulus shapes were rotated relative to each other when the correct response was 'same' and they had generally similar orientations when the shape-pairs were 'different'. Contrary to expectations from the attentional-deficit hypothesis group differences were observed more reliably in the 'global' condition than in the attentional processing condition - the additional requirement

of feature verification in the attentional condition apparently did not change the difference in performance between schizophrenics and controls.

Again the more pronounced differential deficit found in the 'global'; rather than 'attentional' condition in Experiment 4 is consistent with a failure in preattentive processing. According to the model in Figure 4.1 an automatic preattentive response could be elicited based on the early registration and organization of the stimulus objects. There is minimal requirement for attentional feature verification in the global processing condition. Schizophrenics were found to be less accurate and slower at judging that two objects were the same compared with controls, suggesting they might have attempted to do the task using attentional strategy. However, the differential deficit was not found for 'different' judgements in the global processing condition and it remains possible that the initial result was obtained merely by chance.

Since the earlier experiments in this series failed to clearly identify the processing factors responsible for the difference in performance between schizophrenics and controls, the simple model of processing was extended to include possible influences of stimulus familiarity on processing efficiency. A failure to use stimulus familiarity could well account for increased intrusion errors as found in Experiment 1 and the reduced accuracy in the detection task of Experiment 3 (particularly in the 'global' level condition). It might have also explained the performance difference between the groups in visual search (Experiment 2). As suggested by the model in Figure 4.1 stimulus familiarity has been found to

influence stimulus integration through parallel processing of a number of stimulus features (which LaBerge termed 'unitization') and by modifying attentional focus. (It was also noted that these two proposed processes might simply be one phenomenon - feature localization - see Chapter 4 for discussion.)

Contrary to expectations, Experiment 4 found that the present sample of schizophrenics utilised familiarity in stimulus processing to the same extent as controls. Furthermore, in circumstances where a failure to utilise familiarity could result in better detection (since familiarity exerted an interference effect) schizophrenics were found to be normal compared with controls (Experiment 5). The present results are consistent with the findings of Russell and Knight (1977) who also found that familiarity of stimuli (letter strings in their case) afforded the same processing advantage in both schizophrenic and control groups. Neither the present results nor those of Russell and Knight support the results of Pharr and Connor (1980) who found a reversed familiarity effect in chronic schizophrenics (an advantage for random letter strings) while in acute schizophrenics there was no effect of familiarity. The number of experiments in the literature on this issue is small and precludes any strong conclusion to be drawn, especially since all the studies (including the present) used small samples. However, the present findings do not support the idea that there is a differential effect in the groups for stimulus familiarity.

Across these experiments the masking-vulnerability

effect reported by Saccuzzo and associates could not be replicated. Stimulus onset asynchrony was varied in Experiments 1, 3, 4, and 5. None of the measures (including unconstrained letter-identification (Experiment 1), limited-choice letter detection (Experiments 3 & 5), and, simultaneous object-matching accuracy and response-time (Experiment 4)) yielded any evidence for an interaction between diagnostic groups and effective stimulus duration. Notably, all of these experiments showed strong main effects of stimulus onset asynchrony. Nor can it be argued that stimulus onset asynchrony was not varied sufficiently to indicate the effect, since in some of the tasks (i.e., see Experiments 1, 3, & 5) performance was observed to vary between 'floor' and 'ceiling' levels.

Neither were there consistent differential effects on processing between the groups due to variations in display-load. According to the attentional-deficit hypothesis, the performance of schizophrenics should have been equal to controls for small display loads but it should have deteriorated progressively compared with controls as the load increased (i.e., Neale's (1971) finding). In the partial-report task (Experiment 1), the 'accuracy' results indicated an interaction between groups and display-size in both attention conditions, but in each case this was in the opposite direction to that expected from the attentional-deficit hypothesis. In the present task, performance differed between the groups for displays with few items but was matched for displays with many items. In the Focused Attention condition this 'opposite' interaction was evident only in the 100 msec effective stimulus duration condition. However, the

main effects of Groups in the other two effective stimulus durations is also contrary to the expectations from the attentional-deficit hypothesis.

In Experiment 1, if one compares the groups in conditions where performances of the groups were equal for single item displays the deterioration in performance due to increasing display size was also of equal degree across the groups (compare in particular 'correct responses' at 100 and 150 milliseconds in Figures 5.4 and 5.5). Furthermore, normal display-load effects were found in Experiment 2. In Experiment 4, the attentional condition was assumed to require more feature-by-feature verification between the simultaneous objects compared with the global attention condition. In this respect the attentional condition in this task can be considered to have an effect on processing similar to an increase in the number of elements in the more traditional display-size variations. Again there was little evidence that schizophrenics were particularly poor in performing in this condition.

The display load results seem to be robust, they are consistent with the results of a number of studies (Alumbaugh, 1976; Davis, Glaros & Davidson, 1981; Place and Gilmore, 1980; Russell, Consendine & Knight, 1980). However, they contradict Neale's (1971) findings and the subsequent replication work (Asarnow et al., 1978; Asarnow & MacCrimmon, 1981). The contradictions cannot be resolved simply by suggesting that the processing tasks differed across the studies since Davis, Glaros and Davidson (1981) used the same task as Neale (1971) finding no differential effect of display load in the groups.

It is possible that variations in subject selection criteria could explain the conflicting results across these and other studies if it is assumed that some subtypes of schizophrenics are especially vulnerable to the effects of display load. However, since the replication studies (e.g., Asarnow et al., 1978; Asarnow & MacCrimmon, 1981) attempted to argue that the span of apprehension deficit is an index of vulnerability to the heterogeneous class of schizophrenia it is expected that subtypes are irrelevant. That is, these studies suggested that remitted schizophrenics, children thought to be vulnerable to the disorder by genetic means, and non-symptomatic schizotypes should all have a deficit in information processing, particularly when display-load is increased. This literature does not distinguish among the possible subtypes of schizophrenia. Yet despite the expectation that subtyping is not critical to the result it remains possible that selection biases are operating across the studies.

(Note: Cash et al.'s., (1972) finding that increasing display-load was associated with better performance does not fit the general body of results and would therefore have to be discounted as an effect any theoretical value. Also Cash et al., found this effect using the whole report task rather than a partial report procedure suggesting that the finding might have been due to the greater probability of processing an item when there were more presented.)

In conclusion, the results of the present experiments have not clearly supported either of the preattentive or attentional deficit hypotheses. All but the results of Experiment 5 indicated impaired performance in schizophrenics

relative to controls, consistent with most of the previous literature. However, the impairment could not be attributed to processing factors associated with any processing level. That is, stimulus onset asynchrony, target-noise discriminability, display-load, stimulus familiarity, attentional distribution strategy and practice, did not seem to be factors in explaining the processing difference between schizophrenics and controls in the present experiments. Equal effects of practice and similar performance patterns across the conditions of the various experiments also suggest that differential motivation and general attentiveness to the task were not sufficient to explain the performance differences between the groups.

8.3 Re-evaluating the preattentive-deficit hypothesis

Given the present failure to support the preattentive-deficit hypothesis it is necessary to re-evaluate the previously published studies supporting this hypothesis. There are two lines of evidence in the literature for the hypothesis: findings that schizophrenics perform more poorly in measurements of 'complex' thresholds compared with 'simple' thresholds (Cox & Leventhal, 1978; Pharr & Connor, 1977; Stilton & Koppell, 1964); and, demonstrations that schizophrenics are insensitive to Gestalt organization in stimuli (Frith et al., 1980; Place & Gilmore, 1980; Wells & Leventhal, 1984). The aim of the present section is to explore this evidence in some detail. I will concentrate on two studies which are considered to provide the principle evidence for the hypothesis (Knight, 1984).

In the first line of evidence, the definitive study is

that of Cox & Leventhal (1978). They based their conclusions that there is a preattentive deficit in schizophrenia on the finding that performance differences in the groups could be demonstrated in tasks which are traditionally taken to indicate the existence of preattentive processing (Beck, 1972; Beck & Ambler, 1972; Kahneman, 1973). First, they found that in 'unenriched' conditions, where the target shared features with the noise, schizophrenics were poorer than controls in performing the said preattentive tasks. Second, their findings indicated that, if target-noise discriminability could be increased, schizophrenics now performed the task normally. This second result was regarded as confirmation of the initial hypothesis, for if the deficient process could be 'helped along', as it were, by increasing target-noise discriminability, then in the initial, 'unenriched' condition the process responsible for such discrimination must have been impaired. However, this does not follow, as it represents a simplified view of the relation between preattentive and attentional processing. Specifically, the view suggests that changing target-noise discriminability alters the efficiency of preattentive processing exclusively.

Alternatively, it is more likely that the 'enriched' and 'unenriched' conditions in the Cox and Leventhal experiment, stressed the balance between preattentive and attentional processing in a different way. For example, it is quite conceivable that in the 'unenriched' conditions, where the deficit was apparent, processing strategy was predominantly attentional whereas in the 'enriched' conditions performance was more dependent on preattentive analysis. Such a balance between the two processing levels might be expected, since

'unenriched' conditions should yield grouping of the target, with the noise making precise localization and identification of the target difficult in the absence of attentional scanning and selection (see, Beck & Ambler, 1972). Under such an interpretation, the attentional-deficit hypothesis gains the ascendancy over the preattentive-deficit hypothesis in explaining the results. Significantly, this interpretation implies normalcy of preattentive processing in schizophrenia, as is suggested in the present findings (especially in Experiment 3).

The second line of evidence for the preattentive-deficit hypothesis comes, predominantly, from Place and Gilmore's (1980) study which investigated stimulus gestalt-organization effects on processing. Let us examine their second experiment in some detail since it provides the strongest evidence for the hypothesis. In the experiment the task was to estimate the number of vertical and horizontal lines presented in each of three conditions ('numeration'). Lines on the display were either: Horizontal or vertical (Homogeneous Condition); a mixture of horizontal and vertical but each orientation clearly separated from the other (Heterogeneous Adjacent); or, lines were a mixture of horizontal and vertical and the orientations were not separated (Heterogeneous Non-Adjacent).

According to the perceptual grouping principles of similarity and proximity, Place and Gilmore expected that the more organization in the displays, the greater the number of perceptual groups that would be formed through preattentive analysis. That is, Homogeneous displays should have resulted in a single group defined by orientation and proximity;

Heterogeneous Adjacent should have been perceived to contain two such groups; and, Heterogeneous Non-Adjacent should form multiple perceptual groups. Consonant with Treisman's (1982) description of processing, parallel processing operations should be carried out on elements within a group while focal attention must 'travel' across groups. Place and Gilmore therefore predicted that if controls carried out preattentive analysis then their attention should be drawn to groups formed by similarity and proximity and, given that the displays were presented at threshold stimulus-exposure conditions, they expected that "there may not be enough time to examine more than one group" (Place & Gilmore, 1980, p. 414). Essentially, the prediction was that in Heterogeneous conditions processing by controls would be carried out in a serial manner across groups elements defined automatically by preattentive processing. On the other hand, if schizophrenics were not conducting preattentive analysis then they should not have been influenced by the organization conditions. (Presumably they would process all displays by focal attention).

The results of the study were generally as predicted. First, schizophrenics and controls responded in a similar way to the display-size variation - performance deteriorated in all organization conditions with increases in display-size - indicating equal inter-item scanning in the two groups. Second, controls were found to perform more poorly than schizophrenics in the Heterogeneous conditions than in the Homogeneous condition, favouring the notion that schizophrenics were insensitive to similarity and proximity variations among the displays.

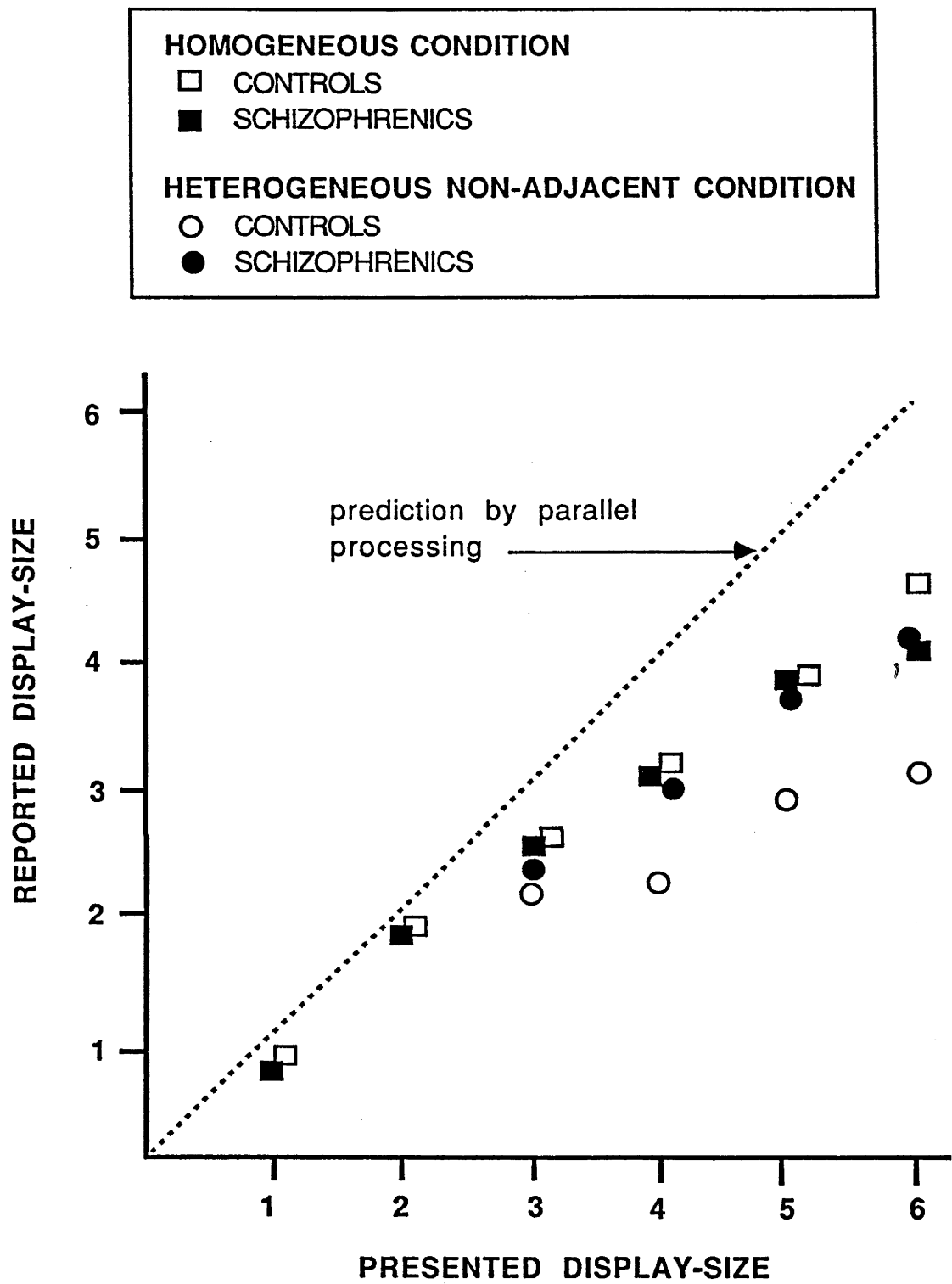


FIGURE 8.1: Place and Gilmore's (Exp. 2, 1980) findings.

The results of the Place and Gilmore study are represented in Figure 8.1, which shows the reported number of elements plotted against the presented number of elements. To understand the meaning of this figure it is necessary to inspect the findings of Oyama, Kikuchi and Ichihara (1981) who used a similar numeration task in normals. In this study it was found that the reported number of dots matched the presented number of dots in displays containing up to nine dots (in unmasked conditions) - that is, there was evidence for unlimited, parallel processing. Beyond this point (i.e. nine dots), subjects tended to under-estimate the presented number of dots indicating the parallel-processing limit. Sagi and Julez (1985) also observed that numeration was independent of display-size when targets were embedded in noise of a different orientation (however, they only varied display-size up to four elements).

Furthermore, in the Oyama et al. study, masking was shown to reduce the upper limit of parallel-processing which was found to be dependent on stimulus onset asynchrony. In other words, masking caused a shift from parallel to serial processing as would be expected from the effects of reduced target-discriminability hypothesis discussed above. Moreover, using reaction-time measures, Oyama et al. indicated that displays containing up to 4 dots were processed with an estimated processing time of 40 msec per dot while beyond this display-size the rate of processing was estimated at 370 msec per dot. Oyama et al. explained their findings by the constructs of 'subitizing', which involves parallel processing, and 'counting' which involves serial-search

operations across the elements. Consonant with this explanation, Neisser (1967) noted that a few elements might be processed in parallel because the subject can impose 'structure' on the elements - for example, three dots might be perceived in the shape of a triangle - whereas with many elements such simple 'structures' cannot be imposed on the stimulus and the subject reverts to serial-processing strategy.

Returning to the results in Figure 8.1, it appears that in the Place and Gilmore study, the first processing stage (Oyama et al., 1981), parallel processing, was limited to display-sizes containing one, two or perhaps three elements. This was probably due to the threshold duration conditions in the study. Beyond the display-size of three or four, inclusive, performance appears to deviate from the 'predicted' line, suggesting that elements in the large displays were examined by the serial, second, stage of processing. That is, the observed deficit in performance of controls was in the display-size range within which the primary processing mechanism was focal attention. This suggests an alternative interpretation of the Place and Gilmore results. Perhaps schizophrenics simply 'underanalyse' stimuli (Russell & Knight's, 1977, conclusion) within focal attention. Of course the demonstrated independent effect of organization and display-size (Place & Gilmore, 1980) strongly suggests that different stages in processing are involved (Sternberg, 1969; Townsend & Ashby, 1983). This is consonant with Place and Gilmore's conclusions that the deficit in controls is caused by 'extra' processing in preattention relative to schizophrenics. However, it is apparent that the demonstration

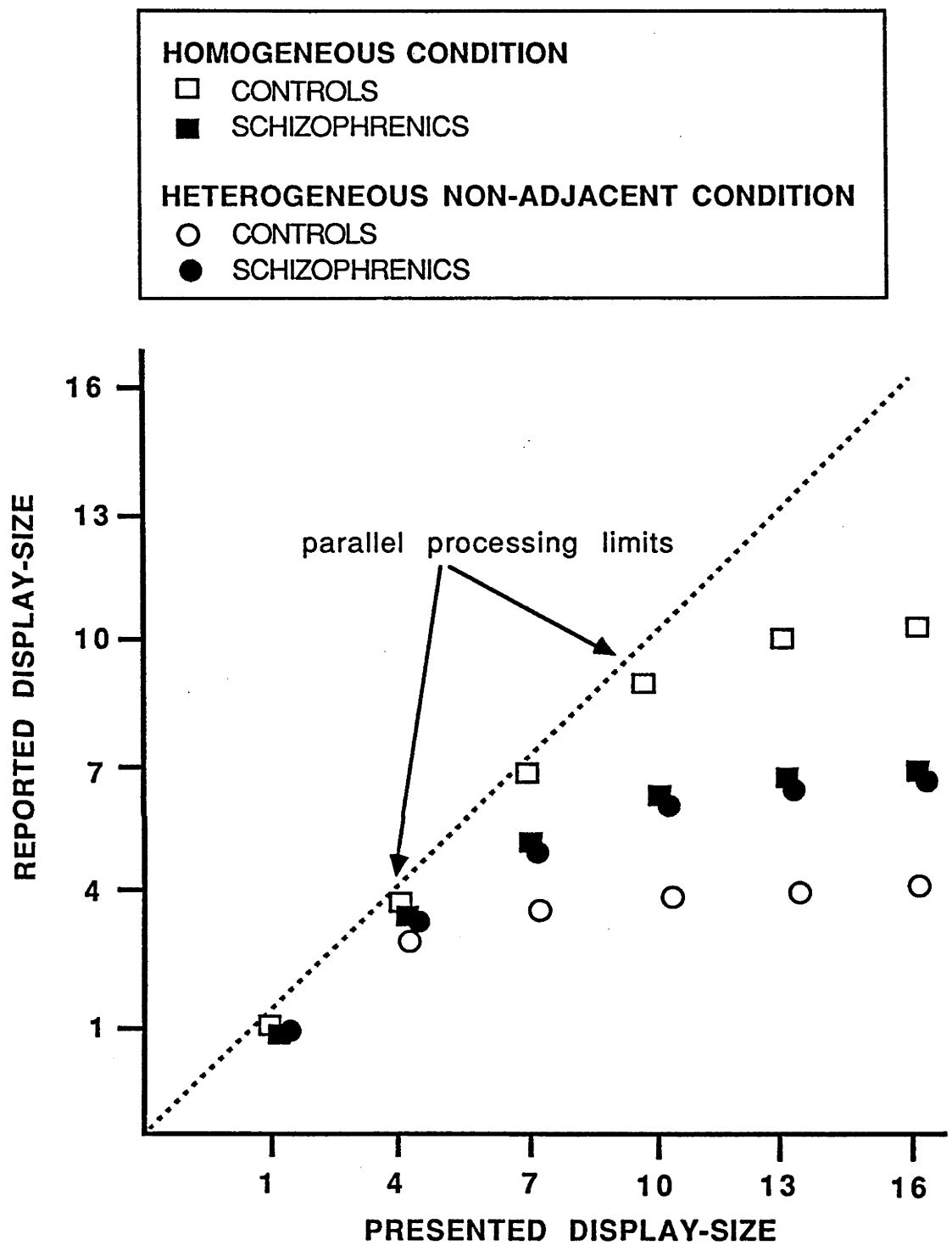


FIGURE 8.2: Theoretical extention of Place and Gilmore's findings.

would benefit from an extension of the result to show that parallel processing by controls is less limited (by the display-size) than schizophrenics.

The theoretical expectations of such an extension are represented in Figure 8.2. According to this figure, controls' performance in the Homogeneous condition should be relatively unlimited (perhaps up to 9 elements, by Oyama's et al. estimate) compared with schizophrenics. Viewed differently, schizophrenics should behave in this condition as if they were experiencing masking - their performance should reflect a shift to serial processing at smaller display-sizes than controls (Oyama et al., 1981). Finally, in replication of the Place and Gilmore result, the Heterogeneous condition should limit controls but not schizophrenics and this limitation should be apparent as an 'early' shift from parallel to serial processing (Figure, 8.2). (Of course the results can be extended further to demonstrate a 'family' of strategy-shift curves showing controls to be progressively limited in parallel processing as the number of 'preattentive groups' increases systematically.) As is apparent in comparing Figures 8.1 and 8.2, Place and Gilmore's results almost meet the full expectations of the theoretical curve. However, there is a need to demonstrate the result within the region of parallel processing. (Notably, Wells & Leventhal's 1984 replication study also fails to meet above predictions since only main effects involving display-size were reported suggesting equal deterioration in performance in the Homogeneous and Heterogeneous conditions.)

Figure 8.1 indicates a second difficulty with the Place and Gilmore findings. In the region of the graph where subitizing is the primary processing strategy there is no difference between the groups in performance. This is in conflict with the preattentive deficit hypothesis since subitizing, as noted earlier in this Chapter, is supposedly a preattentive level integration of the input. It appears, however, that schizophrenics were able in the task to organise preattentively the same number of elements as controls. Thus not all of the Place and Gilmore results are entirely consistent with their conclusions.

To summarise, the strongest evidence for the preattentive-deficit hypothesis remains Place and Gilmore's study, however, this study demonstrated the preattentive distractibility effect in displays which were searched by focal attention (serial strategy). It was also argued that the target-discriminability findings (e.g. Cox & Leventhal, 1978; Pharr & Connor, 1977; Stilton & Koppell, 1964) can be accommodated by the attention-deficit hypothesis. That is, in each case the attentional deficit hypothesis could just as well explain the results considered as evidence for the preattentive deficit hypothesis. Especially in the Place and Gilmore (1980) study, the pattern of results, just like in the present experiments, did not fully comply with the expectations from the preattentive deficit hypothesis.

8.4 Re-evaluation of the attentional-deficit hypothesis

As noted above (Section 8.2) the present results contradict the attentional deficit hypothesis. None of the findings, including the error pattern in tachistoscopic

identification (Experiment 1), display-size effects (Experiment 1 and 2), and object matching in the attentional condition (Experiment 4), were consistent with the hypothesis. In the literature the hypothesis gained support from two sources - the differential effect of display-size on visual search (e.g. Neale, 1971) in the groups and the 'vulnerability' to masking suggested by Saccuzzo and associates.

Display size effects were discussed at length above. Regarding the second source of evidence, the Saccuzzo findings, it was suggested in Chapter 3 that it is difficult to localise the deficit to any processing stage using masking (note: Saccuzzo has recently adopted this position, e.g., Saccuzzo & Braff, 1986). The masking findings might reflect inadequate preattentive processing in schizophrenics or they might reflect selection impairment. In addition to the arguments presented in Chapter 3, Oyama's et al. (1981) analysis of masking, reported in the present Chapter, suggests that masking limits preattentive processing by reducing target-noise discriminability. Masking seems to effect a shift in processing strategy to attentional processing. Oyama's et al. study points to the interactive nature (or 'balance') between the two processing mechanisms in any processing task - and indeed, in any condition within a task (e.g. Cox & Leventhal, 1978) - an issue which has been largely ignored in the processing studies in schizophrenia.

By and large, the visual-information processing studies including the present, have not supported the attentional-deficit hypothesis. There is a need to adopt a more complex model of processing which concerns itself with the interaction

between preattentive and attentional processing levels in any task.

8.5 Synopsis of the correlation results and evaluation

The issue surrounding processing dysfunction in schizophrenia is complicated by the heterogeneous nature of the disorder (Chapter 1). Processing disorder for example might be a 'trait' of schizophrenics or schizophrenia spectrum disorders (Asarnow et al., 1978; Asarnow & MacCrimmon, 1981; Balogh & Merritt, 1985; Merritt & Balogh, 1984; Merritt & Balogh, 1985; Merritt, Balogh & Leventhal, 1986; Saccuzzo, Braff, Sprock & Sudik, 1984) or it might be associated with an episode of psychosis (Dobson & Neufeld, 1987; George & Neufeld, 1985). It might be more severe as the assessment of the patient is made more recent to the admission time - that is, it might be related to the current severity of psychosis. It might characterise a particular subgroup of patients sharing specific symptoms ('paranoid'-'non-paranoid', 'positive'-'negative') or sharing levels of a particular dimension ('acute'-'chronic', 'process'-'reactive', 'good-premorbid'-'bad-premorbid'). Alternatively, symptoms and dimensions might be irrelevant and deficit might be associated with general debility due to chronic 'mental' illness, unrelated to the schizophrenia spectrum. It might also be associated with influences of medication or other 'iatrogenic' factors such as restricted stimulation accompanying chronic institutionalization (Johnstone et al., 1981).

The complexity of the issue necessitates a long-term multivariate approach to the study of information-processing dysfunction. This requires large number of subjects and

TABLE 8.1 : Summary of the correlations between processing and clinical measures in the Experiments.

EXPERIMENT	1			2			3			4			5		
MEASURE	FOCAL ATTENTION ACCURACY	DIVIDED ATTENTION ACCURACY		TOTAL SORTING TIME	CHANGE IN SORTING TIME		LOCAL LEVEL ACCURACY	GLOBAL LEVEL ACCURACY	GLOBAL PROCESSING ACCURACY	GLOBAL PROCESSING RESPONSE TIME	LOCAL PROCESSING ACCURACY	LOCAL PROCESSING RESPONSE TIME	FAMILIAR DISTRACTOR ACCURACY	UNFAMILIAR DISTRACTOR ACCURACY	RANDOM DISTRACTOR ACCURACY
OBSERVER-REPORTED PATHOLOGY															
MAINE PARANOID	-	-		p	-		-	-	-	-	-	-	-	-	-
MAINE NON-PAR.	-	-		-	-		-	-	-	-	-	n	-	-	-
GAS Worst	-	na		-	-		-	-	-	-	-	-	-	-	-
GAS Current	-	na		-	-		-	-	-	-	-	-	-	-	-
SUBJECT-REPORTED PATHOLOGY															
DSSI Dylimb	-	-		-	-		-	-	-	-	-	-	-	-	n
DSSI Neurotic	-	-		-	-		-	-	-	-	-	-	-	-	-
DSSI Integ. Del.	p	-		-	-		-	-	p	p	-	-	-	-	-
DSSI Disint. Del.	-	-		-	-		p	-	p	-	p	-	-	-	-
THOUGHT DISORDER MEASURES															
LOWBOND SORTING	-	-		-	p		-	na	-	-	na	-	-	na	-
PROVERBS TEST	-	-		-	-		-	-	-	-	-	-	-	-	-
OTHER MEASURES															
HARRIS PREMORBID	-	na		-	-		n	-	-	-	-	-	-	-	-
VOCAB IQ	-	-		-	-		-	-	-	-	-	-	-	-	-
HOSP/AGE	-	-		-	-		-	n	-	-	-	n	n	n	-
MEDICATION	p	-		p	p		n	-	n	-	-	-	-	-	-

- no signif. correlation
p signif. positive correlation
n signif. negative correlation
na not administered

adequate follow-up rates in repeated observations and assessments. In the present work therefore the issue of whether processing dysfunction can be linked to any 'special' variables in schizophrenia is only tentative and can serve only to stimulate 'hunches' for further investigation. The correlation approach presented here also serves to indicate whether the present findings could be associated with uncontrolled factors such as current medication levels, which might reduce the strength of the conclusions that the deficit, when present, was due to the disease process.

The correlation findings from all the Experiments are summarised in Table 8.1. The individual correlations have already been described in the various Chapters and only the inter-study pattern will be considered here. First, it is clear from the table that no clinical variable was found to be consistently associated with reduced performance. As Table 8.1 indicates, there was a relatively consistent association between reporting psychotic symptoms and better performance - reflected in positive correlations between these variables. This has been discussed in previous Chapters as probably indicating a general compliance effect. It was suggested, though it was difficult to verify the idea, that the positive correlation between performance and symptom-report reflected the influence of subjects who were less 'pathological' at the time of testing and could therefore comply with the demands of the symptom-signs inventory and the processing tasks.

Another clinical measure in Table 8.1 which showed some tendency to correlate with the performance variables across the tasks was the variable 'Hosp/age' - the number of life-

time hospitalizations corrected for age by division. This was thought to reflect how severe the disorder was for any patient over time. However, the pattern was inconsistent. The measure was negatively correlated with performance in Experiments 3 and 5 but there was a positive association with performance (i.e., negative correlation with reaction-time) in Experiment 4.

Finally, medication level was found to be positively correlated with performance in Experiment 1 but it was otherwise found to be associated with poorer performance (i.e., in Experiments 2, 3 and 4). Therefore, in these latter experiments the findings with regard to processing deficit ought to be regarded with caution since the effect of medication as a cause of reduced performance cannot be ruled out. This conclusion does not extend to the results of Experiment 1.

In summary, little of theoretical interest is generated by the analysis presented in Table 8.1, particularly since a number of the significant correlations might be expected to be due to Type I error (i.e., the probability of finding a significant correlation when none is there increases with the number of statistical comparisons conducted - Keppel, 1973). Moreover, the small sample-size in the present Experiments might allow subject selection bias to have a major influence on the results (this will be discussed in the next section). The complex nature of the phenomenon of schizophrenia compounds this problem.

8.6 Conclusions and generality

The present study suggests that there is insufficient

evidence that any particular level of visual information processing is dysfunctional in schizophrenia. Preattentive deficit was suggested by the greater rate of intrusion errors in schizophrenics in Experiment 1, the possibility of slower preattentive resolution of a stimulus in Experiment 2 and a poorer object-matching accuracy in the Global Condition of Experiment 5. However, this hypothesis could not accommodate the results of other Experiments (especially Experiment 3). The findings of Experiment 2 could have been interpreted with the notion of slow attentional scanning however this hypothesis could not explain the results of Experiments 1, 3, or 4. Collectively the experiments which tested such functions as perceptual segregation and organization, selective attention and scanning, and stimulus familiarity effects on processing - failed to find convincing evidence of a specific deficit in schizophrenics' information-processing.

There are several reservations associated with the conclusion that there is no specific information processing deficit in schizophrenia. In the first place, the results were obtained with small samples of patients and with selection criteria which included subjects within average (to above average) intelligence. Subjects for whom the disorder had an early onset and debilitating early course may therefore have been under-represented. Secondly, most of the subjects suffered from episodic psychosis rather than a continuous psychosis with deteriorating course. Therefore the findings cannot be generalized to the typical chronically-hospitalised patient. Thirdly, all subjects were volunteers and therefore the results may reflect a sample bias away from the 'avolitional' or the highly suspicious patient. However,

despite this selection bias all subjects had suffered from a schizophrenic psychosis and currently received medication for the control of their symptoms (even those recruited from the community clinics). Furthermore, such biases were not expected to influence the results, since most studies have used similar selection criteria with regard to intelligence measures, and other studies have demonstrated the deficit in 'remitted' patients (Asarnow & MacCrimmon, 1981). Moreover, the suggestion that information-processing deficit is a 'trait' of schizophrenics and therefore observable in asymptomatic groups suspected to be 'at risk' of developing schizophrenia (Merritt, Balogh & Leventhal, 1986) suggests that the selection criteria adopted presently should not have influenced the outcome of the experiments.

It should also be mentioned that the present conclusions are limited to the processing of information in the visual modality. This is in line with the present attempt to explain the phenomenology of impaired visual perception in schizophrenia, as evidenced in the studies reviewed in Chapters 2 and 3. Processing through other modalities appears to require an analysis of processing levels similar to the present (Nuercherlein, 1982).

8.7 Future directions

Although the present findings dispute the notion of a specific information-processing deficit underlying the visual phenomena accompanying schizophrenic illness, the strength of some results in the literature (e.g. Place & Gilmore, 1980) and the replicability of others (Braff & Saccuzzo, 1981, 1982) suggest a need for further study of the issue. In the course

of the present analysis, several prospects for future research were outstanding. First, there is a need to investigate what is the nature of 'masking vulnerability' in schizophrenia. As noted in Chapter 3 at least three possible masking mechanisms exist that can be separated according to their effects on stimulus processing and by the stimulus onset asynchrony at which they are effective (Hellige et al., 1979; Turvey, 1973). Distinguishing between masking by early stimulus summation, integration or complete interruption (and reallocation of attention to the mask) can further the knowledge of the level that the stimulus representation of schizophrenics begins to differ from normal.

Secondly, an extension of the Place and Gilmore result to the conditions of the numeration task where preattentive processing is the predominant mechanism would strengthen their conclusions. How this can be done has been described. However, it is important to acknowledge the perspective developed with such an extension and this is to stress that attentional selection depends on the products of preattentive analysis (Neisser, 1967). Not only will attention seem disrupted by a preattentive deficit in some tasks (as suggested by Cox and Leventhal, 1978) but in other tasks there will be a recruitment of attentional processing if limitations are imposed on preattentive analysis by an experimental procedure. This idea, developed in the present Chapter, suggests that it is possible to explain supposedly preattentive phenomena by the hypothesis of a dysfunctional attentional process. The analysis highlights the need to define clearly the predictions of the preattentive and

attentional deficit hypotheses and to include concurrent diagnostics for each level of processing in a single task.

Thirdly, the notion of perceptual 'mislocation' of information when attention is divided among visual inputs has found a prominent role in explaining normal perception (Treisman and Gelade, 1980). Although the present investigation failed to find more mislocation errors in schizophrenics than controls, the approach should not be discarded on the basis of a single study. Specifically, Treisman and Schmidt's (1982) approach to 'illusory conjunctions' which distinguishes between these errors and errors reflecting the early registration and identification of 'features' is a possible research path in schizophrenia. The advantage of this work over the Butler approach adopted presently is that it adheres more closely to physical characteristics of stimuli, thus reducing potential processing differences between groups due to the influence of factors such as stimulus familiarity. In addition, it allows for stimulus familiarity and gestalt organization to be investigated as orthogonal variations to the induction of feature errors and illusory conjunctions (as Prinzmetal & Millis-Wright, 1984, and Prinzmetal, 1981, have demonstrated, respectively).

As has become obvious through the development of the present analysis, there is a need to select subjects on the basis of the phenomenon under investigation. The emphasis should be on the phenomenology of schizophrenia. In the present experiments (and indeed in the rest of the visual processing literature) for example, schizophrenics might have been allocated to groups based on whether or not they

experienced aberrant perception (e.g. visual illusions and/or visual hallucinations). In this way, other variables (e.g. medication, the hospitalization experience, etc.) can be better controlled. Such designs have the added advantage of committing the schizophrenia researcher to make the logical link between the clinical signs and symptoms and information-processing variables - a process which has been under much neglect (George & Neufeld, 1985; Hemsley, 1977).

Such designs also have the potential to introduce adequate control groups based on the phenomenon under investigation, which may be termed 'criterion' groups. These are (additional) groups which are known, or strongly suspected to be incapable of processing information in a particular way. For example, while recruiting subjects for Experiment 2, which used colour-cueing, a number of subjects were rejected from the study because they reported themselves to be colour-blind. In Experiment 2, if the stimulus material was controlled so that colour discrimination could not take place by discriminating between shades, a group of colour-blind people might have formed an adequate 'criterion group'. Since such a group would be expected not to be sensitive to the colour cues across the conditions, they would therefore be expected to conduct serial processing strategy in all conditions - this of course was the prediction made for schizophrenics in the task. The advantage of the 'criterion' group is to strengthen the conclusion about a result in the predicted direction in the experimental group as both the 'criterion' and experimental group are expected to deviate from other control groups.

Finally, the study of subgroups in schizophrenia with relation to processing variables requires multivariate design and longitudinal methodology. This has been mentioned elsewhere. However, it is of interest, as indicated by the present enquiry with the delusions symptoms-signs inventory, that schizophrenics do not suffer simply from psychotic symptoms. For example, in Chapter 4 where a summary was presented of the mean scores on the various classes of illness, schizophrenics were found to have many symptoms and signs in the Dysthymic States and Neurotic Symptoms categories, as well as in the delusions classes (see also, Bedford & Foulds, 1977, 1978). The relationship between information-processing and the more global phenomenology of schizophrenia has received little (if any) attention.

8.8 The clinical syndromes of schizophrenia and information processing

According to the medical model of psychological-behavioural disorder, symptoms and signs are observable phenomena which are caused by some common, malfunctioning mechanism (e.g., aphasia can be 'caused' by ablation to Wernicke's area). Accordingly, the term 'schizophrenia' refers to a number of clinical manifestations which, by definition, should have a common cause and process. For example, it was Bleuler's (1950) contention that in time the syndromes of schizophrenia would be shown to be variants of a single disease process and that the cause would be found to be a biological impairment. Consistent with this approach, many theories of schizophrenia have attempted to explain the disorder by a single mechanism, with little success (for review see, Chapman & Chapman, 1973).

Outcome, course, and cross-sectional descriptors of the clinical picture have not favoured the idea that schizophrenia is a single disease (Ciompi, 1984). This is true for experimental measures, including biochemical markers, brain-imaging measures, psychophysiological measures, and patterns of familial inheritance. For example, some types of schizophrenia (florid type) appear to involve a disorder in dopaminergic neurotransmission in the interaction between the limbic system and frontal-lobe structures (Levin, 1984a, 1984b) and this might be genetically transmitted. Other types of schizophrenia (withdrawn, avolitional) appear to be associated with brain atrophy. Neither have measures of information processing in schizophrenia yielded consistent results when studies have compared patients with 'schizophrenia' and other groups. Again somewhat more consistent patterns (though not compelling) have been observed in the study of subgroups of schizophrenics.

The notion of vulnerability to 'information overload' (Ciompi, 1984; Docherty et al., 1978), introduced in Chapter 1, also assumes a single process explanation for the variety of clinical syndromes represented by the term 'schizophrenia'. As the present research suggests, it is far from clear that a single mechanism can explain the signs and symptoms of the disorder. It might be more fruitful if research concentrated, not on understanding 'schizophrenia' as an entity, but if it focused on the various phenomena that are observable in people who have received the psychiatric label. Such an approach does not assume, for example, that the mechanism for communication disorder in schizophrenia is the same as that for

dysfunctional figural synthesis. Of course the pitfal of this approach is that understanding the 'parts' does not necessarily lead to the understanding of the 'whole'. On the other hand, the 'single disease' model has not yielded an adequate understanding of schizophrenic psychosis.

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APPENDIX 1 : INSTRUCTIONS AND MATERIALS
(includes only information referred to in the text)

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1. EXPERIMENT 1: INSTRUCTIONS AND TRAINING

Either of two instruction sets and training then ensued. If the subject entered the pre-stimulus cueing condition, the following standard training and instructions were given:

"Shortly I will show you some slides like this one (shown letter display) and I want you to report to me only one of these letters. First of all you will see a square with eight dots and a 'box' in it like this (shown mask/probe display). Then a slide with letters will come on like this one (shown letter display). Different slides will have many or few letters on them. And lastly, a slide like this one (shown mask/mask display) with nine boxes will come on.

The slides will come on one after another really fast, just like this (demonstration of a trial). The first slide, this one (shown mask/probe display) tells you to report the letter in that position. For example, (shown letter display) in this case the answer is 'A'. Lets try another example, (another unspeeded trial was given as above and the subject was required to give the answer. If the subject could not answer the explanation of a trial was repeated.)

Now you are ready to do some practice tries where I show you the slides very quickly, just like this (speeded trial demonstrated).

One last thing, when you look at the slides try to look at the middle of the display. Also, if you do not know an answer I want you to give me your best guess."

If the subject entered the post-stimulus cueing condition the following instructions and training were administered:

"Shortly I will show you some slides like this one (shown letter display) and I want you to report to me only one of these letters. First of all you will see a square with nine dots in it like this (shown pre-stimulus display). Then a slide with letters will come on like this one (shown letter display). Different slides will have many or few letters on them. And lastly, a slide like this one (shown mask/probe display) with eight dots and a 'box' will come on.

The slides will come on one after another really fast, just like this (demonstration of a trial). As you may have noticed the 'box' appears

where a letter used to be. The 'box' tells you which letter to report to me. So in this example, this display comes on (shown pre-stimulus display), then this comes one (shown the letter display) and lastly this comes on (shown mask/probe display). The answer in this case is 'A'

Lets try another example, (another unspeeded trial was given as above and the subject was required to give the answer. If the subject could not answer the explanation of a trial was repeated.)

Now you are ready to do some practice tries where I show you the slides very quickly, just like this (speeded trial demonstrated).

One last thing, when you look at the slides try to look at the middle of the display but try to pay attention to the display as a whole. Also, if you do not know an answer I want you to give me you best guess."

Following these instructions subjects did 10 practice trials. Trial were repeated if the subject indicated a lack of understanding of the task. Following the practice trials the test trials were presented.

2. EXPERIMENT 3 : REPRODUCTION OF THE INSTRUCTION SHEET

I WILL SHOW YOU A NUMBER OF SLIDES.

EACH SLIDE WILL HAVE A LARGE LETTER ON IT. THE LARGE LETTER WILL BE MADE UP OF SMALL LETTERS. FOR EXAMPLE, EACH SLIDE MIGHT LOOK SOMETHING LIKE THIS ONE:

```

NNNNNNNNNN
NNNNNNNNNN
NN
NN
NNNNNNNNNN
NNNNNNNNNN
NN
NN
NNNNNNNNNN
NNNNNNNNNN

```

SOME SLIDES WILL BE LIKE THIS ONE AND SOME OTHERS WILL HAVE CHARACTERS IN THE BACKGROUND LIKE THIS ONE:

[illegible]

YOUR TASK IS TO PAY ATTENTION SOMETIMES TO THE LARGE LETTER AND SOMETIMES TO THE SMALL LETTER SO THAT YOU CAN REPORT TO ME WHAT THE LETTER IS.

I WILL TELL YOU WHICH LETTER TO PAY ATTENTION TO (LARGE OR SMALL)
JUST BEFORE I SHOW YOU EACH SLIDE.

TO HELP YOU DECIDE WHICH LETTER APPEARED ON THE SCREEN YOU HAVE IN FRONT OF YOU A SHEET CONTAINING ALL THE LETTERS THAT WILL APPEAR. YOUR TASK IS TO POINT TO THE LETTER THAT YOU SAW ON THE SLIDE.

WE WILL DO SOME PRACTICE SLIDES TOGETHER SO THAT YOU CAN GET THE HANG OF THE TASK AND HOW TO USE THE SHEET IN FRONT OF YOU.

3. EXPERIMENT 3 : REPRODUCTION OF THE
RESPONSE-CHOICE SHEET

CHOICES FOR THE BIG LETTERS

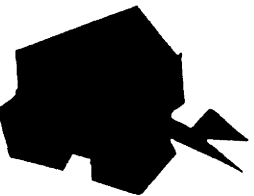
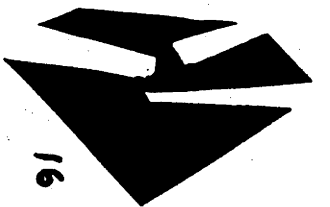
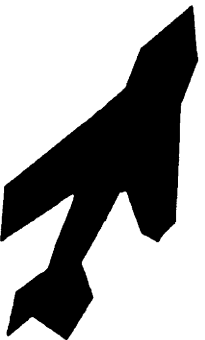
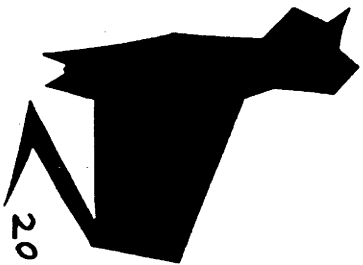
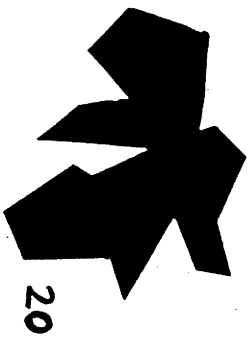
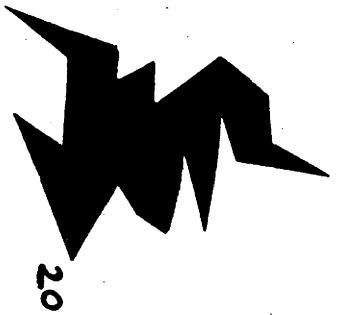
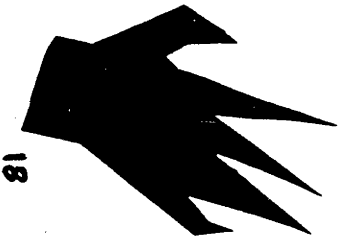
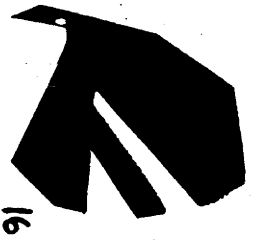
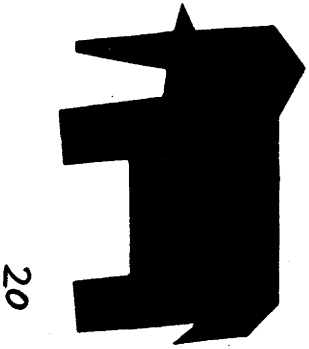
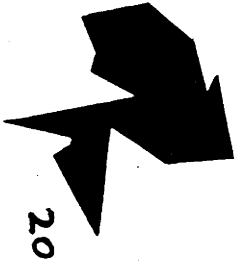
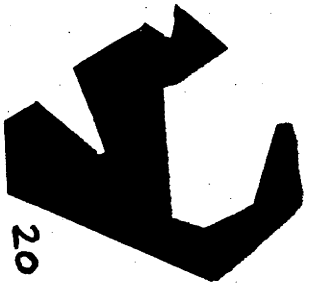
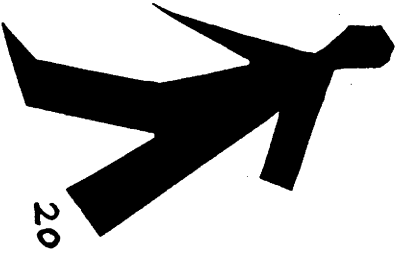
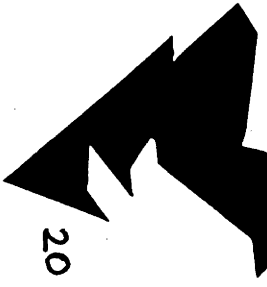
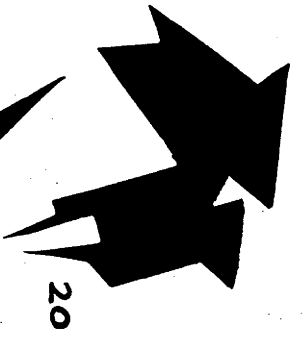
POINT TO THE LARGE LETTER THAT YOU SAW ON THE LAST
SLIDE

K O P H

POINT TO THE SMALL LETTER THAT YOU SAW ON THE LAST
SLIDE

T V A N

4. EXPERIMENT 4 : THE SHAPES USED AS STIMULI IN
THE CONDITIONS (the number presented with each
shape represents the complexity level)



APPENDIX 2 : TABLES OF THE DATA.

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TABLE SERIES A2.1

Performance in the Focused Attention condition of Experiment 1.
Successive tables indicate the number of correct responses,
mislocation errors, and intrusion errors.

In the tables:

Group 1 refers to schizophrenics
Group 2 refers to controls

EXPERIMENT 1 DATA : FOCUSED ATTENTION , correct responses

GROUP 1

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec	
1.00	2.00	2.00	2.00
2.00	1.00	2.00	0.00
1.00	2.00	0.00	2.00
1.00	3.00	2.00	0.00
1.00	0.00	0.00	0.00
1.00	0.00	1.00	0.00
1.00	2.00	0.00	3.00
2.00	1.00	1.00	0.00
1.00	1.00	0.00	1.00
4.00	4.00	2.00	2.00

LEVEL B (stimulus duration)		100 msec	
5.00	6.00	7.00	5.00
6.00	2.00	2.00	4.00
5.00	2.00	1.00	3.00
4.00	2.00	3.00	1.00
7.00	4.00	5.00	4.00
6.00	4.00	8.00	3.00
10.00	9.00	6.00	5.00
3.00	5.00	4.00	4.00
5.00	3.00	5.00	2.00
8.00	6.00	9.00	6.00

LEVEL B (stimulus duration)		150 msec	
10.00	8.00	7.00	6.00
9.00	6.00	2.00	2.00
8.00	3.00	4.00	3.00
2.00	3.00	3.00	1.00
8.00	7.00	5.00	4.00
9.00	7.00	6.00	4.00
9.00	7.00	8.00	8.00
8.00	3.00	7.00	4.00
10.00	7.00	8.00	4.00
6.00	8.00	6.00	5.00

GROUP 2

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)			
LEVEL B (stimulus duration) 50 msec			
1.00	4.00	4.00	5.00
4.00	2.00	4.00	4.00
3.00	1.00	4.00	4.00
5.00	2.00	3.00	4.00
5.00	4.00	2.00	4.00
3.00	1.00	4.00	5.00
2.00	2.00	1.00	0.00
2.00	5.00	1.00	3.00
3.00	1.00	1.00	1.00
3.00	2.00	3.00	2.00
LEVEL B (stimulus duration) 100 msec			
10.00	9.00	8.00	4.00
10.00	9.00	8.00	7.00
8.00	9.00	9.00	7.00
7.00	6.00	5.00	2.00
9.00	8.00	5.00	5.00
8.00	6.00	5.00	5.00
8.00	8.00	7.00	6.00
10.00	7.00	8.00	6.00
6.00	7.00	5.00	3.00
7.00	6.00	4.00	1.00
LEVEL B (stimulus duration) 150 msec			
9.00	8.00	8.00	10.00
10.00	7.00	6.00	9.00
10.00	10.00	9.00	9.00
9.00	9.00	7.00	2.00
10.00	9.00	9.00	9.00
10.00	7.00	9.00	8.00
10.00	10.00	8.00	6.00
7.00	9.00	5.00	7.00
10.00	6.00	5.00	3.00
8.00	6.00	5.00	5.00

EXPERIMENT 1 : FOCUSED ATTENTION , mislocation errors

GROUP 1

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec
2.00	0.00	4.00
1.00	3.00	8.00
1.00	2.00	4.00
1.00	1.00	6.00
0.00	0.00	3.00
1.00	1.00	2.00
0.00	5.00	5.00
2.00	1.00	2.00
5.00	2.00	3.00
1.00	0.00	4.00

LEVEL B (stimulus duration)		100 msec
0.00	2.00	3.00
4.00	5.00	6.00
2.00	5.00	4.00
2.00	3.00	5.00
0.00	2.00	1.00
0.00	0.00	4.00
1.00	1.00	4.00
1.00	2.00	3.00
4.00	1.00	5.00
2.00	0.00	3.00

LEVEL B (stimulus duration)		150 msec
0.00	2.00	2.00
3.00	2.00	8.00
1.00	5.00	6.00
3.00	2.00	7.00
0.00	3.00	0.00
0.00	1.00	2.00
0.00	1.00	1.00
3.00	2.00	5.00
1.00	1.00	6.00
0.00	2.00	3.00

GROUP 2

 LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

0.00	2.00	2.00
0.00	0.00	4.00
0.00	3.00	6.00
2.00	2.00	3.00
2.00	4.00	2.00
0.00	2.00	1.00
2.00	1.00	5.00
0.00	1.00	3.00
1.00	4.00	8.00
2.00	2.00	3.00

LEVEL B (stimulus duration) 100 msec

0.00	1.00	2.00
0.00	0.00	3.00
0.00	0.00	3.00
3.00	2.00	7.00
1.00	4.00	1.00
0.00	2.00	3.00
0.00	1.00	1.00
0.00	1.00	3.00
2.00	4.00	6.00
0.00	3.00	6.00

LEVEL B (stimulus duration) 150 msec

0.00	2.00	0.00
1.00	2.00	0.00
0.00	0.00	1.00
1.00	2.00	8.00
1.00	0.00	1.00
0.00	1.00	2.00
0.00	0.00	2.00
0.00	3.00	1.00
2.00	2.00	6.00
4.00	4.00	3.00

EXPERIMENT 1 : FOCUSED ATTENTION , intrusion errors

GROUP 1

LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec
6.00	8.00	4.00
8.00	5.00	2.00
7.00	8.00	4.00
6.00	7.00	4.00
10.00	10.00	7.00
9.00	8.00	8.00
8.00	5.00	2.00
7.00	8.00	8.00
4.00	8.00	6.00
5.00	8.00	4.00

LEVEL B (stimulus duration)		100 msec
4.00	1.00	2.00
4.00	3.00	0.00
6.00	4.00	3.00
6.00	4.00	4.00
6.00	3.00	5.00
6.00	2.00	3.00
0.00	3.00	1.00
4.00	4.00	3.00
3.00	4.00	3.00
2.00	1.00	1.00

LEVEL B (stimulus duration)		150 msec
2.00	1.00	2.00
1.00	6.00	0.00
6.00	1.00	1.00
4.00	5.00	2.00
3.00	2.00	6.00
3.00	3.00	4.00
3.00	1.00	1.00
4.00	1.00	1.00
2.00	1.00	0.00
2.00	2.00	2.00

GROUP 2

 LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

6.00	4.00	3.00
8.00	6.00	2.00
9.00	3.00	0.00
6.00	5.00	3.00
4.00	4.00	4.00
9.00	4.00	4.00
6.00	8.00	5.00
5.00	8.00	4.00
8.00	5.00	1.00
6.00	5.00	5.00

LEVEL B (stimulus duration) 100 msec

1.00	1.00	4.00
1.00	2.00	0.00
1.00	1.00	0.00
1.00	3.00	1.00
1.00	1.00	4.00
4.00	3.00	2.00
2.00	2.00	3.00
3.00	1.00	1.00
1.00	1.00	1.00
4.00	3.00	3.00

LEVEL B (stimulus duration) 150 msec

2.00	0.00	0.00
2.00	2.00	1.00
0.00	1.00	0.00
0.00	1.00	0.00
0.00	1.00	0.00
3.00	0.00	0.00
0.00	2.00	2.00
1.00	2.00	2.00
2.00	3.00	1.00
0.00	1.00	2.00

TABLE SERIES A2.2

Performance in the Divided Attention condition of Experiment 1.
Successive tables indicate the number of correct responses,
mislocation errors, and intrusion errors.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

EXPERIMENT 1 : DIVIDED ATTENTION , correct responses

GROUP 1

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec	
3.00	2.00	4.00	2.00
0.00	1.00	2.00	1.00
0.00	0.00	0.00	0.00
1.00	0.00	0.00	0.00
2.00	1.00	0.00	0.00
0.00	0.00	0.00	1.00
5.00	0.00	3.00	0.00
0.00	1.00	0.00	0.00
1.00	0.00	1.00	0.00
3.00	0.00	2.00	1.00
LEVEL B (stimulus duration)		100 msec	
8.00	1.00	5.00	4.00
6.00	1.00	0.00	1.00
2.00	2.00	0.00	2.00
4.00	1.00	0.00	1.00
8.00	1.00	2.00	1.00
5.00	1.00	2.00	1.00
9.00	5.00	4.00	1.00
4.00	0.00	1.00	1.00
6.00	1.00	0.00	1.00
6.00	4.00	2.00	2.00
LEVEL B (stimulus duration)		150 msec	
7.00	4.00	4.00	5.00
9.00	2.00	1.00	2.00
3.00	1.00	2.00	2.00
5.00	2.00	0.00	2.00
10.00	2.00	1.00	0.00
7.00	1.00	1.00	0.00
9.00	8.00	5.00	2.00
1.00	3.00	1.00	2.00
4.00	3.00	2.00	0.00
9.00	2.00	5.00	2.00

GROUP 2

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec	
0.00	0.00	0.00	1.00
6.00	1.00	1.00	4.00
7.00	2.00	3.00	1.00
8.00	1.00	2.00	2.00
6.00	1.00	1.00	1.00
5.00	3.00	2.00	0.00
2.00	2.00	1.00	0.00
3.00	2.00	3.00	1.00
2.00	0.00	2.00	2.00
2.00	0.00	0.00	2.00
LEVEL B (stimulus duration)		100 msec	
9.00	6.00	4.00	2.00
6.00	3.00	5.00	1.00
10.00	8.00	4.00	3.00
8.00	5.00	2.00	3.00
9.00	1.00	5.00	5.00
9.00	5.00	5.00	3.00
9.00	2.00	1.00	1.00
5.00	3.00	4.00	2.00
8.00	3.00	3.00	1.00
6.00	1.00	3.00	1.00
LEVEL B (stimulus duration)		150 msec	
10.00	7.00	4.00	2.00
10.00	8.00	3.00	2.00
10.00	7.00	3.00	2.00
10.00	4.00	5.00	3.00
10.00	5.00	4.00	3.00
10.00	3.00	3.00	0.00
9.00	4.00	3.00	0.00
9.00	5.00	5.00	1.00
8.00	5.00	3.00	2.00
9.00	3.00	3.00	1.00

EXPERIMENT 1 : DIVIDED ATTENTION , mislocation errors

GROUP 1

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)	50 msec	
2.00	0.00	2.00
4.00	4.00	5.00
1.00	2.00	3.00
3.00	1.00	5.00
4.00	5.00	8.00
2.00	1.00	1.00
7.00	3.00	6.00
1.00	1.00	4.00
3.00	0.00	2.00
3.00	5.00	4.00

LEVEL B (stimulus duration)	100 msec	
3.00	2.00	5.00
8.00	8.00	9.00
1.00	2.00	3.00
3.00	5.00	7.00
6.00	8.00	6.00
1.00	1.00	0.00
2.00	5.00	6.00
4.00	6.00	6.00
0.00	2.00	5.00
2.00	1.00	2.00

LEVEL B (stimulus duration)	150 msec	
2.00	3.00	4.00
3.00	7.00	7.00
1.00	2.00	1.00
4.00	5.00	1.00
5.00	2.00	3.00
0.00	1.00	1.00
1.00	5.00	4.00
0.00	3.00	7.00
3.00	2.00	3.00
1.00	3.00	4.00

GROUP

2

 LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec
3.00	1.00	3.00
6.00	5.00	6.00
0.00	3.00	8.00
6.00	4.00	4.00
3.00	4.00	3.00
2.00	2.00	4.00
2.00	3.00	3.00
1.00	1.00	4.00
2.00	4.00	5.00
3.00	4.00	4.00

LEVEL B (stimulus duration)		100 msec
0.00	3.00	1.00
5.00	3.00	8.00
0.00	3.00	5.00
0.00	7.00	3.00
3.00	2.00	1.00
0.00	2.00	4.00
0.00	2.00	1.00
0.00	0.00	7.00
4.00	6.00	6.00
0.00	2.00	4.00

LEVEL B (stimulus duration)		150 msec
1.00	0.00	4.00
1.00	3.00	7.00
0.00	4.00	6.00
3.00	4.00	5.00
1.00	1.00	4.00
3.00	3.00	3.00
1.00	2.00	5.00
1.00	0.00	5.00
3.00	5.00	5.00
2.00	4.00	5.00

EXPERIMENT 1 : DIVIDED ATTENTION , intrusion errors

GROUP 1

LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration)	50 msec	
6.00	6.00	6.00
5.00	4.00	4.00
9.00	8.00	7.00
7.00	9.00	5.00
5.00	5.00	2.00
8.00	9.00	8.00
3.00	4.00	4.00
8.00	9.00	6.00
7.00	9.00	8.00
7.00	3.00	5.00

LEVEL B (stimulus duration)	100 msec	
6.00	3.00	1.00
1.00	2.00	0.00
7.00	8.00	5.00
6.00	5.00	2.00
3.00	0.00	3.00
8.00	7.00	9.00
3.00	1.00	3.00
6.00	3.00	3.00
9.00	8.00	4.00
4.00	7.00	6.00

LEVEL B (stimulus duration)	150 msec	
4.00	3.00	1.00
5.00	2.00	1.00
8.00	6.00	7.00
4.00	5.00	7.00
3.00	7.00	7.00
9.00	8.00	9.00
1.00	0.00	4.00
7.00	6.00	2.00
4.00	6.00	7.00
7.00	2.00	4.00

GROUP 2

 LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

7.00	9.00	6.00
3.00	4.00	0.00
8.00	4.00	1.00
3.00	4.00	4.00
6.00	5.00	6.00
5.00	6.00	6.00
6.00	6.00	7.00
7.00	6.00	5.00
8.00	4.00	3.00
7.00	6.00	4.00

LEVEL B (stimulus duration) 100 msec

4.00	3.00	7.00
2.00	2.00	1.00
2.00	3.00	2.00
5.00	1.00	4.00
6.00	3.00	4.00
5.00	3.00	3.00
8.00	7.00	8.00
7.00	6.00	1.00
3.00	1.00	3.00
9.00	5.00	5.00

LEVEL B (stimulus duration) 150 msec

2.00	6.00	4.00
1.00	4.00	1.00
3.00	3.00	2.00
3.00	1.00	2.00
4.00	5.00	3.00
4.00	4.00	7.00
5.00	5.00	5.00
4.00	5.00	4.00
2.00	2.00	3.00
5.00	3.00	4.00

TABLE SERIES A2.3

Performance in Experiment 1 depicted by the derived 'Pre-cueing advantage scores'. Successive tables indicate the derived scores for correct responses, mislocation errors, and intrusion errors.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

EXPERIMENT 1 : pre-cueing advantage scores

GROUP 1

LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec	
-2.00	0.00	-2.00	1.00
2.00	0.00	0.00	-1.00
1.00	2.00	0.00	2.00
0.00	3.00	2.00	0.00
-1.00	-1.00	0.00	0.00
1.00	0.00	1.00	-1.00
-4.00	2.00	-3.00	3.00
0.00	0.00	1.00	0.00
0.00	1.00	1.00	1.00
1.00	4.00	0.00	1.00
LEVEL B (stimulus duration)		100 msec	
-3.00	5.00	2.00	1.00
0.00	1.00	2.00	3.00
3.00	0.00	1.00	1.00
0.00	1.00	2.00	0.00
-1.00	3.00	3.00	3.00
1.00	3.00	6.00	2.00
1.00	4.00	2.00	4.00
-1.00	5.00	3.00	3.00
-1.00	2.00	5.00	1.00
2.00	2.00	7.00	4.00
LEVEL B (stimulus duration)		150 msec	
3.00	4.00	3.00	1.00
0.00	4.00	1.00	0.00
5.00	2.00	2.00	1.00
-3.00	1.00	3.00	-1.00
-2.00	5.00	4.00	4.00
2.00	5.00	5.00	4.00
0.00	-1.00	3.00	6.00
7.00	0.00	6.00	2.00
6.00	4.00	6.00	4.00
-3.00	6.00	1.00	3.00

GROUP

2

 LEVELS OF FACTOR C (display size, 1, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec	
1.00	4.00	4.00	4.00
-2.00	1.00	3.00	0.00
-4.00	-1.00	2.00	2.00
3.00	1.00	1.00	2.00
-1.00	3.00	1.00	3.00
-2.00	-2.00	2.00	5.00
0.00	0.00	0.00	0.00
-1.00	3.00	-2.00	2.00
1.00	1.00	-1.00	-1.00
1.00	2.00	3.00	0.00
LEVEL B (stimulus duration)		100 msec	
1.00	3.00	4.00	2.00
4.00	6.00	3.00	6.00
0.00	4.00	7.00	4.00
-1.00	1.00	3.00	-1.00
0.00	7.00	0.00	0.00
-1.00	1.00	0.00	2.00
-1.00	6.00	6.00	5.00
5.00	4.00	4.00	4.00
-2.00	4.00	2.00	2.00
1.00	5.00	1.00	0.00
LEVEL B (stimulus duration)		150 msec	
-1.00	1.00	4.00	8.00
0.00	-1.00	3.00	7.00
0.00	6.00	4.00	6.00
-1.00	5.00	2.00	-1.00
0.00	4.00	5.00	6.00
0.00	4.00	6.00	8.00
1.00	6.00	5.00	6.00
-2.00	4.00	0.00	6.00
2.00	1.00	2.00	1.00
-1.00	3.00	2.00	4.00

EXPERIMENT 1 : 'pre-cueing advantage' mislocations

GROUP 1

LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration)		50 msec
0.00	0.00	2.00
-3.00	-1.00	3.00
0.00	0.00	1.00
-2.00	0.00	1.00
-4.00	-5.00	-5.00
-1.00	0.00	1.00
-7.00	2.00	-1.00
1.00	0.00	-2.00
2.00	2.00	1.00
-2.00	-5.00	0.00

LEVEL B (stimulus duration)		100 msec
-3.00	0.00	-2.00
-4.00	-3.00	-3.00
1.00	3.00	1.00
-1.00	-2.00	-2.00
-6.00	-6.00	-5.00
-1.00	-1.00	4.00
-1.00	-4.00	-2.00
-3.00	-4.00	-3.00
4.00	-1.00	0.00
0.00	-1.00	1.00

LEVEL B (stimulus duration)		150 msec
-2.00	-1.00	-2.00
0.00	-5.00	1.00
0.00	3.00	5.00
-1.00	-3.00	6.00
-5.00	1.00	-3.00
0.00	0.00	1.00
-1.00	-4.00	-3.00
3.00	-1.00	-2.00
-2.00	-1.00	3.00
-1.00	-1.00	-1.00

GROUP

2

 LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

-3.00	1.00	-1.00
-6.00	-5.00	-2.00
0.00	0.00	-2.00
-4.00	-2.00	-1.00
-1.00	0.00	-1.00
-2.00	0.00	-3.00
0.00	-2.00	2.00
-1.00	0.00	-1.00
-1.00	0.00	3.00
-1.00	-2.00	-1.00

LEVEL B (stimulus duration) 100 msec

0.00	-2.00	1.00
-5.00	-3.00	-5.00
0.00	-3.00	-2.00
3.00	-5.00	4.00
-2.00	2.00	0.00
0.00	0.00	-1.00
0.00	-1.00	0.00
0.00	1.00	-4.00
-2.00	-2.00	0.00
0.00	1.00	2.00

LEVEL B (stimulus duration) 150 msec

-1.00	2.00	-4.00
0.00	-1.00	-7.00
0.00	-4.00	-5.00
-2.00	-2.00	3.00
0.00	-1.00	-3.00
-3.00	-2.00	-1.00
-1.00	-2.00	-3.00
-1.00	3.00	-4.00
-1.00	-3.00	1.00
2.00	0.00	-2.00

EXPERIMENT 1 : 'pre-cueing advantage' intrusions

GROUP 1

LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

0.00	2.00	-2.00
3.00	1.00	-2.00
-2.00	0.00	-3.00
-1.00	-2.00	-1.00
5.00	5.00	5.00
1.00	-1.00	0.00
5.00	1.00	-2.00
-1.00	-1.00	2.00
-3.00	-1.00	-2.00
-2.00	5.00	-1.00

LEVEL B (stimulus duration) 100 msec

-2.00	-2.00	1.00
3.00	1.00	0.00
-1.00	-4.00	-2.00
0.00	-1.00	2.00
3.00	3.00	2.00
-2.00	-5.00	-6.00
-3.00	2.00	-2.00
-2.00	1.00	0.00
-6.00	-4.00	-1.00
-2.00	-6.00	-5.00

LEVEL B (stimulus duration) 150 msec

-2.00	-2.00	1.00
-4.00	4.00	-1.00
-2.00	-5.00	-6.00
0.00	0.00	-5.00
0.00	-5.00	-1.00
-6.00	-5.00	-5.00
2.00	1.00	-3.00
-3.00	-5.00	-1.00
-2.00	-5.00	-7.00
-5.00	0.00	-2.00

GROUP

2

 LEVELS OF FACTOR C (display size, 3, 5, 9)

LEVEL B (stimulus duration) 50 msec

-1.00	-5.00	-3.00
5.00	2.00	2.00
1.00	-1.00	-1.00
3.00	1.00	-1.00
-2.00	-1.00	-2.00
4.00	-2.00	-2.00
0.00	2.00	-2.00
-2.00	2.00	-1.00
0.00	1.00	-2.00
-1.00	-1.00	1.00

LEVEL B (stimulus duration) 100 msec

-3.00	-2.00	-3.00
-1.00	0.00	-1.00
-1.00	-2.00	-2.00
-4.00	2.00	-3.00
-5.00	-2.00	0.00
-1.00	0.00	-1.00
-6.00	-5.00	-5.00
-4.00	-5.00	0.00
-2.00	0.00	-2.00
-5.00	-2.00	-2.00

LEVEL B (stimulus duration) 150 msec

0.00	-6.00	-4.00
1.00	-2.00	0.00
-3.00	-2.00	-2.00
-3.00	0.00	-2.00
-4.00	-4.00	-3.00
-1.00	-4.00	-7.00
-5.00	-3.00	-3.00
-3.00	-3.00	-2.00
0.00	1.00	-2.00
-5.00	-2.00	-2.00

TABLE SERIES A2.4

Performance in Experiment 2. Successive tables show the raw data for each subject in each of the conditions of the experiment, the mean decision-time collapsing over practice trials, and the mean sorting-time collapsing over decks (i.e., conditions).

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

The units in the tables represent 'seconds'.

EXPERIMENT 2 : The raw data , sorting-time (secs.).

GROUP

1

SORTING TRIALS (1 to 5

Subject	1					
DECK	1	19.24	13.42	17.21	12.82	13.33
DECK	2	18.37	20.25	17.24	17.11	17.20
DECK	3	19.15	20.36	14.80	17.44	17.49
DECK	4	21.43	19.54	19.20	19.69	16.60
Subject	2					
DECK	1	25.49	25.02	27.77	28.41	28.19
DECK	2	31.10	29.28	29.80	30.37	31.38
DECK	3	32.56	29.69	30.31	33.58	31.11
DECK	4	32.94	35.40	36.86	32.66	34.90
Subject	3					
DECK	1	33.10	42.20	26.99	30.77	31.94
DECK	2	45.70	36.19	44.91	35.75	37.50
DECK	3	37.70	42.63	44.46	40.55	43.25
DECK	4	50.45	46.52	47.84	47.89	50.32
Subject	4					
DECK	1	44.89	44.53	38.34	35.93	31.38
DECK	2	41.15	52.45	41.75	41.63	40.69
DECK	3	55.01	56.91	50.06	50.31	44.54
DECK	4	115.07	59.04	53.63	57.94	55.64
Subject	5					
DECK	1	49.88	50.78	48.99	48.38	49.89
DECK	2	53.82	50.63	49.43	51.21	65.67
DECK	3	50.73	50.84	53.38	61.94	57.84
DECK	4	52.87	59.80	56.27	58.77	59.01
Subject	6					
DECK	1	44.05	37.14	38.36	41.49	33.98
DECK	2	47.82	44.90	47.32	47.64	45.39
DECK	3	54.58	45.19	47.97	45.75	47.50
DECK	4	48.93	50.67	47.45	48.05	49.01
Subject	7					
DECK	1	35.33	38.63	37.32	34.72	33.84
DECK	2	35.75	34.69	41.15	36.20	39.86
DECK	3	36.79	39.16	35.66	38.55	41.59
DECK	4	45.67	45.29	41.53	43.28	42.14
Subject	8					
DECK	1	27.96	22.29	22.29	22.88	22.49
DECK	2	30.06	26.24	23.41	27.19	28.99
DECK	3	29.20	28.29	31.85	30.74	28.39
DECK	4	34.42	32.84	35.12	33.55	30.77
Subject	9					
DECK	1	35.33	41.10	37.97	31.72	29.41
DECK	2	44.29	46.92	43.82	42.95	34.51
DECK	3	50.53	46.38	41.95	40.92	43.86
DECK	4	56.35	50.70	44.83	44.50	42.59

GROUP 1 table continued

SORTING TRIALS (1 to 5

Subject	10					
DECK	1	19.71	16.55	16.74	16.31	18.83
DECK	2	24.78	19.91	20.28	23.78	20.93
DECK	3	25.42	22.62	22.68	23.06	22.57
DECK	4	28.17	21.53	26.02	23.90	25.13
Subject	11					
DECK	1	18.19	14.99	16.40	14.53	17.56
DECK	2	21.43	19.61	16.21	16.25	15.23
DECK	3	17.98	17.88	16.55	15.91	14.62
DECK	4	18.39	18.60	18.40	19.66	17.07
Subject	12					
DECK	1	11.65	10.77	12.02	13.97	13.48
DECK	2	15.99	14.78	17.19	14.56	17.92
DECK	3	22.50	15.49	21.19	19.79	18.63
DECK	4	30.86	24.31	24.16	25.09	22.11
Subject	13					
DECK	1	11.43	9.89	8.90	11.69	9.30
DECK	2	12.60	12.45	12.09	11.70	12.38
DECK	3	15.13	15.05	14.60	13.82	12.88
DECK	4	17.27	17.88	16.45	16.33	14.44
Subject	14					
DECK	1	17.60	14.73	12.95	13.64	13.88
DECK	2	15.96	15.99	15.27	15.51	16.38
DECK	3	22.27	17.96	16.77	16.05	16.24
DECK	4	22.02	20.44	20.17	16.02	15.21
Subject	15					
DECK	1	10.85	13.01	12.89	12.09	12.09
DECK	2	16.06	15.71	14.44	14.70	13.39
DECK	3	20.76	19.04	18.28	16.34	14.80
DECK	4	24.92	20.23	20.49	19.59	19.61
Subject	16					
DECK	1	26.95	15.75	16.77	13.29	12.57
DECK	2	25.83	18.91	18.50	17.35	18.04
DECK	3	25.51	16.72	16.99	18.14	19.23
DECK	4	21.75	22.20	20.06	20.53	15.87
Subject	17					
DECK	1	20.65	18.82	16.88	19.36	19.47
DECK	2	21.76	20.61	22.41	18.50	15.96
DECK	3	29.94	26.55	24.44	32.34	19.82
DECK	4	32.17	21.72	26.37	26.04	34.84
Subject	18					
DECK	1	24.25	25.78	21.76	20.00	18.35
DECK	2	26.60	22.23	22.69	22.14	25.65
DECK	3	23.57	25.58	25.39	24.36	18.48
DECK	4	25.91	26.79	26.23	34.84	30.84

GROUP 1 table continued

SORTING TRIALS (1 to 5

Subject	19					
DECK	1	14.01	13.32	11.31	12.86	14.02
DECK	2	18.15	16.95	14.79	16.88	14.63
DECK	3	18.55	19.48	17.65	22.91	18.81
DECK	4	23.95	21.03	20.11	23.25	26.68
Subject	20					
DECK	1	16.70	14.43	14.03	16.26	13.80
DECK	2	16.38	14.69	14.69	15.22	16.48
DECK	3	20.07	20.30	15.30	16.84	15.73
DECK	4	20.32	19.93	18.58	18.76	17.16
Subject	21					
DECK	1	21.57	25.80	19.22	33.02	19.66
DECK	2	25.40	32.12	27.10	27.71	36.25
DECK	3	33.91	53.42	34.62	34.57	45.60
DECK	4	57.08	66.98	46.14	44.25	46.64
Subject	22					
DECK	1	14.01	12.11	12.50	13.49	15.24
DECK	2	17.89	15.60	14.97	16.79	17.80
DECK	3	16.49	17.04	15.57	17.07	17.06
DECK	4	19.22	17.36	18.95	18.25	15.18
Subject	23					
DECK	1	10.22	13.11	13.54	12.56	12.71
DECK	2	15.22	15.40	14.97	14.62	14.46
DECK	3	17.16	15.89	16.39	14.98	13.91
DECK	4	23.71	16.76	20.96	18.62	16.89

GROUP 2

SORTING TRIALS (1 to 5

Subject	1					
DECK	1	9.10	7.80	7.80	8.35	7.47
DECK	2	10.41	10.01	8.68	8.25	8.24
DECK	3	12.54	11.03	9.25	10.25	9.71
DECK	4	12.59	11.18	10.34	9.39	11.14
Subject	2					
DECK	1	14.87	9.80	10.99	10.89	10.76
DECK	2	14.40	12.18	13.68	12.73	13.04
DECK	3	15.62	12.68	12.69	13.45	13.33
DECK	4	16.33	13.65	13.43	13.06	12.75
Subject	3					
DECK	1	10.80	10.37	8.97	10.31	9.67
DECK	2	12.43	10.70	10.70	10.48	9.29
DECK	3	14.57	12.66	11.80	11.73	11.13
DECK	4	17.15	15.27	12.74	13.94	12.69
Subject	4					
DECK	1	14.73	13.50	12.30	12.83	11.56
DECK	2	18.70	18.66	19.20	13.59	14.95
DECK	3	18.85	16.80	14.46	15.54	14.90
DECK	4	21.35	21.38	22.93	18.70	17.80
Subject	5					
DECK	1	10.80	9.25	9.90	9.81	8.27
DECK	2	12.68	11.21	10.83	11.60	11.13
DECK	3	15.94	15.19	12.03	11.98	12.37
DECK	4	17.73	17.26	16.23	15.62	15.65
Subject	6					
DECK	1	15.81	13.64	13.86	12.63	13.95
DECK	2	15.68	15.31	15.73	14.37	16.28
DECK	3	18.16	19.87	18.02	17.76	17.74
DECK	4	20.14	20.94	17.07	19.29	18.56
Subject	7					
DECK	1	9.25	13.68	14.19	12.26	11.19
DECK	2	15.62	14.27	13.62	15.69	12.74
DECK	3	16.69	15.34	18.71	13.49	12.43
DECK	4	17.52	16.34	13.20	12.95	15.03
Subject	8					
DECK	1	9.35	9.42	8.44	8.99	9.63
DECK	2	10.59	12.18	11.42	11.27	10.15
DECK	3	11.27	11.91	11.48	10.49	10.34
DECK	4	14.10	12.66	13.20	12.30	11.96
Subject	9					
DECK	1	11.86	12.50	11.84	10.83	10.04
DECK	2	12.79	12.71	11.84	11.34	13.84
DECK	3	13.69	13.11	13.24	13.16	10.75
DECK	4	17.69	17.29	14.91	15.22	14.08

GROUP 2 table continued

SORTING TRIALS < 1 to 5

Subject	10					
DECK	1	10.65	10.45	9.63	9.37	8.39
DECK	2	11.79	10.53	9.96	10.28	9.99
DECK	3	11.81	12.67	10.49	11.87	11.13
DECK	4	13.19	12.62	13.08	11.77	11.70
Subject	11					
DECK	1	11.41	12.62	11.99	12.54	11.71
DECK	2	14.27	14.41	14.60	12.50	12.22
DECK	3	14.76	16.96	16.53	15.14	15.40
DECK	4	19.32	19.90	17.17	17.06	15.60
Subject	12					
DECK	1	16.24	12.38	11.62	10.51	10.55
DECK	2	17.94	14.27	14.45	11.25	12.82
DECK	3	14.26	13.08	13.48	12.24	11.12
DECK	4	14.43	15.09	13.39	13.19	11.51
Subject	13					
DECK	1	12.62	10.01	11.21	11.21	9.72
DECK	2	12.78	10.82	12.49	12.33	10.21
DECK	3	12.05	12.94	14.34	13.23	11.41
DECK	4	14.56	14.90	15.32	13.04	11.91
Subject	14					
DECK	1	10.23	11.38	12.45	10.82	9.46
DECK	2	12.22	11.49	12.59	12.14	11.50
DECK	3	15.30	13.55	13.73	14.87	12.90
DECK	4	16.38	14.91	15.56	15.61	15.34
Subject	15					
DECK	1	10.28	9.15	9.29	8.72	9.69
DECK	2	10.86	10.79	9.99	10.25	9.96
DECK	3	12.75	12.84	11.55	11.03	10.45
DECK	4	11.58	12.58	11.77	12.42	12.48
Subject	16					
DECK	1	13.04	12.31	10.54	12.15	11.20
DECK	2	14.71	13.12	12.37	14.89	11.30
DECK	3	14.09	14.01	13.46	13.88	12.25
DECK	4	17.34	15.80	15.57	14.56	13.55
Subject	17					
DECK	1	10.19	11.85	12.35	9.60	9.12
DECK	2	13.94	12.34	10.78	10.49	10.79
DECK	3	14.25	12.72	11.94	11.12	10.40
DECK	4	16.18	14.30	11.84	12.54	10.32
Subject	18					
DECK	1	13.94	11.18	12.25	12.47	11.76
DECK	2	14.08	12.25	11.33	12.29	11.85
DECK	3	16.70	13.59	13.99	14.63	13.98
DECK	4	13.32	14.71	14.98	17.37	12.87

GROUP 2 table continued

SORTING TRIALS (1 to 5

Subject	19					
DECK	1	13.34	12.20	11.52	10.53	8.66
DECK	2	16.16	14.13	11.68	12.68	9.98
DECK	3	15.29	13.84	12.35	13.05	11.62
DECK	4	14.38	13.69	12.73	11.81	11.98
Subject	20					
DECK	1	11.00	11.09	10.24	11.44	10.46
DECK	2	12.43	12.27	12.68	11.69	12.40
DECK	3	13.94	13.96	13.58	15.20	13.81
DECK	4	17.45	16.49	14.01	15.15	16.30
Subject	21					
DECK	1	16.01	16.89	15.69	15.46	14.61
DECK	2	15.84	18.23	17.43	14.54	15.14
DECK	3	18.79	17.52	18.58	14.87	17.94
DECK	4	20.60	18.62	22.24	18.92	15.96
Subject	22					
DECK	1	9.97	10.44	11.13	11.13	9.93
DECK	2	11.71	13.07	14.28	11.93	12.01
DECK	3	14.14	12.46	14.44	13.50	13.31
DECK	4	14.54	15.82	17.89	14.00	14.13
Subject	23					
DECK	1	14.48	14.18	12.87	14.41	13.59
DECK	2	17.28	15.40	15.38	13.11	12.80
DECK	3	18.26	16.44	14.58	14.70	15.88
DECK	4	23.19	17.11	17.36	16.64	16.31

EXPERIMENT 2 : Mean decision-time, collapsing over trials.

CONDITIONS 1, 2 and 3			
GROUP	1		
	2.83	2.65	4.09
	3.32	4.47	7.57
	7.01	8.72	15.60
	4.50	12.36	17.25
	4.57	5.37	7.76
	7.61	9.20	9.82
	1.56	2.44	7.61
	3.58	6.10	9.74
	7.39	9.62	12.68
	4.31	5.64	7.32
	1.22	0.06	1.89
	3.71	7.14	12.93
	2.00	4.06	6.23
	2.29	2.20	3.59
	1.26	3.30	4.21
	2.67	5.67	8.78
	0.81	7.58	9.19
	1.83	1.45	6.89
	3.18	6.38	9.90
	0.45	2.61	3.91
	5.86	16.57	28.30
	3.14	3.17	3.12
	2.50	3.24	6.96
GROUP	2		
	1.02	2.46	2.83
	1.58	2.09	2.38
	0.70	2.36	4.34
	4.04	3.13	7.45
	1.88	3.89	6.89
	1.49	4.33	5.22
	1.28	2.22	1.90
	1.95	1.93	3.67
	1.09	1.38	4.43
	0.81	1.89	2.77
	1.55	3.71	5.76
	1.89	0.58	1.26
	0.88	0.76	3.00
	1.12	3.20	4.69
	1.14	2.49	2.97
	1.43	1.69	3.51
	1.05	1.47	2.42
	0.24	1.86	1.93
	1.68	1.98	1.67
	1.44	3.25	5.03
	0.51	1.81	3.50
	2.08	3.05	4.76
	0.88	2.06	4.21

EXPERIMENT 2 : Mean sorting-time collapsing over the decks.

CONDITIONS 1, 2 and 3					
GROUP	1				
	19.55	18.39	17.11	16.77	16.16
	29.02	29.85	31.19	31.26	31.40
	41.74	41.89	41.05	38.74	40.75
	64.03	53.23	45.20	46.45	43.06
	51.83	56.95	52.02	55.08	58.10
	48.85	44.48	45.28	45.73	43.97
	38.39	39.44	38.92	38.19	39.43
	30.41	27.42	28.19	28.59	27.66
	46.63	46.28	42.12	40.02	37.59
	24.52	20.15	21.43	21.76	21.87
	19.00	17.46	16.89	16.35	16.07
	20.25	16.34	18.64	18.35	18.04
	14.11	13.82	13.01	13.38	12.25
	14.84	15.52	15.92	15.62	14.96
	19.46	17.28	16.29	15.31	15.43
	18.15	16.99	16.53	15.66	14.90
	26.01	18.39	18.02	24.06	22.52
	25.08	25.10	24.02	25.34	23.33
	18.67	17.70	15.97	18.98	18.54
	18.37	17.34	15.65	16.77	15.79
	34.49	44.58	31.77	34.89	37.04
	16.90	15.53	15.50	16.40	16.32
	16.58	15.29	16.47	15.20	14.49
GROUP	2				
	11.16	10.01	9.02	9.06	9.14
	15.31	12.08	12.70	12.53	12.47
	13.74	12.25	11.05	11.62	10.70
	18.41	17.59	17.22	15.17	14.80
	14.29	13.23	12.25	12.25	11.86
	17.45	17.44	16.17	16.01	16.63
	16.02	14.91	14.93	13.60	12.85
	11.33	11.54	11.14	10.76	10.52
	14.01	13.90	12.96	12.64	12.18
	11.86	11.57	10.79	10.82	10.70
	14.94	15.97	15.07	14.31	13.73
	15.72	13.72	13.24	11.80	11.50
	13.00	12.17	13.34	12.45	10.81
	13.53	12.83	13.58	13.36	12.30
	11.37	11.34	10.65	10.61	10.65
	14.80	13.81	12.99	13.87	12.08
	13.64	12.80	11.73	10.94	10.16
	14.15	12.93	13.14	14.44	12.62
	14.79	13.46	12.07	12.02	10.56
	13.71	13.45	12.63	13.37	13.24
	17.81	17.82	18.49	15.95	15.91
	12.59	12.95	14.44	12.64	12.35
	18.30	15.78	15.05	14.72	14.65

TABLE SERIES A2.5

Performance in Experiment 3. Successive tables indicate the data for the Local and the Global processing conditions, and the derived Global Precedence Score.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

Scores represent the number of correct responses.

Discrimination Difficulty Levels

1 : Easy level

2 : Intermediate level

3 : Difficult level

EXPERIMENT 3 : LOCAL LEVEL DETECTION

GROUP 1

LEVELS OF FACTOR C (stimulus duration)

LEVEL B (discrimination difficulty)		1
2.00	5.00	8.00
3.00	5.00	7.00
4.00	8.00	7.00
5.00	7.00	8.00
3.00	2.00	7.00
4.00	6.00	8.00
5.00	5.00	8.00
1.00	6.00	4.00
3.00	6.00	6.00
5.00	3.00	5.00
7.00	7.00	8.00
2.00	6.00	5.00
3.00	5.00	3.00
2.00	3.00	4.00
4.00	4.00	7.00

LEVEL B (discrimination difficulty)		2
3.00	7.00	6.00
3.00	4.00	5.00
3.00	6.00	6.00
2.00	6.00	6.00
4.00	5.00	8.00
3.00	5.00	7.00
2.00	5.00	6.00
2.00	7.00	8.00
5.00	5.00	7.00
3.00	6.00	5.00
4.00	8.00	7.00
2.00	3.00	4.00
2.00	4.00	4.00
0.00	0.00	1.00
4.00	5.00	7.00

LEVEL B (discrimination difficulty)		3
2.00	2.00	5.00
1.00	7.00	4.00
5.00	8.00	7.00
3.00	3.00	5.00
0.00	3.00	7.00
3.00	5.00	6.00
2.00	6.00	6.00
4.00	3.00	6.00
5.00	4.00	6.00
0.00	2.00	3.00
4.00	7.00	7.00
4.00	3.00	1.00
2.00	2.00	2.00
4.00	5.00	2.00
5.00	4.00	7.00

GROUP 2

 LEVELS OF FACTOR C (stimulus duration)

LEVEL B (discrimination difficulty)		1	
5.00	5.00		7.00
4.00	7.00		6.00
1.00	7.00		8.00
3.00	8.00		8.00
2.00	6.00		6.00
2.00	6.00		8.00
2.00	7.00		6.00
2.00	5.00		6.00
3.00	8.00		7.00
3.00	5.00		6.00
5.00	8.00		7.00
2.00	5.00		4.00
6.00	8.00		8.00
7.00	8.00		8.00
5.00	5.00		8.00

LEVEL B (discrimination difficulty)		2	
4.00	6.00		5.00
5.00	6.00		7.00
2.00	5.00		6.00
1.00	8.00		7.00
7.00	6.00		7.00
3.00	8.00		7.00
1.00	5.00		5.00
4.00	4.00		4.00
5.00	8.00		8.00
3.00	7.00		7.00
3.00	5.00		7.00
5.00	5.00		6.00
7.00	8.00		8.00
6.00	8.00		7.00
3.00	5.00		8.00

LEVEL B (discrimination difficulty)		3	
4.00	4.00		2.00
3.00	7.00		8.00
3.00	6.00		6.00
2.00	6.00		6.00
6.00	6.00		5.00
3.00	2.00		5.00
1.00	5.00		3.00
4.00	3.00		4.00
4.00	8.00		8.00
4.00	3.00		8.00
2.00	7.00		5.00
2.00	5.00		7.00
6.00	8.00		7.00
4.00	7.00		6.00
2.00	3.00		3.00

EXPERIMENT 3 : GLOBAL LEVEL DETECTION

GROUP 1

LEVELS OF FACTOR C (stimulus duration)

LEVEL B (discrimination difficulty)		1
8.00	7.00	6.00
8.00	8.00	8.00
7.00	7.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
4.00	8.00	8.00
7.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
6.00	5.00	7.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00

LEVEL B (discrimination difficulty)		2
2.00	5.00	7.00
0.00	7.00	8.00
2.00	7.00	7.00
2.00	8.00	8.00
4.00	4.00	5.00
1.00	1.00	5.00
2.00	3.00	4.00
3.00	5.00	5.00
3.00	3.00	7.00
3.00	5.00	7.00
3.00	8.00	8.00
1.00	2.00	6.00
3.00	3.00	7.00
3.00	4.00	8.00
4.00	5.00	8.00

LEVEL B (discrimination difficulty)		3
2.00	1.00	3.00
0.00	1.00	1.00
2.00	2.00	4.00
1.00	2.00	0.00
1.00	2.00	3.00
3.00	4.00	3.00
1.00	2.00	1.00
0.00	0.00	0.00
1.00	2.00	2.00
1.00	2.00	3.00
1.00	1.00	2.00
2.00	2.00	1.00
2.00	2.00	1.00
1.00	1.00	4.00
1.00	1.00	3.00

GROUP

2

LEVELS OF FACTOR C (stimulus duration)

LEVEL B (discrimination difficulty)

1

8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	7.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	7.00
8.00	8.00	8.00
8.00	8.00	8.00
8.00	8.00	8.00

LEVEL B (discrimination difficulty)

2

5.00	5.00	8.00
3.00	7.00	8.00
2.00	5.00	7.00
4.00	7.00	8.00
3.00	6.00	8.00
4.00	8.00	8.00
1.00	6.00	8.00
4.00	7.00	8.00
1.00	5.00	6.00
3.00	5.00	8.00
3.00	7.00	7.00
4.00	7.00	8.00
3.00	8.00	8.00
6.00	8.00	8.00
2.00	8.00	8.00

LEVEL B (discrimination difficulty)

3

1.00	3.00	4.00
2.00	3.00	3.00
1.00	4.00	2.00
3.00	1.00	4.00
2.00	5.00	3.00
2.00	4.00	5.00
4.00	2.00	4.00
2.00	2.00	4.00
5.00	2.00	4.00
2.00	1.00	4.00
5.00	3.00	4.00
1.00	1.00	4.00
1.00	2.00	1.00
3.00	2.00	4.00
2.00	2.00	3.00

EXPERIMENT 3 : GLOBAL PRECEDENCE SCORES

GROUP 1

LEVELS OF FACTOR C (stimulus duration)		
LEVEL B (discrimination difficulty)		
		1
6.00	2.00	-2.00
5.00	3.00	1.00
3.00	-1.00	1.00
3.00	1.00	0.00
5.00	6.00	1.00
4.00	2.00	0.00
3.00	3.00	0.00
3.00	2.00	4.00
4.00	2.00	2.00
3.00	5.00	3.00
1.00	1.00	0.00
4.00	-1.00	2.00
5.00	3.00	5.00
6.00	5.00	4.00
4.00	4.00	1.00
LEVEL B (discrimination difficulty)		
		2
-1.00	-2.00	1.00
-3.00	3.00	3.00
-1.00	1.00	1.00
0.00	2.00	2.00
0.00	-1.00	-3.00
-2.00	-4.00	-2.00
0.00	-2.00	-2.00
1.00	-2.00	-3.00
-2.00	-2.00	0.00
0.00	-1.00	2.00
-1.00	0.00	1.00
-1.00	-1.00	2.00
1.00	-1.00	3.00
3.00	4.00	7.00
0.00	0.00	1.00
LEVEL B (discrimination difficulty)		
		3
0.00	-1.00	-2.00
-1.00	-6.00	-3.00
-3.00	-6.00	-3.00
-2.00	-1.00	-5.00
1.00	-1.00	-4.00
0.00	-1.00	-3.00
-1.00	-4.00	-5.00
-4.00	-3.00	-6.00
-4.00	-2.00	-4.00
1.00	0.00	0.00
-3.00	-6.00	-5.00
-2.00	-1.00	0.00
0.00	0.00	-1.00
-3.00	-4.00	2.00
-4.00	-3.00	-4.00

GROUP

2

 LEVELS OF FACTOR C (stimulus duration)

LEVEL B (discrimination difficulty)		1
3.00	3.00	1.00
4.00	1.00	2.00
7.00	1.00	0.00
5.00	0.00	0.00
6.00	2.00	2.00
6.00	2.00	0.00
6.00	1.00	2.00
6.00	3.00	2.00
5.00	0.00	0.00
5.00	3.00	2.00
3.00	0.00	1.00
6.00	3.00	3.00
2.00	0.00	0.00
1.00	0.00	0.00
3.00	3.00	0.00

LEVEL B (discrimination difficulty)		2
1.00	-1.00	3.00
-2.00	1.00	1.00
0.00	0.00	1.00
3.00	-1.00	1.00
-4.00	0.00	1.00
1.00	0.00	1.00
0.00	1.00	3.00
0.00	3.00	4.00
-4.00	-3.00	-2.00
0.00	-2.00	1.00
0.00	2.00	0.00
-1.00	2.00	2.00
-4.00	0.00	0.00
0.00	0.00	1.00
-1.00	3.00	0.00

LEVEL B (discrimination difficulty)		3
-3.00	-1.00	2.00
-1.00	-4.00	-5.00
-2.00	-2.00	-4.00
1.00	-5.00	-2.00
-4.00	-1.00	-2.00
-1.00	2.00	0.00
3.00	-3.00	1.00
-2.00	-1.00	0.00
1.00	-6.00	-4.00
-2.00	-2.00	-4.00
3.00	-4.00	-1.00
-1.00	-4.00	-3.00
-5.00	-6.00	-6.00
-1.00	-5.00	-2.00
0.00	-1.00	0.00

TABLE SERIES A2.6

Performance in Experiment 4. Successive tables indicate the number of correct responses and response-time (in milliseconds) in the Global Processing condition.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

Response types include:

Fsame : Familiar Same

Usame : Unfamiliar Same

Fdiff. : Familiar Different

Udiff. : Unfamiliar Different

EXPERIMENT 4 : GLOBAL PROCESSING , correct responses

GROUP 1

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
5.00	6.00	9.00	6.00
9.00	7.00	7.00	5.00
10.00	7.00	7.00	5.00
9.00	9.00	9.00	9.00
10.00	8.00	6.00	2.00
9.00	9.00	8.00	8.00
9.00	8.00	10.00	7.00
8.00	8.00	8.00	5.00
6.00	5.00	9.00	9.00
10.00	10.00	9.00	6.00
10.00	9.00	10.00	7.00
7.00	7.00	5.00	8.00
10.00	9.00	8.00	8.00
9.00	9.00	10.00	10.00
10.00	9.00	10.00	7.00
LEVEL B (stimulus duration)		60 msec	
10.00	9.00	10.00	9.00
10.00	9.00	7.00	7.00
10.00	9.00	10.00	8.00
10.00	8.00	10.00	9.00
7.00	10.00	10.00	10.00
10.00	10.00	9.00	9.00
8.00	9.00	9.00	8.00
6.00	9.00	8.00	8.00
10.00	7.00	10.00	7.00
10.00	10.00	9.00	8.00
10.00	10.00	10.00	10.00
8.00	10.00	10.00	10.00
10.00	10.00	9.00	8.00
9.00	10.00	10.00	9.00
10.00	9.00	10.00	8.00

GROUP 2

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
10.00	10.00	9.00	7.00
10.00	10.00	10.00	9.00
10.00	9.00	9.00	8.00
8.00	9.00	8.00	6.00
10.00	8.00	10.00	8.00
9.00	10.00	10.00	9.00
8.00	8.00	10.00	9.00
10.00	10.00	10.00	9.00
10.00	9.00	10.00	5.00
10.00	10.00	10.00	9.00
9.00	10.00	9.00	6.00
9.00	9.00	9.00	10.00
9.00	9.00	9.00	10.00
10.00	6.00	10.00	9.00
9.00	8.00	10.00	10.00

LEVEL B (stimulus duration)		60 msec	
10.00	10.00	10.00	10.00
10.00	10.00	10.00	10.00
10.00	10.00	10.00	10.00
9.00	10.00	10.00	8.00
10.00	10.00	10.00	10.00
10.00	10.00	10.00	10.00
10.00	10.00	10.00	7.00
9.00	10.00	10.00	7.00
10.00	9.00	10.00	10.00
10.00	10.00	10.00	9.00
8.00	9.00	10.00	9.00
10.00	10.00	10.00	10.00
9.00	10.00	9.00	10.00
10.00	10.00	10.00	9.00
9.00	8.00	10.00	10.00

EXPERIMENT 4 : GLOBAL PROCESSING , response latency

GROUP 1

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
1272.46	1318.08	1245.54	1282.62
1405.35	1109.83	1471.14	1460.78
811.19	792.89	906.82	1001.66
745.15	814.43	659.79	829.55
889.26	954.76	1154.28	1302.03
848.98	1046.93	952.48	884.85
627.85	559.68	632.41	632.92
1203.43	1047.29	1010.31	1127.66
879.44	761.88	865.72	743.32
686.27	699.03	750.46	878.21
695.95	759.37	745.82	916.57
1211.89	1462.06	1412.09	1450.66
729.28	810.21	809.72	895.20
765.24	807.99	755.52	870.42
948.15	800.43	868.72	1021.96
LEVEL B (stimulus duration)		60 msec	
925.57	850.31	888.76	1282.77
1305.44	1112.71	1008.63	1052.35
653.57	681.29	862.32	845.18
572.48	640.17	582.15	697.41
859.41	681.87	755.77	890.51
658.80	733.30	787.10	786.72
537.54	508.71	547.07	538.54
1152.94	1355.84	1134.53	937.46
596.05	722.36	642.50	684.23
674.98	720.65	680.91	721.88
704.82	649.59	784.22	815.31
1316.95	1065.81	1015.06	988.13
629.55	622.97	692.86	735.89
675.20	721.02	652.98	647.35
855.42	823.18	786.07	1016.61

GROUP

2

 LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
807.43	1013.23	968.16	988.63
449.81	512.91	580.21	593.83
520.92	576.57	568.86	564.48
865.16	916.07	937.41	996.89
990.48	1441.03	1271.77	1680.62
945.51	1020.97	844.37	1100.24
924.10	1024.07	881.55	1156.53
758.21	753.48	760.45	914.94
739.67	1018.22	1143.59	1183.24
625.19	594.46	599.10	660.01
1223.04	1261.70	1592.97	1606.19
883.93	909.73	865.81	887.55
745.89	744.91	688.09	719.95
609.15	740.63	601.39	726.73
845.30	963.27	922.18	835.56

LEVEL B (stimulus duration)		60 msec	
727.13	663.83	663.58	677.23
471.17	595.01	535.34	558.67
629.98	593.18	608.74	644.89
884.92	991.25	892.91	955.99
674.01	539.93	581.98	777.86
845.48	887.98	669.83	1150.30
840.61	751.62	635.02	844.64
693.12	521.95	632.39	914.37
578.21	624.27	661.14	912.81
634.31	566.21	737.78	640.05
1506.97	1477.59	1302.60	1441.26
854.59	776.77	687.85	711.27
704.70	741.09	555.71	734.31
550.53	542.67	590.31	593.75
903.39	958.02	709.54	852.33

TABLE SERIES A2.7

Performance in Experiment 4. Successive tables indicate the number of correct responses and response-time (in milliseconds) in the Attentional Processing condition.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

Response types include:

Fsame : Familiar Same

Usame : Unfamiliar Same

Fdiff. : Familiar Different

Udiff. : Unfamiliar Different

EXPERIMENT 4 : ATTENTIONAL PROCESSING , correct responses

GROUP 1

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
4.00	3.00	6.00	7.00
7.00	3.00	4.00	5.00
10.00	8.00	10.00	10.00
10.00	6.00	8.00	7.00
5.00	8.00	4.00	4.00
4.00	4.00	8.00	7.00
2.00	8.00	4.00	6.00
7.00	6.00	7.00	5.00
7.00	4.00	9.00	6.00
5.00	7.00	6.00	4.00
3.00	6.00	10.00	7.00
4.00	7.00	7.00	1.00
6.00	6.00	6.00	4.00
6.00	7.00	7.00	6.00
9.00	8.00	8.00	6.00

LEVEL B (stimulus duration)		60 msec	
6.00	6.00	8.00	9.00
5.00	7.00	8.00	7.00
10.00	10.00	10.00	7.00
8.00	9.00	9.00	6.00
8.00	7.00	9.00	5.00
9.00	9.00	9.00	6.00
6.00	8.00	7.00	3.00
7.00	5.00	7.00	9.00
8.00	8.00	10.00	5.00
8.00	7.00	8.00	4.00
8.00	7.00	10.00	8.00
5.00	8.00	8.00	10.00
4.00	5.00	9.00	6.00
7.00	5.00	10.00	5.00
10.00	8.00	9.00	7.00

GROUP 2

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
6.00	8.00	5.00	4.00
7.00	9.00	3.00	2.00
5.00	5.00	8.00	3.00
9.00	8.00	8.00	4.00
7.00	5.00	6.00	5.00
8.00	4.00	8.00	7.00
6.00	8.00	9.00	6.00
6.00	8.00	7.00	2.00
5.00	7.00	9.00	4.00
9.00	7.00	10.00	5.00
7.00	5.00	7.00	5.00
10.00	8.00	8.00	10.00
7.00	8.00	7.00	7.00
9.00	8.00	8.00	4.00
6.00	6.00	7.00	7.00

LEVEL B (stimulus duration)		60 msec	
10.00	9.00	4.00	4.00
10.00	10.00	9.00	4.00
9.00	7.00	9.00	7.00
10.00	8.00	10.00	5.00
8.00	8.00	10.00	7.00
6.00	3.00	10.00	9.00
7.00	5.00	10.00	5.00
8.00	10.00	10.00	2.00
8.00	6.00	8.00	6.00
10.00	10.00	10.00	7.00
10.00	9.00	9.00	6.00
10.00	6.00	10.00	8.00
9.00	9.00	10.00	6.00
10.00	9.00	10.00	6.00
8.00	7.00	9.00	8.00

EXPERIMENT 4 : ATTENTIONAL PROCESSING , response latency

GROUP 1

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
1293.77	1353.64	1444.59	1427.20
1385.60	1365.60	1242.52	1375.21
790.36	845.86	850.36	947.15
891.61	854.89	819.06	819.43
1041.61	1272.36	1270.04	1125.03
1029.81	1435.79	1355.08	1274.61
670.67	860.11	765.81	796.36
1012.75	1268.71	984.74	1055.76
865.66	769.75	760.84	762.50
883.32	852.35	842.18	915.85
1059.13	1062.80	1034.83	904.17
1352.25	1341.66	1203.43	1265.64
862.51	934.28	1033.40	873.39
834.63	869.56	794.50	1012.20
1015.05	863.52	952.57	1093.75

LEVEL B (stimulus duration)		60 msec	
1224.55	1158.91	1167.59	1182.77
1294.69	1560.13	1331.56	1348.75
845.30	921.81	762.51	920.87
773.61	720.65	652.89	727.14
1228.16	1559.30	957.29	1068.97
1151.22	1379.70	860.27	970.78
669.71	663.70	630.43	627.03
756.59	973.16	868.32	839.49
618.44	758.52	657.10	733.47
894.25	964.44	859.88	869.21
976.12	969.02	926.82	1048.33
1255.05	1429.32	1123.63	1474.67
1054.58	1018.75	840.05	1075.84
1018.48	949.22	782.83	794.03
1094.58	936.48	895.11	1096.19

GROUP

2

LEVELS OF FACTOR C (response types, Fsame, Usame, Fdiff., Udiff.)

LEVEL B (stimulus duration)		30 msec	
1048.13	908.27	965.28	943.96
894.74	799.57	641.24	613.37
604.83	599.81	645.23	676.21
884.92	991.25	892.91	955.99
1330.94	1327.90	1456.05	1343.83
969.25	1344.67	880.32	1164.71
1162.84	1268.68	1005.43	1388.31
982.40	912.53	960.13	1081.99
1382.99	1451.35	1387.41	1130.96
927.25	1203.83	799.47	942.28
2090.66	1986.12	1296.46	1791.37
1000.57	1091.86	871.71	1069.55
966.11	835.75	838.77	946.42
872.91	782.44	696.23	848.88
968.33	944.61	949.55	914.03
LEVEL B (stimulus duration)		60 msec	
760.95	1153.47	860.82	846.18
566.69	512.01	566.71	534.30
558.85	605.72	556.76	601.09
759.60	661.10	660.45	728.38
944.31	1038.51	811.38	964.67
1028.81	1329.98	792.06	1139.68
1004.26	1268.93	791.93	999.91
712.57	752.89	652.31	693.70
1329.57	1261.88	869.89	1137.46
1275.20	1400.19	789.36	1084.51
1894.41	2339.09	1333.63	1923.25
843.35	1131.29	630.75	950.57
816.17	877.19	647.42	778.81
737.67	714.69	701.94	638.13
1174.92	1005.05	947.71	1077.94

TABLE SERIES A2.8

Performance in Experiment 5. The table indicates the number of correct responses the conditions of the experiment.

In the tables:

Group 1 refers to schizophrenics

Group 2 refers to controls

Stimulus durations are, 30, 60, and 90 milliseconds, respectively

Distractor types include:

Level 1 : Familiar distractors

Level 2 : Unfamiliar, organized distractors

Level 3 : Random form distractors

EXPERIMENT 5 DATA

GROUP 1

LEVELS OF FACTOR C (stimulus duration)

LEVEL B (distractor type)	1	
0.00	9.00	7.00
5.00	9.00	10.00
8.00	10.00	10.00
6.00	10.00	8.00
2.00	4.00	7.00
4.00	5.00	5.00
4.00	10.00	9.00
4.00	6.00	4.00
3.00	9.00	9.00
1.00	1.00	4.00
4.00	7.00	9.00
2.00	10.00	9.00
1.00	2.00	2.00
0.00	3.00	4.00
9.00	8.00	9.00

LEVEL B (distractor type)	2	
4.00	8.00	9.00
6.00	10.00	10.00
7.00	9.00	10.00
8.00	10.00	10.00
2.00	5.00	4.00
6.00	6.00	9.00
6.00	10.00	10.00
7.00	5.00	6.00
3.00	9.00	10.00
2.00	1.00	4.00
4.00	9.00	10.00
6.00	9.00	9.00
2.00	4.00	4.00
2.00	5.00	8.00
6.00	10.00	10.00

LEVEL B (distractor type)	3	
6.00	9.00	10.00
4.00	9.00	10.00
9.00	10.00	10.00
9.00	9.00	10.00
5.00	7.00	7.00
7.00	6.00	10.00
4.00	10.00	10.00
9.00	8.00	9.00
5.00	10.00	9.00
4.00	7.00	8.00
2.00	10.00	10.00
6.00	8.00	9.00
2.00	6.00	7.00
3.00	9.00	8.00
8.00	10.00	10.00

GROUP

2

 LEVELS OF FACTOR C (stimulus duration)

LEVEL B (distractor type)

1

6.00	10.00	8.00
5.00	10.00	8.00
4.00	7.00	10.00
4.00	4.00	6.00
5.00	8.00	10.00
2.00	8.00	10.00
5.00	7.00	7.00
3.00	9.00	9.00
2.00	10.00	10.00
4.00	5.00	9.00
3.00	5.00	8.00
5.00	9.00	10.00
2.00	7.00	9.00
2.00	10.00	8.00
3.00	9.00	8.00

LEVEL B (distractor type)

2

8.00	2.00	10.00
5.00	10.00	9.00
6.00	9.00	10.00
5.00	8.00	7.00
4.00	9.00	9.00
9.00	10.00	10.00
3.00	8.00	10.00
9.00	10.00	10.00
3.00	9.00	10.00
1.00	7.00	7.00
4.00	8.00	8.00
6.00	10.00	10.00
7.00	9.00	8.00
3.00	8.00	10.00
1.00	8.00	9.00

LEVEL B (distractor type)

3

10.00	5.00	10.00
8.00	10.00	10.00
7.00	10.00	10.00
10.00	10.00	8.00
6.00	8.00	10.00
7.00	10.00	10.00
6.00	10.00	10.00
8.00	10.00	10.00
3.00	10.00	10.00
2.00	9.00	10.00
8.00	10.00	10.00
5.00	10.00	10.00
6.00	10.00	10.00
3.00	9.00	10.00
5.00	9.00	10.00

APPENDIX 3 : ANALYSIS OF VARIANCE TABLES
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EXPERIMENT 1. TABLE A3.1: FOCUSED ATTENTION, correct responses.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	450.08	19.0		
GROUPS	201.67	1.0	201.67	14.61
ERROR1	248.42	18.0	13.80	
WITHN S	1646.17	220.0		
FACT. B	1000.98	2.0	500.49	119.18
INTR. AB	2.01	2.0	1.00	0.24
ERROR2	151.18	36.0	4.20	
FACT. C	136.98	3.0	45.66	24.45
INTR. AC	2.33	3.0	0.78	0.42
ERROR3	100.85	54.0	1.87	
INTR.BC	59.09	6.0	9.85	6.31
INTR ABC	24.19	6.0	4.03	2.58
ERROR4	168.55	108.0	1.56	
Totals	2096.25	239.0		

EXPERIMENT 1. TABLE A3.2: FOCUSED ATTENTION / 50 msec, correct resp.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	49.61	1.0	49.61	18.48
ERROR 1	48.33	18.0	2.68	
CONDITN	2.14	3.0	0.71	0.55
INTERACT	5.04	3.0	1.68	1.30
ERROR 2	69.57	54.0	1.29	
TOTAL	174.69	79.0		

EXPERIMENT 1. TABLE A3.3 : FOCUSED ATTENTION / 100 msec, correct resp.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	78.01	1.0	78.01	7.67
ERROR 1	183.12	18.0	10.17	
CONDITN	88.04	3.0	29.35	19.96
INTERACT	15.84	3.0	5.28	3.59
ERROR 2	79.38	54.0	1.47	
TOTAL	444.39	79.0		

EXPERIMENT 1. TABLE A3.4: FOCUSED ATTENTION / 150 msec, correct resp.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	76.05	1.0	76.05	8.14
ERROR 1	168.15	18.0	9.34	
CONDITN	105.90	3.0	35.30	15.83
INTERACT	5.65	3.0	1.88	0.84
ERROR 2	120.45	54.0	2.23	
TOTAL	476.20	79.0		

EXPERIMENT 1. TABLE A3.5: FOCUSED ATTENTION, mislocations.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	198.53	19.0		
GROUPS	9.80	1.0	9.80	0.93
ERROR1	188.73	18.0	10.49	
WITHN S	491.78	160.0		
FACT. B	2.41	2.0	1.21	0.77
INTR. AB	3.43	2.0	1.72	1.09
ERROR2	56.60	36.0	1.57	
FACT. C	196.21	2.0	98.11	37.98
INTR. AC	3.90	2.0	1.95	0.75
ERROR3	93.00	36.0	2.58	
INTR.BC	3.09	4.0	0.77	0.44
INTR ABC	6.87	4.0	1.72	0.98
ERROR4	126.27	72.0	1.75	
Totals	690.31	179.0		

EXPERIMENT 1. TABLE A3.6: FOCUSED ATTENTION, intrusions.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	194.87	19.0		
GROUPS	85.42	1.0	85.42	14.05
ERROR1	109.44	18.0	6.08	
WITHN S	950.44	160.0		
FACT. B	542.41	2.0	271.21	174.90
INTR. AB	0.21	2.0	0.11	0.07
ERROR2	55.82	36.0	1.55	
FACT. C	64.48	2.0	32.24	12.40
INTR. AC	1.01	2.0	0.51	0.19
ERROR3	93.62	36.0	2.60	
INTR.BC	39.82	4.0	9.96	5.37
INTR ABC	19.56	4.0	4.89	2.64
ERROR4	133.51	72.0	1.85	
Totals	1145.31	179.0		

EXPERIMENT 1. TABLE A3.7: FOCUSED ATTENTION, disp = 3.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	33.75	1.0	33.75	8.63
ERROR 1	70.43	18.0	3.91	
CONDITN	262.30	2.0	131.15	69.98
INTERACT	10.90	2.0	5.45	2.91
ERROR 2	67.47	36.0	1.87	
TOTAL	444.85	59.0		

EXPERIMENT 1. TABLE A3.8: FOCUSED ATTENTION, disp = 5.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	32.27	1.0	32.27	18.11
ERROR 1	32.07	18.0	1.78	
CONDITN	246.70	2.0	123.35	61.05
INTERACT	5.23	2.0	2.62	1.30
ERROR 2	72.73	36.0	2.02	
TOTAL	389.00	59.0		

EXPERIMENT 1. TABLE A3.9: FOCUSED ATTENTION, disp = 9.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	20.42	1.0	20.42	3.65
ERROR 1	100.57	18.0	5.59	
CONDITN	73.23	2.0	36.62	26.83
INTERACT	3.63	2.0	1.82	1.33
ERROR 2	49.13	36.0	1.36	
TOTAL	246.98	59.0		

EXPERIMENT 1. TABLE A3.10: DIVIDED ATTENTION, corrects.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	341.90	19.0		
GROUPS	135.00	1.0	135.00	11.74
ERROR1	206.90	18.0	11.49	
WITHN S	1523.83	220.0		
FACT. B	301.76	2.0	150.88	96.39
INTR. AB	4.23	2.0	2.11	1.35
ERROR2	56.35	36.0	1.57	
FACT. C	676.63	3.0	225.54	89.62
INTR. AC	34.63	3.0	11.54	4.59
ERROR3	135.90	54.0	2.52	
INTR.BC	125.74	6.0	20.96	13.09
INTR ABC	15.74	6.0	2.62	1.64
ERROR4	172.85	108.0	1.60	
Totals	1865.73	239.0		

EXPERIMENT 1. TABLE A3.11: DIVIDED ATTENTION, mislocations.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	302.86	19.0		
GROUPS	2.94	1.0	2.94	0.18
ERROR1	299.92	18.0	16.66	
WITHN S	525.33	160.0		
FACT. B	4.31	2.0	2.16	0.79
INTR. AB	22.04	2.0	11.02	4.06
ERROR2	97.64	36.0	2.71	
FACT. C	124.34	2.0	62.17	23.83
INTR. AC	9.08	2.0	4.54	1.74
ERROR3	93.91	36.0	2.61	
INTR.BC	16.89	4.0	4.22	2.06
INTR ABC	9.29	4.0	2.32	1.13
ERROR4	147.82	72.0	2.05	
Totals	828.19	179.0		

EXPERIMENT 1. TABLE A3.12: DIVIDED ATTENTION, 50 msec.s.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	0.15	1.0	0.15	0.05
ERROR 1	54.03	18.0	3.00	
CONDITN	82.63	2.0	41.32	18.21
INTERACT	3.70	2.0	1.85	0.82
ERROR 2	81.67	36.0	2.27	
TOTAL	222.18	59.0		

EXPERIMENT 1. TABLE 3.13: DIVIDED ATTENTION, 100 msec.s.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	4.27	1.0	4.27	0.89
ERROR 1	86.47	18.0	4.80	
CONDITN	67.43	2.0	33.72	23.83
INTERACT	1.63	2.0	0.82	0.58
ERROR 2	50.93	36.0	1.41	
TOTAL	210.73	59.0		

EXPERIMENT 1: TABLE A3.14: DIVIDED ATTENTION, 150 msec.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	8.82	1.0	8.82	1.51
ERROR 1	104.83	18.0	5.82	
CONDITN	49.23	2.0	24.62	10.23
INTERACT	5.43	2.0	2.72	1.13
ERROR 2	86.67	36.0	2.41	
TOTAL	254.98	59.0		

EXPERIMENT 1. TABLE A3.15: DIVIDED ATTENTION, intrusions.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	488.11	19.0		
GROUPS	35.56	1.0	35.56	1.41
ERROR1	452.56	18.0	25.14	
WITHN S	506.00	160.0		
FACT. B	86.18	2.0	43.09	16.38
INTR. AB	7.78	2.0	3.89	1.48
ERROR2	94.71	36.0	2.63	
FACT. C	29.14	2.0	14.57	5.46
INTR. AC	0.14	2.0	0.07	0.03
ERROR3	96.04	36.0	2.67	
INTR.BC	19.79	4.0	4.95	2.18
INTR ABC	9.12	4.0	2.28	1.01
ERROR4	163.09	72.0	2.27	
Totals	994.11	179.0		

EXPERIMENT 1. TABLE A3.16: PRE-CUEING ADVANTAGE, corrects.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	104.52	19.0		
GROUPS	12.15	1.0	12.15	2.37
ERROR1	92.37	18.0	5.13	
WITHN S	1344.67	220.0		
FACT. B	188.96	2.0	94.48	15.36
INTR. AB	0.77	2.0	0.39	0.06
ERROR2	221.43	36.0	6.15	
FACT. C	221.02	3.0	73.67	16.41
INTR. AC	25.15	3.0	8.38	1.87
ERROR3	242.50	54.0	4.49	
INTR.BC	38.11	6.0	6.35	1.88
INTR ABC	41.23	6.0	6.87	2.03
ERROR4	365.50	108.0	3.38	
Totals	1449.18	239.0		

EXPERIMENT 1. TABLE A3.17: PRE-CUEING ADVANTAGE, mislocations.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	311.84	19.0		
GROUPS	2.01	1.0	2.01	0.12
ERROR1	309.83	18.0	17.21	
WITHN S	681.11	160.0		
FACT. B	0.90	2.0	0.45	0.12
INTR. AB	19.88	2.0	9.94	2.75
ERROR2	130.33	36.0	3.62	
FACT. C	9.03	2.0	4.52	0.89
INTR. AC	16.48	2.0	8.24	1.62
ERROR3	183.60	36.0	5.10	
INTR.BC	19.37	4.0	4.84	1.23
INTR ABC	18.59	4.0	4.65	1.18
ERROR4	282.93	72.0	3.93	
Totals	992.95	179.0		

EXPERIMENT 1. TABLE A3.18: PRE-CUEING ADVANTAGE, intrusions.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	360.98	19.0		
GROUPS	10.76	1.0	10.76	0.55
ERROR1	350.22	18.0	19.46	
WITHN S	854.22	160.0		
FACT. B	201.03	2.0	100.52	21.54
INTR. AB	6.54	2.0	3.27	0.70
ERROR2	167.98	36.0	4.67	
FACT. C	10.30	2.0	5.15	1.10
INTR. AC	0.68	2.0	0.34	0.07
ERROR3	168.58	36.0	4.68	
INTR.BC	23.97	4.0	5.99	1.65
INTR ABC	13.72	4.0	3.43	0.94
ERROR4	261.42	72.0	3.63	
Totals	1215.20	179.0		

EXPERIMENT 2. TABLE A3.19: Decision-time, raw data analysis.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	420.98	1.0	420.98	20.02
ERROR 1	925.32	44.0	21.03	
CONDITN	366.63	2.0	183.31	53.12
INTERACT	58.24	2.0	29.12	8.44
ERROR 2	303.66	88.0	3.45	
TOTAL	2074.83	137.0		

EXPERIMENT 2. TABLE A3.20: Decision-time, log-transformed data.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	3.70	1.0	3.70	20.12
ERROR 1	8.10	44.0	0.18	
CONDITN	4.55	2.0	2.27	54.54
INTERACT	0.03	2.0	0.02	0.39
ERROR 2	3.67	88.0	0.04	
TOTAL	20.05	137.0		

EXPERIMENT 2. TABLE A3.21: ANALYSIS OF PRACTICE EFFECTS.
SUMMARY ANOVA TABLE , 2-WAY with REPEATED MEASURES ON CONDITN.

SOURCE	SS	DF	MS	F-VALUE
GROUPS	10643.03	1.0	10643.03	25.17
ERROR 1	18606.27	44.0	422.87	
CONDITN	156.79	4.0	39.20	12.18
INTERACT	12.86	4.0	3.21	1.00
ERROR 2	566.27	176.0	3.22	
TOTAL	29985.23	229.0		

EXPERIMENT 3. TABLE 3A.22: ANALYSIS OF DETECTION, local level.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	325.22	29.0		
GROUPS	40.83	1.0	40.83	4.02
ERROR1	284.39	28.0	10.16	
WITHN S	844.44	240.0		
FACT. B	42.16	2.0	21.08	8.74
INTR. AB	2.49	2.0	1.24	0.52
ERROR2	135.13	56.0	2.41	
FACT. C	358.45	2.0	179.23	75.44
INTR. AC	6.29	2.0	3.14	1.32
ERROR3	133.04	56.0	2.38	
INTR.BC	8.81	4.0	2.20	1.60
INTR ABC	3.56	4.0	0.89	0.64
ERROR4	154.52	112.0	1.38	
Totals	1169.66	269.0		

EXPERIMENT 3. TABLE A3.23: ANALYSIS OF DETECTION, global level.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	101.76	29.0		
GROUPS	55.13	1.0	55.13	33.10
ERROR1	46.64	28.0	1.67	
WITHN S	1978.44	240.0		
FACT. B	1396.72	2.0	698.36	392.36
INTR. AB	12.05	2.0	6.03	3.39
ERROR2	99.67	56.0	1.78	
FACT. C	150.67	2.0	75.34	102.22
INTR. AC	0.50	2.0	0.25	0.34
ERROR3	41.27	56.0	0.74	
INTR.BC	163.22	4.0	40.80	42.68
INTR ABC	7.26	4.0	1.81	1.90
ERROR4	107.08	112.0	0.96	
Totals	2080.21	269.0		

EXPERIMENT 3. TABLE A3.24: GLOBAL DETECTION, removing the Easy condition.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	112.44	29.0		
GROUPS	64.80	1.0	64.80	38.08
ERROR1	47.64	28.0	1.70	
WITHN S	933.67	150.0		
FACT. B	399.02	1.0	399.02	136.62
INTR. AB	0.20	1.0	0.20	0.07
ERROR2	81.78	28.0	2.92	
FACT. C	217.48	2.0	108.74	101.68
INTR. AC	1.30	2.0	0.65	0.61
ERROR3	59.89	56.0	1.07	
INTR.BC	96.21	2.0	48.11	37.33
INTR ABC	5.63	2.0	2.82	2.19
ERROR4	72.16	56.0	1.29	
Totals	1046.11	179.0		

EXPERIMENT 3. TABLE A3.25: GLOBAL PRECEDENCE ANALYSIS.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	294.33	29.0		
GROUPS	1.07	1.0	1.07	0.10
ERROR1	293.26	28.0	10.47	
WITHN S	1856.44	240.0		
FACT. B	966.10	2.0	483.05	121.49
INTR. AB	6.36	2.0	3.18	0.80
ERROR2	222.65	56.0	3.98	
FACT. C	56.59	2.0	28.29	9.11
INTR. AC	3.25	2.0	1.63	0.52
ERROR3	173.94	56.0	3.11	
INTR.BC	162.53	4.0	40.63	18.33
INTR ABC	16.75	4.0	4.19	1.89
ERROR4	248.28	112.0	2.22	
Totals	2150.77	269.0		

EXPERIMENT 4. TABLE A3.26: GLOBAL PROCESSING, correct 'same' responses.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	68.87	29.0		
GROUPS	12.03	1.0	12.03	5.93
ERROR1	56.83	28.0	2.03	
WITHN S	95.50	90.0		
FACT. B	13.33	1.0	13.33	11.32
INTR. AB	1.20	1.0	1.20	1.02
ERROR2	32.97	28.0	1.18	
FACT. C	1.63	1.0	1.63	1.86
INTR. AC	0.30	1.0	0.30	0.34
ERROR3	24.57	28.0	0.88	
INTR.BC	3.33	1.0	3.33	5.18
INTR ABC	0.13	1.0	0.13	0.21
ERROR4	18.03	28.0	0.64	
Totals	164.37	119.0		

EXPERIMENT 4. TABLE A3.27: GLOBAL PROCESSING, response latency for 'same'.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	5390128.00	29.0		
GROUPS	91704.00	1.0	91704.00	0.48
ERROR1	5298424.00	28.0	189229.420	
WITHN S	1551840.00	90.0		
FACT. B	315224.000	1.0	315224.000	11.92
INTR. AB	4880.00	1.0	4880.00	0.18
ERROR2	740688.000	28.0	26453.14	
FACT. C	9784.00	1.0	9784.00	1.61
INTR. AC	18624.000	1.0	18624.00	3.06
ERROR3	170488.000	28.0	6088.86	
INTR.BC	36072.00	1.0	36072.00	4.29
INTR ABC	20520.000	1.0	20520.00	2.44
ERROR4	235560.000	28.0	8412.86	
Totals	6941961.50	119.0		

EXPERIMENT 4. TABLE A3.28: GLOBAL PROCESSING, correct 'diff.' responses.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	90.24	29.0		
GROUPS	29.01	1.0	29.01	13.26
ERROR1	61.23	28.0	2.19	
WITHN S	189.75	90.0		
FACT. B	33.07	1.0	33.07	16.11
INTR. AB	3.68	1.0	3.68	1.79
ERROR2	57.50	28.0	2.05	
FACT. C	35.21	1.0	35.21	33.27
INTR. AC	0.41	1.0	0.41	0.39
ERROR3	29.63	28.0	1.06	
INTR.BC	3.01	1.0	3.01	3.09
INTR ABC	0.01	1.0	0.01	0.01
ERROR4	27.23	28.0	0.97	
Totals	279.99	119.0		

EXPERIMENT 4. TABLE A3.29: GLOBAL PROCESSING, response latency for 'diff'
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	5425224.00	29.0		
GROUPS	89920.00	1.0	89920.00	0.47
ERROR1	5335304.00	28.0	190546.580	
WITHN S	2459296.00	90.0		
FACT. B	840816.000	1.0	840816.000	25.41
INTR. AB	96.00	1.0	96.00	0.00
ERROR2	926680.000	28.0	33095.71	
FACT. C	226344.000	1.0	226344.000	21.71
INTR. AC	17688.000	1.0	17688.00	1.70
ERROR3	291920.000	28.0	10425.71	
INTR.BC	824.00	1.0	824.00	0.15
INTR ABC	5264.001	1.0	5264.00	0.98
ERROR4	149664.000	28.0	5345.14	
Totals	7884515.50	119.0		

EXPERIMENT 4. TABLE A3.30: ATTENTIONAL PROCESSING, correct 'same'.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	203.80	29.0		
GROUPS	32.03	1.0	32.03	5.22
ERROR1	171.77	28.0	6.13	
WITHN S	241.50	90.0		
FACT. B	48.13	1.0	48.13	20.31
INTR. AB	0.00	1.0	0.00	0.00
ERROR2	66.37	28.0	2.37	
FACT. C	2.70	1.0	2.70	1.12
INTR. AC	4.03	1.0	4.03	1.67
ERROR3	67.77	28.0	2.42	
INTR.BC	2.13	1.0	2.13	1.21
INTR ABC	1.20	1.0	1.20	0.68
ERROR4	49.17	28.0	1.76	
Totals	445.30	119.0		

EXPERIMENT 4. TABLE A3.31: ATTENTIONAL PROCESSING, response latency, 'same'.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	9816672.00	29.0		
GROUPS	12768.00	1.0	12768.00	0.04
ERROR1	9803904.00	28.0	350139.440	
WITHN S	1569520.00	90.0		
FACT. B	40264.000	1.0	40264.00	1.80
INTR. AB	31816.000	1.0	31816.00	1.42
ERROR2	625840.000	28.0	22351.43	
FACT. C	138480.000	1.0	138480.000	8.60
INTR. AC	24.00	1.0	24.00	0.00
ERROR3	450984.000	28.0	16106.57	
INTR.BC	16992.00	1.0	16992.00	1.87
INTR ABC	10800.000	1.0	10800.00	1.19
ERROR4	254320.000	28.0	9082.86	
Totals	11386194.00	119.0		

EXPERIMENT 4. TABLE A3.32: ATTENTIONAL PROCESSING, correct 'diff'.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	179.67	29.0		
GROUPS	0.13	1.0	0.13	0.02
ERROR1	179.53	28.0	6.41	
WITHN S	411.50	90.0		
FACT. B	56.03	1.0	56.03	27.36
INTR. AB	0.13	1.0	0.13	0.07
ERROR2	57.33	28.0	2.05	
FACT. C	154.13	1.0	154.13	62.67
INTR. AC	7.50	1.0	7.50	3.05
ERROR3	68.87	28.0	2.46	
INTR.BC	6.53	1.0	6.53	3.00
INTR ABC	0.03	1.0	0.03	0.02
ERROR4	60.93	28.0	2.18	
Totals	591.17	119.0		

EXPERIMENT 4. TABLE A3.33: ATTENTIONAL PROCESSING, response latency 'diff'.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	5726800.00	29.0		
GROUPS	89944.00	1.0	89944.00	0.45
ERROR1	5636856.00	28.0	201316.280	
WITHN S	2061728.00	90.0		
FACT. B	443400.000	1.0	443400.000	20.49
INTR. AB	18248.000	1.0	18248.00	0.84
ERROR2	605888.000	28.0	21638.86	
FACT. C	277080.000	1.0	277080.000	18.32
INTR. AC	42448.000	1.0	42448.00	2.81
ERROR3	423376.000	28.0	15120.57	
INTR.BC	37728.00	1.0	37728.00	4.95
INTR ABC	312.00	1.0	312.00	0.04
ERROR4	213248.000	28.0	7616.00	
Totals	7788532.50	119.0		

EXPERIMENT 5. TABLE A3.34: DETECTION IN VARIOUS DISTRACTOR CONDITIONS.
SUMMARY ANOVA TABLE, 3-WAY with REPEATED MEASURES ON B & C.

SOURCE	SS	DF	MS	F-VALUE
BETW. S	565.06	29.0		
GROUPS	42.40	1.0	42.40	2.27
ERROR1	522.65	28.0	18.67	
WITHN S	1536.44	240.0		
FACT. B	151.67	2.0	75.83	29.85
INTR. AB	0.50	2.0	0.25	0.10
ERROR2	142.28	56.0	2.54	
FACT. C	788.47	2.0	394.23	88.33
INTR. AC	6.72	2.0	3.36	0.75
ERROR3	249.93	56.0	4.46	
INTR.BC	6.67	4.0	1.67	1.00
INTR ABC	4.42	4.0	1.10	0.67
ERROR4	185.81	112.0	1.66	
Totals	2101.50	269.0		