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Structures And Strategies Of Attentional Deployment In Schizophrenia

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STRUCTURES AND STRATEGIES 
OF ATTENTIONAL DEPLOYMENT 
IN SCHIZOPHRENIA

by

Leonard Robert George

Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
London, Ontario

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Abstract

Research in three different areas of schizophrenic functioning (the processing of stimuli characteristics, attention, and hemispheric functional specialization) suggests that they are relevant to our understanding of schizophrenia, and yet these areas produce many inconsistent findings. A theoretical perspective which integrates the three areas and explains some of the inconsistent results is presented. This "load/mode" theory is based on recent developments in research concerning attentional resource structures. The theory was tested by comparing the reaction time and error rate performance of paranoid and nonparanoid schizophrenics with that of nonschizophrenic psychiatric patients, volunteers from the general nonpsychiatric population, and university students, on a battery of tachistoscopic delayed recognition tasks. The load/mode theory predicted that the paranoid schizophrenics would show superior performance relative to the nonparanoids at the lower concurrent load levels when the stimuli were words, especially when the matching stimulus was presented in the right field. It was also predicted that at high load levels for the word tasks, paranoid performance would deteriorate to the level of the nonparanoids, and possibly beyond it. Furthermore, it was predicted that such a pattern of responses would not occur in picture tasks, or in trials in which the matching stimulus was presented in the left field. It was found that the psychiatric groups, while significantly slower and
less accurate than the normals, did not display qualitative differences from normals with respect to the hemispherically specialized processing of stimulus characteristics. This result suggests the relative intactness of schizophrenic processing structures. An unexpected lateralized effect was detected — in overall reaction time, paranoids were significantly slower at the highest of four concurrent load levels in the left visual field relative to the right field, and the nonparanoids were significantly slower at the third level in the left field relative to the right field. It is suggested that this effect might result from the presence of a nonexperimentally imposed load on the resources of the paranoids’ left hemisphere, and the nonparanoids’ right hemisphere. Speculations are advanced concerning the possible role of schizophrenic processing strategies in the production of this enigmatic effect. The data were subjected to a signal detection analysis, and two orthogonal effects of particular interest emerged — significantly more conservative responding on the part of nonparanoid schizophrenic females, and on the part of nonparanoids of either sex on word trials.

Secondary analyses included a comparison of the performance of all groups on Eckblad and L.J. Chapman’s (1983) Magical Ideation Scale, and Spielberger, Gorsuch and Lushene’s (1970) State-Trait Anxiety Inventory. It was found that schizophrenics scored significantly higher than
psychiatric controls on the Magical Ideation Scale, with the normal groups' scores falling in between. This finding was interpreted as possibly reflecting the psychopathological nature of both deficits and unmodulated surfeits or magical thinking. Psychiatric groups were found to be marginally higher in state anxiety than normal groups.

In order to study the discriminative properties of two diagnostic instruments, the Symptom-Sign Inventory and the Research Diagnostic Criteria, all psychiatric patient participants were assessed using both systems. A highly significant degree of diagnostic convergence was found, indicating that comparison of results across studies using either instrument may be undertaken with some confidence that inconsistencies in results are not artifacts of disparities in their discriminative properties.

A prediction deriving from Fisk and Neufeld's (1984) discussion of schizophrenic subtypes was that schizophrenic response bias scores should be systematically related to premorbid adjustment and duration of illness. Correlations were calculated between schizophrenic subjects' response bias scores and their scores on Phillips and Zigler's (1961) Premorbid Adjustment Scale, and between the former variable and duration between the first contact with health professionals concerning schizophrenic symptoms and the date of testing. No significant correlations were discovered.

Specific considerations for future research are
discussed. In addition, general comments are offered regarding the value of a multiperspectival approach to the study of schizophrenic processes.
Acknowledgements

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Last but not least, thanks are due to some imaginal beings, named Caroline, Linda, Droma, Wolf and Prasma, for their wise reflections.

This work is dedicated to the memory of my father, Earl George (May 31, 1910 - July 13, 1982).

SARVA MANGALAM

vii
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title page</td>
<td>i</td>
</tr>
<tr>
<td>Certificate of examination</td>
<td>ii</td>
</tr>
<tr>
<td>Abstract</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>vii</td>
</tr>
<tr>
<td>Table of contents</td>
<td>viii</td>
</tr>
<tr>
<td>List or figures</td>
<td>x</td>
</tr>
<tr>
<td>List of tables</td>
<td>xi</td>
</tr>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Processing of verbal and nonverbal stimuli</td>
<td>3</td>
</tr>
<tr>
<td>Attentional anomalies</td>
<td>10</td>
</tr>
<tr>
<td>Functional asymmetry of the cerebral hemispheres</td>
<td>15</td>
</tr>
<tr>
<td>Reasons for inconsistency</td>
<td>23</td>
</tr>
<tr>
<td>The structure of attentional resources</td>
<td>28</td>
</tr>
<tr>
<td>Multiple resources and schizophrenic information processing</td>
<td>33</td>
</tr>
<tr>
<td>Relevance to schizophrenic processing of stimulus characteristics</td>
<td>37</td>
</tr>
<tr>
<td>Relevance to schizophrenic attention</td>
<td>42</td>
</tr>
<tr>
<td>Relevance to schizophrenic hemispheric functional asymmetry</td>
<td>44</td>
</tr>
<tr>
<td>Testing the theory: General considerations</td>
<td>46</td>
</tr>
<tr>
<td>Testing the theory: Methodological considerations</td>
<td>54</td>
</tr>
<tr>
<td>Secondary studies</td>
<td>61</td>
</tr>
<tr>
<td>II. Method</td>
<td>64</td>
</tr>
<tr>
<td>Subjects</td>
<td>64</td>
</tr>
</tbody>
</table>
Table of Contents (Cont'd)

Apparatus 65
Procedure 67

III. Results 70
Demographic variables 70
Analysis of reaction time and error rate 72
Signal detection analyses 88
Secondary analyses 103

IV. Discussion 106
Task characteristics 106
Group differences: Consideration of some non-pathological explanations 114
Group differences in reaction time:
   Implications for understanding of pathological processes 116
Group differences in response bias 135
Secondary analyses 138
Suggestions for future research 141
General conclusions 148

References 151
Vita 184
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interaction between groups, visual field and load (dependent variable = overall reaction time)</td>
<td>77</td>
</tr>
<tr>
<td>2</td>
<td>Interaction between stimulus mode and visual field (dependent variable = overall reaction time)</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>Interaction between stimulus mode and visual field (dependent variable = correct response reaction time)</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>Interaction between stimulus mode and visual field (dependent variable = error rate)</td>
<td>89</td>
</tr>
<tr>
<td>5</td>
<td>Interaction between stimulus mode, visual field and load (dependent variable = sensitivity)</td>
<td>94</td>
</tr>
<tr>
<td>6</td>
<td>Interaction between groups and sex (dependent variable = response bias)</td>
<td>98</td>
</tr>
<tr>
<td>7</td>
<td>Interaction between groups, stimulus mode and load (dependent variable = response bias)</td>
<td>99</td>
</tr>
<tr>
<td>8</td>
<td>Interaction between sex and stimulus mode (dependent variable = response bias)</td>
<td>101</td>
</tr>
<tr>
<td>9</td>
<td>Interaction between stimulus mode, visual field and load (dependent variable = response bias)</td>
<td>102</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demographic characteristics of diagnostic groups</td>
<td>71</td>
</tr>
<tr>
<td>2</td>
<td>Analysis of variance summary table</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>(dependent variable = overall reaction time)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Selected values from Newman-Keuls analyses</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>of groups x visual field x load interaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(dependent variable = overall reaction time)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Analysis of variance summary table</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>(dependent variable = correct response reaction time)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Analysis of variance summary table</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>(dependent variable = error rate)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Analysis of variance summary table</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>(dependent variable = sensitivity)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Selected values from Newman-Keuls analyses</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>of stimulus mode x load interaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(dependent variable = d')</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Analysis of variance summary table</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>(dependent variable = response bias)</td>
<td></td>
</tr>
</tbody>
</table>
When Banzan was walking through a market he overheard a conversation between a butcher and his customer. "Give me the best piece of meat you have," said the customer. "Everything in my shop is the best," replied the butcher. "You cannot find here any piece of meat that is not the best." At these words Banzan became enlightened.

-Zen story, in Senzaki & Reps (1939), no. 31

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It is evident that schizophrenia is an immensely complex and multifaceted phenomenon. As such, it has been approached as an object of study in a wide variety of ways. Throughout the history of schizophrenia research, there has been a tendency for this diversity to promote a fragmented view of schizophrenia rather than a richly integrated one, and each fragment has had its proponents who have claimed for it a position of ultimate heuristic privilege in advancing the understanding of schizophrenia. Recently, efforts have been made to reverse this tendency. Each approach may be optimal for the resolution of specific facets of the mystery, but more global progress may occur when interrelations between approaches are examined.

Theorists such as Zubin and Steinhauser (1981), and Brodsky and Brodsky (1981), have advanced models of schizophrenia which involve causal factors on several levels of analysis, such as genetic, biochemical, cognitive and familial. Similarly, new approaches to the therapy of schizophrenia are less rigidly locked into unidimensional compartments (e.g. Falloon & Liberman, 1983; Matthews, Roper, Mosher & Menn, 1979). The present work is a contribution to the emerging integrated perspective on schizophrenia.
In order to promote an integration of approaches, bridges must be built between them — previous work has focussed on links between schizophrenic symptomatology and experimental studies of cognition (George & Neufeld, in press). The basis of the present work comprises a review of research on three aspects of schizophrenic performance: processing of verbal and nonverbal stimuli; attentional functioning; and the functional asymmetry of the cerebral hemispheres. It is suggested that while results from each of these areas indicate some relevance for an understanding of schizophrenia, the data within each area are markedly inconsistent. Various explanations for this inconsistency are discussed, and one of these — the load/mode theory, which is based on current developments in the study of multiple processing resources — is elaborated as a perspective from which to integrate the three aspects. A study is described which experimentally tested the theory as it applies to the performance of schizophrenics on cognitive tasks.

It may be useful at the outset to define some terms and their relationships. The cognitive perspective is defined rather broadly as pertaining to the encoding, transformation, storage and utilization of information for the purpose of regulating behaviour. The cognitive apparatus comprises patterns of information flow, which may be resolved into levels. Informational patterns which are relatively enduring are designated as structures. Patterns
which are more transient or extremely responsive to task parameters are designated as strategies. Limitations on the diversity of strategies are imposed by attentional resource pools. A more molecular level comprises the actual content of the information. These cognitive levels are regarded as regions of a continuum, rather than discrete realms—structures do change, and strategies can have well-defined forms. Causation can flow either way along the continuum—for instance, strategies can affect the content of information, as in perceptual sets; and variations in information content, by affecting arousal, can influence the availability of attentional resources. Each of the levels is discussed in greater detail in the body or the work. Strictly speaking, physiology is not a level of cognitive explanation, but rather a separate perspective. It is evident, however, that close relationships do exist between certain physiological and cognitive variables.

**Processing of verbal and nonverbal stimuli**

Over the past fifteen years, a large number of studies have been conducted in order to study cognitive processes in schizophrenia. A general finding, with relatively few exceptions, has been that schizophrenics perform cognitive tasks more poorly than do normals tested under similar conditions (L.J. Chapman & J.P. Chapman, 1973). In studies in which schizophrenics are classified into paranoid and nonparanoid subtypes, it has frequently been reported that
the subtypes significantly differ from each other with respect to cognitive performance, and that the nature of the stimuli employed in the task—specifically, whether they are verbal or nonverbal—may be relevant to these findings (e.g., George & Neufeld, 1984; Neufeld, 1976b). A general pattern that emerges from the research comparing paranoids and nonparanoids on a variety of tasks involving the verbal or nonverbal presentation of information is one of a paranoid deficiency in the processing of verbal stimuli relative to nonparanoids, and a nonparanoid deficiency in the processing of nonverbal stimuli relative to paranoids.

The results of several studies have suggested a paranoid deficit in processing verbally presented stimuli. For instance, Neufeld (1975) compared paranoids, nonparanoids, and normals on their judgments of semantic similarity of word pairs. An individual-differences multidimensional scaling analysis revealed that the description of the paranoids' judgments required the inclusion of four dimensions of systematic stimulus variation in the analysis, whereas description of normals' and nonparanoids' judgments required only three dimensions; even the solution with four dimensions was of significantly better fit for the normals than for the paranoids but not for the nonparanoids. These findings indicated the presence of less systematic semantic judgmental variance for the paranoids than for the other groups.

Another study of paranoid, nonparanoid, and normal
judgments of word pair semantic similarity (Neufeld, 1976b) revealed that paranoids were significantly less effective than either normals or nonparanoids in carrying out word pair analyses on multiple constituent dimensions of meaning, although in simple rating of words on individually specified semantic dimensions, the schizophrenic subtypes did not differ significantly. These findings indicate that the paranoid deficit may not involve the availability of the required semantic verbal network as much as the process of relating the presented stimuli to the network of inter-word analysis.

The performance of paranoids, nonparanoids and normals in verifying the content of a sentence purportedly describing a pictorial display was examined by Neufeld (1977). In this experiment, a sentence such as "It is true that the dots are red" and an adjacent array of coloured dots were presented tachistoscopically, and each subject was asked to respond "true" or "false" as quickly as possible. The number of comparisons of constituents of the sentence and picture required to arrive at a response were systematically varied, according to the sentence comprehension model of P.A. Carpenter and Just (1975). When mean reaction time latency was plotted against number of constituent comparisons, it was found that the value of the $y$-intercept, indicating combined encoding and response selection time for the task, was not significantly different between nonparanoids and normals, but was
significantly different between paranoids and normals. Another study by Neufeld (1978) examined performance on this task again, but temporally separated sentence encoding from picture presentation, and found the difference between the subtypes was no longer significant. This finding suggests the possibility of a specific paranoid verbal processing deficit at the encoding stage.

Neufeld and Broga (1977) administered a battery of cognitive tasks to schizophrenics, and performed a canonical correlation analysis directed toward the degree and nature of overlap between the performance variables and a set of diagnostic and demographic measures. They reported that the cognitive performance data suggested an association between a deficit in tasks involving the processing of verbal stimuli and the paranoid diagnosis.

Silverman (1964) compared paranoids and nonparanoids on their performance with Pettigrew's (1958) category width scale, which purports to measure width of semantic categories through a multiple choice questionnaire. Silverman found that the category width of the paranoids was significantly narrowed compared to that of the nonparanoids, perhaps indicating a restriction in semantic interpretation of the former group.

Other experiments have obtained results suggestive of a nonparanoid nonverbal stimulus processing deficit. M.D. Cox and Leventhal (1978) administered a series of tasks designed to assess preattentive cognitive functioning, which involved processing arrays of nonverbal stimuli, to
paranoids, nonparanoids and controls. They reported that, relative to the other groups, the nonparanoids were significantly impaired on all tasks.

Gillis and Blevens (1978) presented three lines of varying lengths to paranoids and nonparanoids, and asked the subjects to estimate the length of an unobserved line about which the lengths of the presented lines served as clues. It was found that only nonparanoid performance was significantly worse than that of normals on this task. One explanation of this finding involves a nonparanoid deficit in processing the line stimuli.

A study by Pic'l, Magaro and Wade (1979) involved the tachistoscopic presentation of a field of dots which were to be enumerated. It was reported that nonparanoids performed this task significantly worse than either paranoids or controls.

Price and Eriksen (1966) compared paranoids, nonparanoids and normals on their performance in a size constancy task, and also recorded confidence judgments for each trial. A signal detection analysis indicated that nonparanoids were significantly less sensitive than either paranoids or normals to size-distance cues. This result is consistent with a nonparanoid deficit in processing nonverbal stimuli.

Yates and Korboot (1970) measured the inspection time of their subjects on a task involving the enumeration of items in a visually presented array, and found that chronic
nonparanoids were generally slower than acute nonparanoids, acute and chronic paranoids, and controls, regardless of the level of complexity of the array. In addition, there was no indication of a speed/accuracy tradeoff, suggesting that the retarded performance of the chronic nonparanoids was not simply a strategy to increase accurate performance.

Silverman (1964) examined the size estimation performance of paranoids and nonparanoids. He found that nonparanoids tend to overestimate sizes, unlike paranoids, and interpreted this in the light of previous work on scanning control in normals to indicate the nonparanoids engaged in limited perceptual scanning.

Several studies (e.g., Schooler, Buchsbaum & W.T. Carpenter, 1976; Silverman, 1972) have examined the neuroelectrical average evoked response to light flashes presented to schizophrenics, and have consistently found that as light flash intensity increases, nonparanoid responding decreases, unlike that of normals or paranoids. In this line of research, such a finding has been interpreted as showing that nonparanoids exhibit narrowed attention to perceptual input, producing reduced perceptual processing.

Some studies have yielded findings which are at odds with the general pattern outlined above. For instance, George and Neufeld (1984) found that paranoids reported using verbal problem-solving strategies in daily life to a significantly greater extent than nonparanoids, possibly suggesting a nonparanoid deficit in semantic processing.
Kay (1982) examined the performance of schizophrenics and controls on D.D. Wickens' (1970) release from proactive inhibition technique, manipulating the release phenomenon by varying the verbal stimuli along conceptual, affective and physical dimensions. The nonparanoids displayed a significantly smaller conceptual shift than paranoids or controls, again suggesting a nonparanoid verbal stimulus processing deficit.

Also inconsistent with a simple paranoid verbal stimulus processing deficit is the fact that paranoids tend to perform the Comprehension subtest of the WAIS better than nonparanoids (e.g. Shafer, 1948; Weiner, 1966).

Other studies are consistent with a nonverbal stimulus processing deficit among paranoids. For example, George and Neufeld (1984) asked paranoids, nonparanoids and controls to perform a mental comparison task using tachistoscopically presented pairs of stimuli. Stimuli were words or pictures, and comparisons were based on either a verbal property (pronounceability) or nonverbal property (real life size). An analysis of variance revealed a paranoid performance deficit associated with pictorial stimulus presentation, which was interpreted as suggesting a paranoid pictorial encoding problem.

Neufeld (1976a) compared paranoids and nonparanoids on their use of stimulus dimensions in making dichotomous judgments regarding schematic faces, and found that paranoids, but not nonparanoids, were significantly
different from normals in this respect, an outcome that could be taken to indicate a specific nonverbal processing deficit in paranoids.

Wisnner, Stein and Paestrel (1978) reported an experiment in which paranoids, nonparanoids and control subjects were compared with respect to their performance on a Sternberg memory-scanning task involving sets of digits. The data revealed a tendency for paranoids to perform this task less efficiently than nonparanoids.

**Attentional anomalies**

Following Kinchla (1980), attentional mechanisms are broadly defined as those structures involved in the loci of processing selectivity, wherever they occur in the system:

the only consistent feature of attentional research is an interest in the selective aspects of information processing. By **selective**, I mean the degree to which one may choose to process specific sources of information and ignore others. The phrase **sources of information** is used rather than **stimuli**, because in some instances it seems useful to think of memory as a source of information, the processing (accessing, recovery) of which may or may not be compatible with the processing of stimulation from external sources (p.214).

It has long been thought that schizophrenia involves some sort of difficulty in the allocation of attentional resources to meet processing demands. Laboratory research pertaining to the assessment of attentional functioning in schizophrenia has often produced evidence of anomalies, and the reported phenomenology of acute schizophrenia requires little interpretation to suggest attentional difficulties (see Bleuler, 1911/1950; Bowers & Freedman, 1966; McGhie & J. Chapman, 1961).
While most researchers would agree that the notion of an attentional dysfunction is probably important for an understanding of schizophrenia, there is a pronounced lack of agreement concerning the nature of this dysfunction. A variety of theories have been advanced which propose that attentional dysfunction is a general underlying cause or mediating variable in schizophrenia. For instance, Payne (1966) and McGhie (1970) suggested that a filter which functions to attenuate the input of task-irrelevant information from the finite processing channel becomes defective in schizophrenia, thus allowing the contamination of relevant information on which adaptive behaviour is based. Some research findings have supported this position (e.g. Lawson, McGhie & J. Chapman, 1964; R. Levy & Maxwell, 1968), but plausible alternative explanations have been suggested (Neufeld & Mothersill, 1980), and some evidence suggests that a form of "filtering defect" may be a concomitant of general psychopathology rather than of schizophrenia in particular (Hemsley & Zawađa, 1976).

An alternative general theory of schizophrenic attention was described by Yates (1966). In this version, schizophrenic cognitive deficit is attributable to a retardation in the early stages of information processing which produces a loss of information held in transient stores. This effect may arise from inadequate or anomalous allocation or processing resources to the initial stages. Studies have been reported which were interpreted as
supporting Yates' theory (e.g. Yates & Korboot, 1970, as described above). The results of other studies are clearly inconsistent with initial processing retardation in schizophrenia. For instance, J.R. Davis, Glaros and G.S. Davidson (1981) conducted a study based on Neisser's (1967) assertion that alpha blocking onset in response to visually presented information reflects initial processing activity. They found that such alpha blocking generally occurred more quickly in schizophrenics than in normals, which they interpreted as being nonsupportive of Yates' theory. A similar finding was also reported by Cromwell and Held (1969).

A third general theory was advanced by S.J. Schneider (1976), who suggested that the attentional anomaly in at least some schizophrenics was one of unusual allocation, rather than a structurally located defect in the information processing system as was proposed by McGhie (1970) and Yates (1966).

Some theorists have proposed a general restriction of processing capacity in schizophrenics. For instance, Knight and Russell (1978) argued that the finding of deficits at almost every information processing stage in schizophrenics suggests a global capacity deficit rather than localized dysfunctions. Similarly, Gjerde (1983) presented a case for a general capacity limitation among schizophrenics which is attributable to hyperarousal.

Recently, there has been a greater tendency for students of schizophrenic attention to present dichotomous
theories rather than unified general ones. This approach is not new, however — Bleuler (1911/1950) inferred two forms of schizophrenic attentional dysfunction, one in which sensory impressions are excessively emphasized, and one in which they are ignored. The recent dichotomous attention approaches propose that distinct forms of attentional dysfunction are associated with the traditional schizophrenic subtypes, or suggest new dichotomies which do not clearly correspond to the traditional classifications. Unfortunately, these theories, and the data on which they are based, are often in conflict.

An example of an attentional dichotomy related to traditional subtypes is that of Venables (1964), who postulated that chronic schizophrenics are characterized by "narrowed" attention and acute schizophrenics by "broadened" attention relative to normals. Experimental support for this theory has been mixed. Neale and Cromwell (1970) presented a comprehensive review of research bearing on Venables' theory, and concluded that the results available at that time tended either not to support Venables' position, or equivocally to support it. Cegalis, Leen and Solómon (1977) examined the peripheral visual discrimination of acutes, chronics and controls. They found that the acutes had more accurate peripheral discrimination than the normals, who were more accurate than the chronic subjects. This result was interpreted as lending some support to Venables' theory.
A number of researchers have proposed that nonparanoids display a maladaptive reduction in their capacity to process stimulus input, whereas paranoids are characterized by an inability to restrict input, leading to the possibility of a dysfunctional overload (e.g., Broen, 1973; Cromwell, 1975). Research findings are mixed concerning this notion — for instance, in a study of schizophrenic cognitive styles by Dykes and McGhie (1976), it was reported that nonparanoids habitually sample a relatively wide range of available environmental input, whereas a signal detection task by Cegalis and Deptula (1981) revealed that nonparanoids display a deficit in detection of peripherally presented visual targets relative to paranoids and normals.

A different attentional correlate of the paranoid/nonparanoid distinction has recently been proposed by Magaro (1981). He drew on the work of W. Schneider and Schiffkin (1977) concerning strategies of attention in normals, and suggested that paranoids are characterized by a rigid adherence to a controlled processing strategy, whereas nonparanoids tend to use an automatic strategy. Recent findings have provided some general support for this theory (e.g., Brennan & Hemsley, 1984; Magaro & Page, 1983).

An example of a nontraditional schizophrenic attentional dichotomy may be found in the research concerning smooth pursuit eye movement anomalies among schizophrenics. Smooth pursuit eye movements appear to be a measure of the intactness of focal attentional
functioning (e.g. Cegalis & Sweeney, 1981; Holzman, D.L. Levy & Proctor, 1976), and deviant movements have been regarded as indicative of a disturbance of attention. Holzman, D.L. Levy and Proctor (1978) reported that between 65 and 80 percent of schizophrenics displayed smooth pursuit eye movement anomalies, compared with 6 percent of normals, and that these anomalies were of two types. In the Type I anomaly, saccades tend to replace pursuit movements; the Type II anomaly is characterized by the occurrence of small amplitude movements in addition to pursuit movements. This dichotomy can be interpreted as reflecting a dichotomy of attentional dysfunction (although other interpretations are possible). The relationship between this dichotomy and the others mentioned above is unclear at present, as empirical attempts to formally compare them have not yet appeared in the research literature.

**Functional asymmetry of the cerebral hemispheres**

The differential relationship of various cognitive functions to the cerebral hemispheres is currently the focus of intense interest among researchers. It has been established that most people display a variety of behavioural lateralities, which are usually interpreted in terms of functional hemispheric asymmetry. The fundamental nature of this asymmetry is currently an unresolved issue. Early research suggested that the functional difference could be most parsimoniously described by postulating a differential preference for processing various kinds of
stimulus materials, such as a verbal specialization for the left hemisphere and a visuo-spatial specialization for the right hemisphere (e.g. Kimura, 1966). More recently a variety of more fundamental, "process" dichotomies have been proposed. For example, J. Levy (1969) suggested an analytic orientation for the left hemisphere, and a holistic style for the right hemisphere. Sergent (1982, 1983, 1984) proposed that the left hemisphere is specialized to process stimuli of high spatial frequency and late onset, whereas the right hemisphere is most adept at processing early onset, low frequency information. More elaborate models incorporating ways in which the hemispheres dynamically interact have also been advanced (e.g. Kinsbourne, 1970; Kinsbourne & Hicks, 1978), and consensus has not yet been reached concerning the most appropriate global model of coordinated hemispheric functioning (Allen, 1983). It appears that, in general, differences among non-commissurotomized subjects regarding reaction time and accuracy in tasks presented to one or the other hemisphere are attributable to differential efficiency of intrahemispheric processing, as opposed to deficits resulting from the interhemispheric transfer of information (Sergent, 1983).

The cerebral functional asymmetry perspective has been applied to schizophrenia, and the literature in this area is immense. Many researchers agree that the area is important for an understanding of schizophrenia, but,
again, they are far from unanimous concerning the content of this understanding.

Four main theoretical positions have emerged with respect to schizophrenic cerebral functional asymmetry. According to some researchers (e.g. Beaumont & Dimond, 1973; Blau, 1977; Carr, 1980), schizophrenics have directive communication between the cerebral hemispheres, which in normals are continually interacting to determine behaviour. Others (e.g. Flor-Henry, 1976; Gur, 1978) have postulated a dysfunction localized in the left hemisphere of schizophrenics, which is reflected in electroencephalographic abnormalities and specific impairments on tasks purporting to measure left hemisphere functioning. A third position suggests that schizophrenics have an overactivated left hemisphere, rather than simply an impaired one (e.g. Lerner, Nachshon, & Carmon, 1977; Gur, 1979). Each of these positions has some research support (see reviews by Merrin, 1981; Walker & McGuire, 1982). Recently, a fourth position concerning schizophrenic functional asymmetry has appeared. Research employing neuropsychological test batteries has been interpreted as indicating a bilateral fronto-temporal impairment in schizophrenics (Kolb & Whishaw, 1983; Sutherland, Kolb, Schoel, Whishaw & Davies, 1982; M.A. Taylor & Abrams, 1984).

The literature on cerebral functional asymmetry in schizophrenia has become sufficiently large that comprehensive review papers have begun to be published. It
is instructive to examine the conclusions presented in the most thorough recent reviews. For instance, Marin and Tucker (1981) stated that while some relevant studies do provide results suggestive of a left hemisphere dysfunction in schizophrenics, a comparable number do not support this notion, and that the entire issue remains equivocal. Merrin (1981) opined that support for left hemisphere dysfunction hypotheses was inconsistent, and suggested instead that "a different overall pattern of cerebral organization" may be responsible for at least some of the findings of schizophrenic hemispheric asymmetry. Merrin suggested that defective interhemispheric transfer, or possibly poorly differentiated cerebral asymmetry, may be involved. Tucker (1981) suggested that the competing hypotheses may not be mutually exclusive—rather, it is possible "that not only do schizophrenics suffer from a faulty left hemisphere contribution to their ideation, they may also have problems in coordinating the contributions of the two hemispheres (p.25)". Walker and McGuire (1982) stated that the interhemispheric deficit and left hemisphere hypotheses are mutually exclusive. They also concluded that experimental support for defective interhemispheric transfer was "highly equivocal", and supported a left hemisphere dysfunction/overactivation hypothesis as the most viable candidate for explaining the schizophrenic laterality data. The divergence of opinion among the reviewers cited above testifies to the ambiguity
of the research findings when examined as a whole. Research reports with conflicting results, staunchly defending various of the above theoretical positions, continue to appear by the dozens in the journals (cf. Hatta, Yamamoto & Kawabata, 1984; Shelton and Knight, 1984).

Some studies suggest that the paranoid/nonparanoid dichotomy may be relevant to schizophrenic cerebral functional asymmetry, although the findings are somewhat inconsistent. Gruzelier (1981), Gruzelier and Hammond (1980), and Nachshon (1980) reported data which they interpreted as suggesting a paranoid left hemisphere overactivation relative to nonparanoids. It should be noted, however, that a reanalysis by R.W.J. Neufeld (personal communication, March 1982) of data collected by Korboot and Damiani (1976) revealed that paranoids were less sensitive than nonparanoids to right ear input in a dichotic listening signal detection task. This finding appears to be inconsistent with the notion that paranoids have overactivated left hemispheres relative to nonparanoids. Walker, Hoppes and Emory (1981) also argued against the paranoid-left hemisphere association. They claimed that the data presented by Nachshon (1980) as indicating left hemisphere overactivation is more parsimoniously interpreted as supporting an interhemispheric transfer deficit hypothesis.

Magaro and his associates reported a series of studies which he interpreted as indicating a left hemisphere...
processing deficit in nonparanoids. In each case, however, his interpretations are questionable. For instance, Pic'l et al. (1979) found that nonparanoids were significantly deficient on a tachistoscopically presented dot enumeration task relative to paranoids and controls, and that, unlike the other groups, nonparanoid performance did not deteriorate with increasing stimulus frame size. Pic'l et al. interpreted this result as indicating a nonparanoid inability to engage in serial processing, and this processing style is associated with the left hemisphere. It seems possible that the absence of increasing deterioration among nonparanoids may be a floor effect rather than a reflection of anomalous processing style. Magaro and Chamrad (1983b) performed a similar study, except that performance using structured and unstructured arrays of dots was compared. The unstructured arrays were intended to tap the controlled processing mode, on which paranoids tend to overrely, according to Magaro, and the structured dots were intended to tap the automatic processing mode, the preferred nonparanoid mode in Magaro's theory. In addition, decreasing accuracy with increasing array size was intended to reflect the presence of serial processing, a characteristically left hemisphere function. On the structured dot task, there was a nonsignificant trend for paranoids and nonparanoids to be superior when the array was presented to the left visual field compared to the right field. It was observed that, unlike the other
groups, the nonparanoids did not show increasing error rate with increasing array size in the right field. The paranoids' left field superiority derived from a marked increase in error rate with the largest array sizes in the right field. For the unstructured dot tasks, there were no group differences; error rate increased as a function of array size in both visual fields. These complex findings were interpreted as follows: the absence of error rate change in the right field for nonparanoids on the structured dot task was thought to indicate a nonparanoid inability to use serial processing in the left hemisphere. However, two cautionary observations should be made: first, this claim is based on a significant post hoc analysis which followed a nonsignificant main analysis (the interaction of groups, field and array size); second, the increment in error rate as a function of array size was found for all groups performing the structured dot task in the left field, and for all groups in both fields on the unstructured dot task, raising serious questions concerning the validity of the effect as an index of left hemisphere functioning. Magaro and Chamrad (1983b) stated that the unstructured dot task seemed to tap controlled processing rather than automatic processing; if this is so, then the adequate nonparanoid performance on that task suggests relatively unimpaired left hemisphere functioning. Also, Magaro and Chamrad (1983b) claimed that the paranoid performance on the structured dot task was equivalent to that of the controls, and that the trend toward left field
superiority was "artifactual", resulting as it did from the high error rate for large arrays in the right field. While the paranoid effects were nonsignificant, and therefore perhaps unworthy of much consideration, they were as striking as the nonsignificant effects on which Magaro and Chamrad based their claim of nonparanoid controlled processing deficit. It is noteworthy that the paranoid trends suggest, if anything, a left hemisphere deficit which manifests at high processing loads, which is inconsistent with Magaro's theory of paranoid right hemisphere impairment.

Magaro and Chamrad (1983a) presented recognition tasks involving unilateral presentation of pairs of letters or faces, or presentation of a letter or face in each visual field. In the unilateral faces condition, paranoids recognized fewer faces in the left field than controls; in the bilateral letters condition, nonparanoids recognized fewer letters in the right field than other groups. These findings were interpreted as suggesting a paranoid right hemisphere deficit, especially in processing faces; and a nonparanoid left hemisphere deficit, especially in processing letters. These interpretations are found to be somewhat misleading, upon close examination of the data. The paranoids appeared to be less accurate in the left field than the right field under all stimulus conditions - rather than a right hemisphere deficit manifesting only under certain stimulus conditions, the paranoids may have
displayed a lateralized deficit that is insensitive to stimulus conditions. Concerning the nonparanoids, under most conditions, their pattern of performance was identical to that of the normal controls, only much less accurate. The exception was in the bilateral faces condition, in which the nonparanoids showed a slight left hemisphere superiority, unlike the normals. Such a pattern does not suggest a nonparanoid left hemisphere impairment as much as a generalized deficit.

Magaro and Page (1983) reported a study in which subjects were tachistoscopically presented with pairs of letters, shapes or words to be compared with respect to intrapair similarity. They found that nonparanoids were impaired in all tasks presented in the right visual field, and in the letter comparison task when one letter was presented in each visual field, compared to paranoids and controls. These data were taken as supporting a nonparanoid left hemisphere deficit hypothesis. However, the right hemisphere was found to perform all tasks more efficiently than the left hemisphere. Therefore, the nonparanoid performance deficit when stimuli were presented to the left hemisphere may simply be a nonparanoid generalized deficit being reflected with greatest salience in the most difficult tasks, rather than a specific left hemisphere deficit.

**Reasons for inconsistency**

In summary, in each of the research areas reviewed
above, there is some agreement that the general issue is
relevant to schizophrenia, but an undesirable level of
inconsistency is present in the findings. This
inconsistency probably arises from a multitude of factors,
some of which apply to all three areas, and some of which
are area-specific. These factors are discussed in the
following paragraphs.

One possibility is that the appearance of a pattern in
much of the data is illusory, and that the reviewed results
are spurious, being based on random fluctuations. This
possibility must be noted, for psychology, with its
political environment biased against strict replication
attempts, is not well protected against it (cf. Greenwald,
1975).

Another possibility is that global hypotheses applying
to a single, undifferentiated construct of schizophrenia,
such as the notion that an interhemispheric communication
deficit characterizes "schizophrenia", may not ever achieve
consistent support, because schizophrenia is quite
heterogeneous. In each of the three areas discussed above,
diagnostic definitions vary across studies - in some
experiments "RDC schizophrenics" are studied, in others
DSM-III or SSI or clinical schizophrenics. These kinds of
schizophrenics may be significantly different from each
other. Also, the traditional schizophrenic divisions may
be relevant - for instance, there is evidence that
paranoid/nonparanoid differences may increase the variance
in all three areas.
It is likely that a host of factors contribute to the lack of consistent findings within the areas of stimulus property, attention and hemispheric functional asymmetry. For example, in the stimulus property area few studies actually compared responses to both linguistic and nonlinguistic stimuli. Therefore, comparisons across studies are confounded with varying experimental tasks, designs and situations, and, presumably, processing demands. It is possible that varying processing demands might affect responding to verbal and nonverbal stimuli (George, 1980).

In the area of attention research, the conceptualization and operationalization of attention has proven troublesome. A unitary notion of attention is not supported by experiments showing low intercorrelations between purported measures of "attention" (e.g. Asarnow & MacCrimmon, 1978; Kopfstein & Neale, 1972; Payne, Hochberg & Hawkes, 1970). As Spring (1980) pointed out, the existence of different types of attention implies that a person may have deficits of one type and not another. Such a state of affairs is bound to create difficulties for attempts to construct ill-defined general "attentional deficit" theories of schizophrenia. Also, even within types of attention, difficulties may have arisen due to inadequate or premature applications of attention theory. For example, researchers concerned with selective attention in schizophrenia have generally applied single channel
capacity models, such as those of Broadbent or Moray, to their data. In the last six years, such simple models have proven inadequate to describe information processing in normals, and have largely been replaced by theories of multiple channel attentional resources (e.g. Navon & Gopher, 1979; C.D. Wickens, 1980). Assuming that schizophrenics process information in a qualitatively similar fashion to that of normals (cf. Neufeld & Broga, 1981), it is not surprising that schizophrenia researchers would encounter difficulties in applying a model which has been unsuccessful in explaining normal behaviour. It is noteworthy that very recent publications in the area of schizophrenic attentional functioning (e.g. Nuechterlein & Dawson, 1984) have continued to neglect the role of multiple attentional resources.

Specific problems also pertain to the area of schizophrenic cerebral functional asymmetry. For instance, the assessment of functional asymmetry is a controversial area, and some researchers (e.g. Bryden, 1978) have suggested that at least some perceptual laterality effects which are usually interpreted as indices of cerebral functional asymmetry may be consequences of attentional strategies adopted by the subjects. These strategies themselves may or may not reflect true cerebral laterality. S. Schwartz and Kirsner (1982) suggested that many laterality effects in non-brain-damaged subjects can be explained without recourse to neuroanatomical constructs — rather, they may result from an interaction between habits
in attentional allocation and individual differences in attentional capacity. Some of the purported measures of laterality employed in schizophrenic functional asymmetry research have never been validated using brain-damaged subjects (e.g. Blau, 1977; P. Green, 1978), rendering their validity suspect. Also, the utility of electrodermal response lateralities as indices of cerebral functional asymmetry in schizophrenics has been cast into doubt because of a controversy concerning whether hemispheric arousal is related to contralateral electrodermal excitation or inhibition (for opposing views and findings, see, e.g., Dawson & Schell, 1983; Walker & Ceci, 1983).

In summary, it seems possible that there are one or more significant variables operating in these research areas which are not currently controlled. Perhaps these variables could be organized into an integrated theory which would more effectively explain the data than currently prevailing approaches.

In the present work, a theory is advanced which suggests that a specific, identifiable set of variables may be partly responsible for the inconsistent findings in all three areas discussed above. Briefly, this "load/mode theory" states that an important determinant of schizophrenic cognitive functioning involves an interaction between subtype-specific factors, stimulus characteristics and the prevailing pattern of attentional allocation. Comprehensive presentation of the theory requires
preliminary familiarity with recent developments in attention theory, and an overview is provided in the following section.

The structure of attentional resources

The study of attention in terms of a limited amount of resources which can be allocated in various ways in order to process information and perform tasks has been pursued for several decades. A variety of experimental methods have been employed in attempts to measure attentional capacity and allocation (for a review, see Sanders, 1979), perhaps the most widely used of which is the dual task paradigm invented by Bornemann (1942). In this approach, the difference in levels of performance of a particular task when it is performed singly and when it is performed simultaneously with another task is conceptualized as the attentional cost associated with task concurrence (C.D. Wickens, 1980).

Several theoretical approaches to attention capacity have arisen. The earliest theories presented the notion of a constant capacity communication channel, and it was thought possible to measure this capacity in terms of bits of information (e.g. Attneave, 1959; Garner, 1962). This approach encountered severe problems, and had to be abandoned as an inadequate model for human information processing (Sanders, 1979).

The next type of theory to achieve prominence eschewed the notion that processing channel capacity could be easily
quantified into bits, but retained the idea of a single pool of attentional capacity, which is undifferentiated in structure - that is, all tasks requiring attention draw from it (Moray, 1967). If the supply represented in the pool is exceeded by the attentional requirements of task performance, then a decrement in performance level results.

An alternative approach to attentional allocation proposed the existence of processing structures which are specialized for certain functions, and which are the objects of competition by the tasks requiring attention (e.g. Keele, 1973). These structures are thought to operate in an all-or-none fashion - that is, the attentional resource contained in one of these processing structures cannot be divided between concurrent tasks.

The amply documented occurrence of continuously changing joint performance ratios as a function of resource allocation (the performance operating characteristic, or POC) argues for the existence of some sort of continuously allocatable factor in attentional functioning (Norman & Bobrow, 1976). A large number of dual task studies have indicated, however, that the notion of limited-capacity processing with a single pool of undifferentiated resources cannot explain the data. C.D. Wickens (1980) summarized the findings which could not be reconciled with the single capacity theories. Several of the reviewed studies found that minor alterations in the structure of the manipulated (load) task occasionally had major effects on the measured task, even when the changes in the apparent difficulty of
the former task were trivial. This effect suggests that the resource composition of the tasks (which determines the degree to which they are in competition for these resources) must be inadequately described by a single dimension of difficulty, implying the presence of multiple resource pools. Other studies revealed that for some task pairings, wide variations in the apparent difficulty of the manipulated task had minimal effects on performance of the measured task. These results suggest that performance of the tasks required resources from two or more relatively independent sources.

Current theories concerning the structure of attentional resources postulate that the concepts of capacity and structure must be combined to adequately explain dual task performance (e.g., Kinsbourne & Hicks, 1978; Navon & Gopher, 1980; Sanders, 1979; C.D. Wickens, 1979). It is generally held by attention theorists that there are multiple processing structures, and that these structures function as discrete resource pools which can be allocated in continuous quantities across various tasks. The allocation of these resources is held to be under some voluntary control, although there might be exceptions in which allocation is automatic (Navon & Gopher, 1979). A crucial point in the present context is that while each processing structure is presumed to be maximally efficient in performing certain kinds of tasks, under certain circumstances the resources comprising its pool can
contribute to the performance of many other kinds of tasks, albeit less efficiently. In other words, the relative processing efficiencies of the structures may vary across tasks, as illustrated by performance-resource functions (Navon & Gopher, 1980).

Therefore, the resource pools are not totally dedicated to particular tasks, but are differentially efficient at different sorts of information processing. This notion implies that it is possible to switch from one composition to another. Four assumptions underlie the resource switching idea: the existence of multiple resource pools; the notion that a task may be performable by more than one structure, but with differing efficiency; the assumption that under circumstances in which more than one structure is available to perform the task, the most efficient one is used; and the assumption that when the most efficient structure is prevented from operating, the processing load may switch to a less efficient one.

It is widely held that a general, nonspecific parameter of arousal affects the functioning of all processing resources (e.g., Beatty, 1982; Kahneman, 1973). The effect of arousal may be thought of as affecting general processing efficiency (Sanders, 1979), or as altering the capacity of all resource pools (Friedman & Polson, 1981). (It should be noted that even though, strictly speaking, changes in general arousal should affect the capacity of all resource pools, they could affect the pools differentially—for instance, if one pool is already
involved in a demanding task, an increment in arousal could "overload" that pool and interfere with task performance, without adversely affecting the other pool(s).) The practical importance of arousal to the performance of experimental tasks has been questioned by Sanders (1979) - he pointed out that variations in arousal may be effects, rather than causes, of capacity/efficiency fluctuations, which may actually be caused by variations in other subject-task parameters; also, the range of changes in arousal may not be significant in the laboratory context, at least for normals.

An important current concern is the identification of these attentional resources. The postulation of a resource for each specific sort of task is unparsimonious and probably unnecessary, so one must consider simpler alternatives. Strong contenders for the identity of the resource pools are the two cerebral hemispheres (Friedman & Polson, 1981; Friedman, Polson, Dafoe & Gaskill, 1982; Kinsbourne & Hicks, 1978; C.B.-Wickens, 1980). The cerebral hemispheres apparently display the major characteristics of attentional resources as described by the multiple resources theorists. For example, the hemispheres display preferential processing, although the underlying dimensions of these preferences are still being debated (Bradshaw & Nettleton, 1981). Each hemisphere is thought to be capable of performing some common tasks, but with differing efficiencies (Friedman & Polson, 1981;
Sergent, 1982). There is also evidence that a concurrent load imposed on the left hemisphere can provoke a switch in maximal processing efficiency to the right hemisphere (Hellige, 1978; Hellige & P.J. Cox, 1976; Hellige, P.J. Cox & Litvac, 1979). The proposition that the cerebral hemispheres are distinct processing resources has allowed the integration of a large amount of data that resisted explanation from other perspectives (see Friedman & Polson, 1981; Hellige et al., 1979), and has generated complex predictions which have been supported by experimental tests (Friedman et al., 1982; Herdman & Friedman, 1985).

It should be noted that, while the literature strongly suggests that there are two discrete resource pools, with differential efficiencies across tasks, and displaying a tendency toward lateralization, it does not necessarily follow that these structures must be identified with the cerebral hemispheres. As Bryden (1978) stated, lateralized behaviour does not logically require cerebral lateralization of function, although the latter factor is probably involved in many cases. In the present work, "left hemisphere" and "right hemisphere" are used as provisional labels, and any final commitment to particular physiological locations of the processing structures so designated should not be inferred.

**Multiple resources and schizophrenic information processing**

It is suggested that some features of the apparent contradictions concerning schizophrenic experimental
performance can be explained from the perspective of recent developments in the theory of attentional resource structure. Furthermore, this approach makes specific, testable predictions concerning schizophrenic information processing.

It is hypothesized that in schizophrenia, available resources in all attentional structures are reduced relative to those of normals. Because of this decrease, these structures will reach their resource limits when faced with incrementing processing loads sooner than would otherwise be the case, with the resultant tendency to switch to less efficient resources for task performance more often than normals. In addition, it is hypothesized that paranoid schizophrenics may display decreased left hemisphere resources relative to nonparanoids. Therefore, paranoids would display a switch to less efficient resources when dealing with tasks optimally drawing on predominantly left hemisphere resources earlier in a load-incrementing series than nonparanoids or normals.

The etiology of the postulated decrease in available resources is uncertain. One intriguing possibility is that the decrease is an effect of abnormally heightened anxiety in schizophrenics. Depue (1974) conducted a study of response interference using schizophrenics, anxious neurotics and normals. Group performance did not differ in a non-aroused condition, whereas in an arousal condition (in which subjects gripped a hand dynamometer while performing the experimental task), response interference of
the former two groups both increased significantly relative to the normals. Although the schizophrenics and neurotics were both suffering from psychopathology and receiving phenothiazine medication (potentially serious confounds), this result is consistent with the notion that anxiety among schizophrenics is highly relevant to their deficient cognitive performance. Hamilton (1979) suggested that schizophrenics are subject to aversive, internally generated information overload, which he equated with anxiety. Perhaps the internally generated processing load produces a general decrease in resources available for other functions. Gjerde (1983) presented a selective review of the literature on schizophrenic processing deficit, in which he interpreted many of the findings as suggesting a schizophrenic "hyperarousal". This construct may be related to the notion of anxiety.

It should be noted that, although arousal and anxiety measures tend to covary in many conditions, these entities are neither synonymous nor isomorphic, and can interact in complex ways. Both constructs actually comprise multiple components, which can become uncoupled, creating complex patterns (R.J. Davidson & G.E. Schwartz, 1976; Lacey, 1967; Lang, D.N. Levin, Miller; & Kozak, 1983). Some researchers have reported that the multiple components of arousal may be unified in schizophrenics, perhaps because of a ceiling effect of chronic hyperarousal (Gjerde, 1983; Spohn, Lacoursiere, Thompson & Coyne, 1978). Such a state of
affairs would not necessarily imply a similarly simplified situation in the realm of anxiety, because of the imperfect correlations between arousal and anxiety: for instance, R.J. Davidson and G.E. Schwartz (1976) noted that activities such as chopping wood, running and dancing, which tend to produce elevated values on physiological indices of arousal, may reduce verbally reported anxiety among some people. Because of these complexities, schizophrenic hyperarousal as a correlate of hyperanxiety may be regarded as a reasonable assumption but not an incontestable fact.

Recent research has indicated that anxiety, unlike other emotional reactions, imposes a processing load specifically on the left hemisphere (Phelan & Gruzelier, cited in Gruzelier, 1981; Tucker, Antes, Stenslie & Barnhardt, 1978). An associated feature of paranoid schizophrenia is "unfocussed anxiety", according to DSM-III (American Psychiatric Association, 1980), and it is plausible that paranoid anxiety consumes specifically left hemisphere resources, producing the postulated differential performance pattern across subtypes. This anxiety may be a primary symptom (in the sense used by Bleuler), arising as a direct consequence of an underlying pathological process, or it may be a consequence of other disturbing features such as threatening delusions.

An alternative explanation for the hypothesized pattern of resource reductions derives from the work of Shmikunas (1978), who suggested that schizophrenics suffer
from specifically "semantic" information overload, which disproportionately consumes left hemisphere resources. George and Neufeld (1984) found that paranoids were significantly more likely than nonparanoids to report using semantic/verbal processing in daily problem solving, and this finding suggests that paranoids may be predisposed toward loading (and overloading?) the left hemisphere.

The postulation of a global schizophrenic resource deficit is in general agreement with positions of Knight and Russell (1978) and Gjerde (1983). Whereas these previous writers have conceptualized attention as an undifferentiated but limited resource pool for cognitive processing, the approach taken in the present work draws on contemporary findings concerning the structure of attentional resources. The result of a generalized capacity reduction is held to be not merely a generalized performance deficit, but a particular pattern of load-dependent deficits, as described in the following sections.

Relevance to Schizophrenic Processing of Stimulus Characteristics

According to the multiple resources perspective, differing tasks may require differing resource compositions for their optimal execution. In perceptual tasks, a salient characteristic is the nature of the presented stimuli. It is no longer held that the two hemispheres exclusively process verbally or nonverbally presented information (Sergent, 1982). It appears in general,
however, that the left hemisphere tends to be more analytically oriented, which is often optimal for the performance of verbal tasks, and that the right hemisphere is more efficient in employing holistic processing strategies, which most often are preferred in tasks involving nonverbal stimuli (for a review, see Bradshaw & Nettleton, 1981).

It is suggested that the inconsistency in the literature on differential responses to stimulus modality across schizophrenic subtypes may be partially accounted for by the failure to control the variable of processing load. If paranoid schizophrenics are chronically subject to an extra processing load drawing on left hemisphere resources, it may be predicted that, at relatively low levels of left hemisphere loading, when surplus processing capacity is abundant, the functioning of paranoids and nonparanoids on tasks with predominantly left hemisphere resource compositions would be roughly equivalent; or perhaps paranoids might show superior performance because of a facilitation effect, as has sometimes been observed in normals (Kinsbourne & Hicks, 1978). At higher left hemisphere load levels, one would expect that paranoids would become impaired relative to nonparanoids, as the former group would exhaust the left hemisphere resource pool first, and be compelled to switch to less efficient right hemisphere resources. Such a sequence of shifting performance levels depending on load was described by
Moscovitch and Klein (1980), from the perspective of dual task performance by normals:

When the demands of the concurrent and primary tasks exceed the resources of the hemisphere specialized to process the primary task, perceptual asymmetries for the primary task will usually be slightly reduced relative to a single-task situation. If, however, the hemisphere is operating below capacity, the concurrent task may lead to priming, thereby improving detection (p.602).

Concerning subtype performance on tasks with predominantly right hemisphere resource compositions, predictions must be more tentative. It may seem as if paranoids and nonparanoids should function equivalently on such tasks. Some of the behavioural laterality data from experiments with normals indicate that a concurrent load on the left hemisphere can cause that hemisphere to become more efficient at performing certain tasks than the right hemisphere, whereas without the concurrent load the right hemisphere is more efficient (Hellige et al., 1979). This finding suggests that under some conditions, paranoids may perform typically right hemisphere predominant tasks more efficiently than nonparanoids, because of a facilitation of left hemisphere efficiency in this regard. Conversely, Gur (1979) suggested that the "left hemisphere overactivation" she regards as characteristic of schizophrenics might result in the use of less appropriate and efficient left hemisphere resources for the execution of tasks optimally performed by the right hemisphere. If paranoids are more left hemisphere overactivated than nonparanoids, Gur's suggestion would lead to a prediction of a paranoid nonverbal stimulus processing deficit relative to
nonparanoids. Data are too sparse to decide between these predictions. Indeed, they may not be mutually exclusive, but pertain to different regions of the left hemisphere processing load dimension.

It is evident that the multiple resources approach is consistent with the apparently paradoxical findings found in the literature concerning subtype differences in responding to stimulus modalities. The theory cannot be properly evaluated by examining the literature, because the experiments described therein vary so widely in design that they cannot clearly be arranged on a dimension of increasing load. Variations in load could arise from differences in explicit task characteristics, and differences in the effects of stressors in the testing situations, which consume resources for coping and for anxiety-related processes.

A recently completed study by Highgate-Maynard (1984) provided more detailed data which are consistent with the load/mode theory described above. She presented memory sets of varying sizes consisting of either words or pictures to schizophrenics, psychiatric controls and normals. Following this presentation, an object-name or depiction was shown to the subjects, who executed a key press response indicating whether the object was the same real-life size as any of the memory set items. A significant interaction between blocks of trials, stimulus type and subject group, involving correct response reaction time,
was discovered. Specifically, in the pictorial condition
the mean reaction time of paranoid schizophrenics increased
across blocks, whereas that of the nonparanoids decreased
slightly. In the word condition, mean reaction time of the
paranoids decreased across blocks, and that of the
nonparanoids increased. Mean reaction times for the
control groups decreased or remained constant across blocks
in both conditions. One explanation for these complex
findings requires consideration of the efficiency of task
performance as varying in an inverted U-shaped fashion
along a continuum of arousal. If the left hemisphere is
chronically overactivated in paranoids, then their
performance curve for verbal tasks may be translated to the
left along the continuum. An effect of this translation is
that paranoid processing efficiency for verbal material
would peak and begin to decline earlier than that of the
nonparanoids under conditions of increasing arousal, and
conversely, paranoid efficiency would still be increasing
after nonparanoids had reached their peak if arousal was
decreasing. This scheme is consistent with Highgate-
Maynard's data if one supposes that the subjects habituated
to the novelty of the experimental situation, and became
less anxious and aroused across blocks; and if the subjects
were functioning within the range of arousal in which
decreasing arousal increases paranoid efficiency
(decreasing reaction time) and decreases nonparanoid
efficiency (increasing reaction time). In the case of the
picture tasks, a similar explanation can be advanced, if
one assumes that the task was significantly mediated by right hemisphere resources, and that paranoid right hemisphere functioning was underactivated relative to that of nonparanoids (or, alternatively, that paranoids were performing the task with a less efficient resource, perhaps associated with the left hemisphere). While these explanations are able to accommodate the data, they are highly speculative, as there were no measures of arousal/anxiety or hemispheric functioning.

Relevance to Schizophrenic Attention

The multiple resources approach also illuminates some of the difficulties which have prevailed in the research literature on schizophrenic attention. It has been suggested that each hemisphere functions as a distinct resource pool, and that the nature of these pools differs. A substantial number of studies with normal subjects have indicated that there are two modes of selective attention, one which operates primarily on local, detailed or high frequency spatial information, and one which processes more global stimulus features (e.g. Alwitt 1981; Beck & Ambler, 1972, 1973; Eichelman, 1971; Navon, 1977, 1981; Sergent, 1982; Trevarthen, 1968). Research findings have linked these modes to the operation of the cerebral hemispheres - specifically, focal attention as controlled by the left hemisphere (Alwitt, 1981; Martin, 1979; Sergent, 1982), and global attention as not clearly asymmetrical (Alwitt, 1981; Martin, 1979) or as associated with the right hemisphere.
(Sergent, 1982).

One of the errors that some of the schizophrenic attention deficit theories may have made was to examine selective attention as unitary, when there seems to be two distinct modes. In considering the apparent conflict between research supporting a schizophrenic breakdown in filtering extraneous information and research suggesting a retardation in early processing, for example, one might consider the possibility that either situation may prevail, depending on which hemispheric resource pool is inappropriately dominating current processing. The overwhelming intrusion of extraneous information may reflect a suppressed focal mode, which leaves the global mode the sole selector of input. Conversely, retardation of processing may arise from an overemphasis on focal attention, and a consequent inability to apprehend broader features fast enough to function adequately.

Interestingly, the proposed subtype specific attentional deficits may relate to the dual modes of attention, and the lack of consistency in the research results pertaining to this area may be attributable to load-dependent resource switching, as was also suggested in the case of paranoid/nonparanoid differences in responding to various stimulus characteristics - that is, it is plausible that paranoid subjects may display a predominant focal attention when the left hemisphere is moderately loaded, whereas at higher loads this predominance may fade, perhaps to be
replaced by an emphasis on global processing.

**Relevance to Schizophrenic Hemispheric Functional Asymmetry**

It is evident that much of the confusion in the current literature on schizophrenic hemispheric functional asymmetry would be expected if the pattern of hemispheric functioning (i.e. the relative consumption of resources from the two attentional structures) changes as a function of processing load and stimulus characteristics. Findings indicating little hemispheric difference may characterize low load conditions, medium loads might evoke left hemisphere overactivation, and left hemisphere dysfunction might be suggested by performance in higher load conditions. As in the case of experiments employing differing stimulus modalities, hemispheric functional asymmetry studies have employed a wide variety of tasks in differing settings, rendering estimates of relative processing load across studies difficult.

Certain patterns in the results of relevant studies appear to support the notion of load-dependent functional deficits. For instance, in dichotic listening studies involving schizophrenics, little or no response asymmetry has been found when one word, syllable or digit is presented to each ear per trial (Colbourn & Lishman, 1979; Wexler & Heninger, 1979; Yozawitz et al., 1979). In experiments involving dichotic lists of three or more elements, schizophrenics tend to exhibit pronounced
asymmetries in favour of the right ear (Gruzelieir & Hammond, 1980; Lerner, Nachshon & Carmon, 1977; Lishman, Toone, Colbourn, McMeekan & Mance, 1978; Walker & McGuire, 1981), which has been interpreted as indicating an overactivated left hemisphere (Gruzelieir & Hammond, 1980; Nachshon, 1980). In addition, several studies have indicated that left hemisphere overactivation may be more marked among paranoid schizophrenics (Gruzelieir, 1981; Gruzelieir & Hammond, 1980; Nachshon, 1980).

It should be reiterated that the multiple resources approach to these data does not assume that schizophrenics possess a structurally altered cerebral hemisphere (or hemispheres). Indeed, it is felt that the research concerning the schizophrenic brain is far from compelling in this regard. Marin and Tucker (1981) pointed out that the research associating brain functioning with schizophrenia has thus far failed to reveal reliable correlations between behaviour and specific central nervous system lesions, nor have neural mechanisms involved in abnormal behaviour been clearly delineated. Because of these failures, argued Marin and Tucker, it is premature to assert the superiority of physiological explanations of schizophrenia over explanations deriving from other perspectives. Walker and McGuire (1982) claimed that certain features of schizophrenic experimental performance actually conflict with the suggestion that schizophrenia involves a structural cerebral anomaly. Gruzelieir (1981), on the other hand, suspected that structural deficits are
present in schizophrenia, but also stated that functional aspects are very important.

In the present work, no position is taken concerning whether physiological explanations will prove to be optimal ones for some features of schizophrenia. The terms "left hemisphere" and "right hemisphere" are employed to signify relatively discrete attentional resources which are reflected in certain behavioural lateralities. This usage does not imply a position concerning the conceptualization of certain anatomical features as mediating or causal variables.

**Testing the theory: General considerations**

The multiple resources approach applied to schizophrenia, as described above, has the virtue of being flexible enough to accommodate the conflicting results in three troubled areas of schizophrenia research. It has the further virtue of being falsifiable, by providing testable hypotheses. For example, it predicts that schizophrenics will perform more poorly than normals on many cognitive tasks; that the performance of paranoids and non paranoids on tasks involving primarily left hemisphere resources will change in different ways as a function of increasing processing load (specifically, paranoids should reach capacity limits sooner, leading to a marked performance deterioration under lower loads); and that the subtypes will not display this pattern on tasks involving primarily right hemisphere resources. In addition, some directions
for exploration are suggested: do paranoids exhibit more anxiety than nonparanoids? To what extent are specific symptom configurations associated with individual differences in resource limitations? Some important issues pertaining to the interpretation of attempts to test these hypotheses are discussed below.

One such issue involves the fact that applying the multiple resources approach to schizophrenia requires the assumption that schizophrenic processing resources are organized in a similar fashion to those of normals. It has been asserted that the general structure of the information processing system in schizophrenics and normals is qualitatively similar (Neufeld & Broga, 1981). There also exists evidence suggesting that schizophrenic lateralization patterns are not generally atypical— for instance, handedness is correlated with the lateralization of expressive language function, and consistent findings of unusual frequency of left hand dominance in schizophrenics have not emerged (Marin & Tucker, 1981). Johnson and Crockett (1982) interpreted results of a dichotic listening study involving remitted schizophrenics as suggesting unusual functional lateralization. Findings from such tasks cannot truly be used to assess long-term functional propensities of the hemispheres, because, unlike measures of handedness, they are affected by short-term and situational variables, as Johnson and Crockett themselves demonstrated, and therefore should be regarded as indices of current...
functioning only.

A second issue concerns the distinction between data-limited and resource-limited functions. A data-limited function is one in which the level of performance is constrained by the quality or availability of information required to perform the task, whereas the performance ceiling of a resource-limited function is created by the exhaustion of the relevant resource pool (Navon & Gopher, 1979). It could be argued that a schizophrenic performance deficit may be the result of data limitations—perhaps due to a peripheral factor operating to degrade information—rather than resource limitations. It is difficult conclusively to refute this suggestion. It can be pointed out, however, that the pattern of load-dependent responding predicted from the resources perspective follows the model of a resource pool progressively being depleted and finally being exhausted, producing a switch to another, less efficient pool. It is unclear how a data limitation explanation could parsimoniously account for the predicted pattern of results, unless the postulated peripheral factor itself followed the pattern of depletion and exhaustion, in which case it could be regarded as a resource structure.

C.D. Wickens (1979) and Gjerde (1983) made the distinction between the adequacy of resources and their proper allocation. This distinction is analogous to that made between the integrity of long term memory schemata and the retrievability of the information stored therein. A schizophrenic performance deficit could be regarded as a
deficit in the allocation of resources, rather than a
decrease in capacity. Again, the occurrence of a load-
dependent response pattern would seem to require the
involvement of some resource-limited factor – if this
factor is a mechanism responsible for the allocation of
other resources, then it can probably be regarded as an
integral part of the general attentional structure. It is
also possible that an inefficient strategy of allocation
could actually be the source of a reduction in resources
available for other tasks, or for performance at higher
load levels. However, a pattern of responses indicating
depletion and exhaustion (perhaps preceded by a priming
effect) with increasing load signifies the involvement of
resource pools, regardless of the presence of other
factors.

Also relevant to any study involving quantitative
comparisons between normal and psychopathological
populations is the effect of task difficulty on group
discriminability, first explicated by L.J. Chapman and J.P.
Chapman (1973). They demonstrated that the power of a task
to evoke differential performance levels from normal
subjects and those suffering from a generalized performance
deficit varies with task difficulty. Specifically, the
groups may not differ in performing a task which requires
a relatively light investment of processing resources, but
the group with the deficit may perform more poorly than the
normals on a more difficult task. An erroneous
interpretation of such findings would be to suggest that the second task tapped a specific deficit in the impaired group which the first task did not, whereas in reality the second task only made the generalized deficit of the impaired group more salient. Chapman and Chapman argued on this basis that tasks must be equated in level of difficulty in order for differential performance levels to be meaningfully assessed as evidence for specific deficits. Similarly, it could be argued that in order to meaningfully compare schizophrenic performance on tasks employing verbal and pictorial stimuli, the difficulty levels of the tasks should be equated. In response to this suggestion, it should first be noted that Chapman and Chapman's major concern was with tasks such as questionnaires, which can be equated on the basis of psychometric properties. Many cognitive performance tasks are significantly different, in that there is no comparably direct way to compare levels of difficulty. Attempts to accomplish this are usually based on speculations logically derived from notions concerning the information processing stages thought to be involved in task performance (for exceptions, see Oltmanns & Neale, 1975; Pogue-Geil & Oltmanns, 1980), but such ideas are difficult independently to validate. Second, the use of psychometric principles, developed in the context of measurement of individual differences, for the detection of differences between normal and pathological groups, is open to serious question (Neufeld, 1984). For instance, it has been shown that, under certain circumstances, increasing
the reliability of a measure adversely affects its ability to discriminate between groups. Such findings suggest that an overly obsessive concern with classical psychometrics in the context of psychopathology research may be counterproductive. Furthermore, it is possible that the nature of human attentional functioning may forever preclude the general application of Chapman and Chapman's suggestion to the realm of cognitive task performance. A global cognitive deficit will not manifest simply as harder cognitive tasks affording greater intergroup discriminability than easier tasks, because of the existence of multiple resource pools. The attention research reviewed earlier in this work has clearly demonstrated that tasks requiring attention cannot be arranged along a single dimension of difficulty, so rather than attempting to rank all tasks as "harder", "easier" or "equivalent", we must examine the empirically evaluated resource composition of each task. Comparison of performance across cognitive tasks must be evaluated in this light, rather than with respect to considerations inappropriately borrowed from a different line of research.

Another issue pertains to the fact that research with normals has indicated that the imposition of a processing demand on a resource pool can produce no effect, a facilitating effect or a detrimental effect on task performance, depending on the magnitude of the concurrent demands. The current data base is too small to allow the
quantitative prediction of transition points between
different effects along a load continuum for any task. The
ideal approach would involve a quantified standard scale on
which the mean transition points were mapped, and against
which performance could be measured. In its absence, the
performance of a control group of suitable matched normals
could serve as a standard, against which the performance of
schizophrenics could be compared. One possible problem is
that the resources of the schizophrenics may already be so
deprecated that the predicted effects do not occur because of
a ceiling effect. Hopefully, this is not the case, and the
fact or the varying patterns in the experiments discussed
earlier in this introduction argues against it.

The question of proper control groups merits
discussion as an issue in itself. In order to explore
differences between schizophrenic subtypes, a group of
paranoids and one of nonparanoids is required. A group of
normals, matched to the schizophrenics on potentially
significant confounding variables such as socioeconomic
status, is necessary to compare schizophrenic performance
to that of the normal population. Because most of the
literature on multiple attentional resources is based on
research employing college students as subjects, a control
group of similar subjects facilitates comparison with other
experimental studies of attentional resources. The
diagnosis of schizophrenia is confounded with presence of
psychopathology and residence in a psychiatric institution,
and in order to control for these factors, inclusion of a
nonschizophrenic institutionalized psychiatric group is useful. The appropriate composition of the psychiatric control group is debatable. A group comprising a mixed set of nonschizophrenic disorders has the advantage of controlling for institutionalization while attenuating systematic variance attributable to specific disorders, but has the disadvantage of combining groups which may be markedly different from each other in important respects. A group composed of patients bearing a single diagnosis, such as depression, has the advantage of simplicity in group composition, and the disadvantage that diagnosis is confounded with institutionalization. Because of the possible importance of institutionalization as a factor in manifestations of schizophrenia (e.g. Silverman, Berg, & Kantor, 1965; but see Strauss, 1973), a mixed psychiatric control group was employed in the present study as the least problematic approach.

Sex differences have been noted in schizophrenia (e.g. Loranger, 1984; Wahl, 1977), and gender may be associated with functional laterality patterns (although Kimura (1983) has recently asserted that there is no solid evidence for either greater cross-lateralized or less lateralized hemispheric functioning in either sex - rather, females may have more localized organization within hemispheres for certain functions). Also, handedness has been linked to differences in cerebral functioning. It was therefore thought advisable to have equal numbers of female and male
subjects in each group, and to ensure that the ratio of right- to left-handers was approximately equal across groups.

The schizophrenic subjects who participated in the present study were receiving neuroleptic medications as part of their ongoing therapy. The unavailability of nonmedicated identified schizophrenics makes it necessary to employ medicated ones as subjects, and creates the challenge of differentiating between drug effects and those attributable to the underlying disorder. This problem pervades schizophrenia research. Its threat to validity can only be attenuated by noting that findings have consistently indicated that phenothiazines tend to normalize schizophrenic functioning on cognitive tasks (Neufeld & Broga, 1981), so studies searching for cognitive anomalies in medicated schizophrenics are likely to be conservatively biased. In the present study, current medication dosage was recorded for all participating psychiatric patients, and the associations of this factor with the experimental dependent variables were examined, in order to ascertain the seriousness of the medication confound.

**Testing the theory: Methodological considerations**

One possible empirical approach to the issue of schizophrenic attentional resources involves the execution of a task in which the resource compositions of a primary resource requirement, and the load imposed by the
processing of a concurrent secondary task, are systematically varied. Relevant background information, and a description of the experimental design, now follow.

The notion that recognition of faces draws primarily from right hemisphere resources is firmly supported in both the neurological (e.g. Tzavaras, Hécaen & LeBras, 1970; Yin, 1970) and psychological (e.g. Hilliard, 1973; St. John, 1981) literature. The left hemisphere as the primary resource for verbal processing under most conditions is similarly well-established (e.g. Hines, 1975; Pirozzolo & Rayner, 1977). It should be noted that, depending on the task parameters, either hemisphere appears capable of processing either verbally or pictorially presented information (Sergent, 1982, 1983), indicating that the verbal/pictorial dichotomy is not the fundamental one. Under most task parameter configurations, the specialization of the left hemisphere for processing later-available, high frequency information predisposes it toward efficiency in verbal information processing, whereas the right hemisphere tends to be more suited to pictorial processing because of its specialization for early-available, low frequency data. It is essential, when using tasks which purport to differentially involve hemispheric functioning, to empirically validate the tasks, as the current state of knowledge is insufficiently developed to permit assumptions in this regard.

It has repeatedly been shown that the retention of verbal material is selectively interfered with by
performance of concurrent verbal tasks, and nonverbal retention is affected by concurrent nonverbal loads (e.g. Salthouse, 1975). The magnitude of these material-specific interference effects have been shown to be dependent on the volitional allocation of the appropriate resources to the tasks (Moscovitch & Klein, 1980).

Specifically, Moscovitch and Klein (1980) mapped out an interesting progression of such effects, using a dual task design. In their study, left hemisphere function was assessed by asking the subjects to verbally identify a pair of words presented tachistoscopically, one word in the right visual field and one in the left visual field. (Right field superiority was consistently found). Right hemisphere function was assessed by presenting photographs of faces to the peripheral visual fields, and asking the subjects to respond with a manually executed forced choice. (Left field superiority was reported for these tasks).

Concurrently, various stimuli were presented in the central field. It was found that the following sequence of concurrent loads produced monotonically increasing interference with verbal accuracy: blank central field; central presentation of a face or shape, which was to be ignored; central presentation of a word, which was to be ignored; and central presentation of a word which was to be verbally identified prior to identifying the peripheral stimuli. The following sequence interfered with the right hemisphere task in a progressively increasing fashion:
blank central field; central presentation of an ignored word; central presentation of an ignored face; and central presentation of a face which was to be identified prior to identifying the peripheral stimuli. These concurrent tasks can be conceived as imposing progressively greater loads on the resource pool of the target hemisphere, producing increasing primary task deficits due to reaching resource limitations.

It was thought that an experiment similar to that of Moscovitch and Klein might increase our understanding of attentional resources in schizophrenia. The verbal and nonverbal tasks described in the preceding paragraph may be regarded as possessing resource compositions pertaining primarily to the left and right hemisphere, respectively, and by manipulating the modality of the primary task and load level of the concurrent task, some features of the load/mode theory can be evaluated.

The theory generated the following predictions concerning the performance of these tasks. First, it was predicted that schizophrenics would display a greater generalized processing inefficiency than other subjects, because of decreased processing capacity. Second, it was predicted that the paranoid schizophrenics would show superior performance relative to the nonparanoids at the lower load levels for the word task, especially when the matching stimulus was presented in the right visual field, because of the priming effect of an extra left hemisphere load; and that at higher load levels for the word tasks,
paranoid performance would deteriorate to the level of the nonparanoids, and possibly beyond it. Third, it was predicted that such a pattern of responses would not occur in the picture tasks, or in trials in which the matching stimulus was presented in the left field. The prediction of the load/mode theory as developed in this Introduction is not specific concerning schizophrenic subtype performance on the right hemisphere tasks. However, as was noted in an earlier section, hemispheric functioning as portrayed by Heilige et al. (1979) leads to a prediction of paranoid superiority on right hemisphere tasks, whereas Gur's (1979) position predicts nonparanoid right hemisphere superiority, assuming that the subtypes have equivalent levels of generalized deficiency.

It would be useful to know if resource-dependent effects could be localized within the hemispheric processing structure — that is, do the differential processing efficiencies and resource limitations on performance arise early in the information processing sequence or at later stages? It was hoped that this question could be addressed by modifying the experimental tasks. A trial could be initiated by briefly presenting a criterion stimulus, either a word or a face. Following stimulus offset and an interstimulus interval, the central/peripheral stimulus array could be presented. The subject could be asked to press one of a pair of keys indicating whether either of the test items in the array
matched the criterion stimulus. This approach allows manipulation of the interstimulus interval, thus permitting the study of interactions involving interstimulus interval and patterns of visual field superiority. (Such an approach was used in a different context by Moscovitch, Scullion and Christie, 1976). For instance, if visual field response asymmetries are present only at longer interstimulus intervals, this would suggest that the interhemispheric difference in processing efficiencies lies at a later stage of processing involving categorical memory representation, rather than a very early stage. Pilot work revealed that interstimulus interval variation did not affect task performance to a significant degree, so this feature was not employed in the main study. The modification of the original Moscovitch and Klein experimental design, replacing the identification tasks with the matching tasks, was retained in the main study, for two reasons. First, pilot work with the matching tasks indicated that they significantly discriminated between left and right hemisphere function (that is, reaction time was greatest for verbal target stimuli presented in the left visual field, and for nonverbal target stimuli presented in the right visual field) among normal subjects. Second, in Moscovitch and Klein's study, the verbal tasks involved identification, whereas the pictorial tasks were matching tasks. Sergent (1983) argued that identification tasks and matching tasks differ in terms of the required processing resources. In order to unconfound stimulus modality and
task type, all tasks used in the present study were matching tasks.

The variables of imageability and concreteness of words have been found to affect a range of tasks involving verbal information processing (e.g. Paivio, 1965, 1966), and concern could be raised that these factors might have influenced subjects' responses in the present study. However, a study by Boles (1983) indicated that imageability and concreteness do not affect lateralized word recognition performance.

Many studies using the tachistoscope for the study of behavioural lateralities have encountered difficulty in selecting tasks which lateralize in the predicted way (e.g. Magaro & Page, 1983). This common problem may arise from failure to consider the wide variety of stimulus and procedural variables which have been found to affect lateralized tachistoscopic performance, such as exposure duration, luminance, and retinal eccentricity (see Sergent, 1983, for a comprehensive review). In order to ensure that the experimental tasks produced the desired asymmetries of functioning, pilot work was undertaken in which such variables could be properly calibrated. The values which were selected for use in the main study are listed in the procedure.

The present study used both positive trials (in which the criterion stimulus matched an element in the subsequently presented stimulus array) and negative trials
(in which the criterion stimulus did not correspond to an array element), in order to provide data concerning response accuracy. The number of negative and positive trials were equal within and across tasks, to prevent advantage from accruing from the use of response strategies not based on stimulus characteristics—for instance, if there were more positive than negative trials, subjects could score above chance expectancy by responding positively on every trial.

Several studies have reported that schizophrenic subtypes tend to display different response propensities. The most common finding is that paranoids display a liberal, and nonparanoids a conservative, response bias (e.g., Broga & Neufeld, 1981; McCormick & Broekema, 1978; McDowell, Reynolds & Magaro, 1975; Price & Eriksen, 1966). In order to replicate this finding, and to examine the possibility that it may be related to the postulated differences in behavioural laterality across subtypes, the task performance data from the present study were subjected to a signal detection analysis, which yielded quantitative measures of sensitivity and response bias.

**Secondary Studies**

In addition to the experiment described above, further data were collected from the subjects, in order to explore a variety of issues. For instance, it was suggested above that paranoids may have decreased left hemisphere resources relative to nonparanoids, and that the reason for this
difference may be increased anxiety among paranoids. This issue was probed by administering the State-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1970) to the subjects in the present study, so that quantitative differences in anxiety across groups could be assessed.

As was also mentioned previously, schizophrenia research is complicated by the lack of uniformity in methods of identifying schizophrenic subjects. The dearth of data concerning the equivalence of the various research diagnostic instruments contributes to the difficulties in comparing results across studies which employed different measures. Foulds' Symptom-Sign Inventory (Foulds & Hope, 1968) has been used by several researchers in designating schizophrenic and control groups for research purposes. Currently, the majority of schizophrenia researchers use the Research Diagnostic Criteria (Spitzer, Endicott & Robins, 1978) for this purpose. In order to facilitate comparisons between studies employing either of these diagnostic instruments, the subjects in the present study were given the SSI in addition to being diagnosed according to the RDC, to provide a direct comparison of their diagnostic convergence.

Eckblad and L.J. Chapman's (1983) Magical Ideation Scale was also administered to all subjects. This measure has been advanced as an index of vulnerability to schizophrenia - it has been found to discriminate between university students who scored high or low on other measures of proneness to schizophrenia (Eckblad & L.J.
Chapman, 1983; Fujioka & L.J. Chapman, 1984), and subjects
drawn from temporary employment agencies who scored high on
the scale displayed deviantly low scores on a forced-choice
span of apprehension task (Asarnow, Nuechterlein & Marder,
1983) — but had never been given to a group of
schizophrenics. It was thought that the responses of
schizophrenics on this measure could provide valuable
information concerning its validity.

Fisk and Neufeld (1984) proposed that the subtype
difference in response propensity may be attributable to
differences in the duration of prior experience of the
disorder. Nonparanoids tend to display poorer premorbid
competence than paranoids (e.g. Zigler, Levine & Zigler,
1976), and tend to have an earlier onset of the disorder
(e.g. Zigler & Levine, 1981). This greater experience of
pathology may predispose nonparanoids to be more aware of
the debilitating effects of their disorder, and to
compensate for these effects by adopting a conservative
response propensity, relative to the less experienced
paranoids. In order to evaluate this notion, Phillips and
Zigler's (1961) Premorbid Adjustment Scale data, and date
of overt schizophrenic symptom onset (or date of first
contact with health profession, if the former information
was unavailable), was collected, and the relationships
between these variables and the response propensity data
were studied.
METHOD

Subjects

Five groups of subjects were employed in the study: paranoid schizophrenics, nonparanoid schizophrenics, nonschizophrenic psychiatric inpatients, normals recruited from Employment Canada (London, Ontario) and local newspaper advertisements (designated as general controls), and normals recruited from introductory psychology classes (University of Western Ontario). Each group was composed of seven females and seven males. Subjects in the three psychiatric groups were volunteers in London Psychiatric Hospital and St. Thomas Psychiatric Hospital who met the study's inclusion criteria. These were: age between 18 and 60; less than 3.5 years cumulative hospitalization; no electroconvulsive therapy within the six months prior to testing; no history of drug or alcohol abuse; no evidence of organicity; clinical diagnosis of schizophrenia or nonschizophrenic psychiatric disorder; RDC diagnosis of paranoid schizophrenia, nonparanoid schizophrenia, or nonschizophrenic psychiatric disorder (the diagnosis of subtypes was corroborated using Vojtisek's (1976) Maine Scale of Paranoid and Nonparanoid Schizophrenia); Wais-Clarke IQ score greater than 80; and education level grade 8 or above. The composition of the psychiatric control group, by RDC diagnosis, was as follows: manic disorder, 2; minor depressive disorder, 2; major depressive disorder, 9; unspecified functional psychosis, 1. In order to purify
the sample of schizophrenics, and to minimize overlap with the psychiatric control group, patients with an RDC diagnosis of schizo-affective disorder were excluded from the study. Permission of each patient's psychiatrist was obtained for participation in the study. The following information was collected from each subject, in order to assess the presence of variables confounded with group assignment: Wais-Clarke IQ score (Paitich & Crawford, 1970); age; cumulative hospitalization; education level; medication dosage (converted to chlorpromazine equivalency units according to the procedures of J.M. Davis (1976) and Lehmann (1975)); socio-economic status (Hollingshead, 1975); and handedness (Oldfield, 1971). Normals were excluded from the study if they had a history of drug or alcohol dependency, or evidence of neurological abnormality. All subjects were paid ten dollars for their participation (except for the students, who received course credits).

**Apparatus**

Stimulus material consisted of eight sets of (15cm x 10cm) tachistoscope cards, one set for each experimental task. In each set were 32 cards bearing a criterion stimulus in the viewing field, and 32 corresponding stimulus array cards, comprising 32 trials per task. In 16 trials, the criterion did not match any element of the array (negative trials); in 8 trials, the criterion matched the element on the right of the array; in 8 trials, the
criterion matched the element on the left of the array. In four of the tasks, the criterion was a four-letter word (letter size was 1 cm x 1 cm). In the other four tasks, the criterion was a black-and-white photograph (3 cm x 4 cm), taken from a high school graduation yearbook. The stimulus arrays for the verbal tasks consisted of pairs of four-letter words, one word on each half of each card, 1 degree 6 min from the centre, and pictorial task stimulus arrays consisted of faces similarly arranged. The four verbal tasks varied in terms of the load imposed by the processing of the stimuli in the centre of the test array. In the level one (easiest) task, the centre was blank; in the level two task, a face was displayed in the centre; for levels three and four, a word, printed vertically (so as not to overlap with the peripheral stimuli) was displayed in the centre, and load was varied between these levels by presenting different instructions. The four pictorial tasks were similarly arranged, except that faces were used in the centre rather than words, and words for faces. The words and pictures used in this experiment were organized so that no stimulus was used in more than one trial, in order to avoid complicating the task of comparing the criterion with the array elements within trials.

Stimuli were presented using a Gerbrands two-field tachistoscope (Model T-2B-1), controlled with a Gerbrands lamp driver and timer. Subjects responded by pressing one of two telegraph keys, positioned 13 cm apart, and mounted on a board placed beneath the tachistoscope within easy
reach of the subject. Reaction time was recorded from a Hunter Klockounter (Model 120) attached to the tachistoscope; the key pressed in response was indicated by a light display on the timer.

In addition to the demographic measures listed in the section describing subject characteristics, the following psychometric instruments were employed: Symptom-Sign Inventory (Poults & Hope, 1968); Magical Ideation Scale (Eckblad & L.J. Chapman, 1983); State-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1970); Premorbid Adjustment Scale (Phillips & Zigler, 1961); Maine Scale of Paranoid and Nonparanoid Schizophrenia (Vojtisek, 1976—for psychometric data see Magaro, Abrams & Cantrell, 1981); Research Diagnostic Criteria (Spitzer, Endicott & Robins, 1978; for recent evaluations of the psychometric properties of the RDC, see McGlashan, 1984; Zwick, 1983).

Procedure

First, subjects were verbally administered Poults' Symptom-Sign Inventory, and were asked to fill out the Wais-Clarke Vocabulary Test, the Magical Ideation Scale, State-Trait Anxiety Inventory and the Edinburgh Handedness Inventory. Then, the eight tachistoscope tasks were performed. Order of task performance was randomized across subjects. Order of trials within tasks was randomized. Each trial consisted of a presentation of the criterion stimulus for 1.5 seconds, immediately followed by presentation of the test stimulus (for 20 msec in verbal
tasks; for 200 msec in pictorial tasks). Subjects were asked to press the key marked "yes" if the element in either the left or right fields was the same as the criterion stimulus; if neither element in the array matched the criterion, they were instructed to press the key marked "no". The hand assigned the task of key-pressing was randomly varied across subjects. In the level one tasks, subjects were instructed to simply perform the matching task. In the levels two and three tasks, subjects were asked to perform the matching task, and to ignore the stimulus in the centre of the array. In the level four verbal task, the subject was instructed to perform the matching task, and then to say the central word aloud. In the level four pictorial task, a card displaying the pool of four central faces was placed in front of the subject; the subject was instructed to perform the matching task, and then to point with the left hand to whichever of the faces on this card was the same as the middle face in the test array in that trial.

(Different modes of responding to the load stimulus in the two level four tasks were used in order to more specifically target the loads at the intended hemispheres. As overt responses, as well as covert processing, depend on attentional resources, one way to increase "task-hemispheric integrity" is to employ response modalities which have distinct resource compositions (C.D. Wickens, Mountford, & Schreiner, 1981; C.D. Wickens & Sandry, 1982).
Verbal responding and left-handed manual pointing have been found to be associated with the left and right hemispheres, respectively (Friedman & Polson, 1981; J. Green, 1984).

Subjects were given practice trials after receiving the instructions for each task, and had to display their comprehension of the instructions by correctly performing four consecutive trials before the test trials were conducted.
RESULTS

Demographic Variables

Group differences with respect to the following variables were examined using a series of univariate analyses of variance, in which groups and sex comprised the independent variables: age; education level (in years); Wais-Clarke IQ score; Hollingshead social status index score; and Edinburgh Handedness Inventory score. Also, similar analyses were conducted for the following variables, involving the three psychiatric groups (psychiatric controls, paranoid schizophrenics, nonparanoid schizophrenics) only: cumulative duration of hospitalization (in months); medication dosage (in chlorpromazine equivalency units); and Phillips-Zigler Premorbid Adjustment Scale scores. (Means and standard deviations for all demographic variables are displayed in Table 1).

Concerning age, the analysis revealed a main effect for groups (F(4, 60) = 4.79, p < .01). Newman-Keuls tests indicated that the university students were significantly younger than the other groups, which did not differ significantly from each other (for students and general controls, q(2, 60) = 3.69, p < .05; for students and psychiatric controls, q(4, 60) = 5.09, p < .01; for students and paranoïds, q(5, 60) = 5.49, p < .01; for students and nonparanoïds, q(3, 60) = 4.18, p < .05).

The analysis of education revealed a main effect for groups (F(4, 60) = 3.85, p < .01), which was attributable to
Table 1. Demographic characteristics of diagnostic groups. US = university students; GC = general controls; PC = psychiatric controls; PS = paranoid schizophrenics; NS = nonparanoid schizophrenics; Educ. = education (years); Hol = Hollingshead Social Status Index score; EHI = Edinburgh Handedness Index score; Hosp = cumulative hospitalization (months); Med = current daily antipsychotic medication dosage (CPZ equivalency units); PZ = 'Phillips-Zigler' Premorbid Adjustment Scale score.

<table>
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<th>Variable</th>
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<th>PS</th>
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<td>0.27</td>
<td>0.41</td>
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the students being more highly educated than the psychiatric controls \( (q(5,60) = 5.0, p<.01) \).

Concerning IQ score, a main effect for groups was found \( (F(4,60) = 2.77, p<.05) \), which was due to the students having a higher score than the non paranoids \( (q(5,60) = 3.90, p<.05) \).

No significant differences were reported across groups or sex for Hollingshead scores or Edinburgh Handedness Inventory scores. Also, the psychiatric groups did not differ with respect to duration of hospitalization, medication dosage or premorbid adjustment scores. However, differences in mean medication dosage across psychiatric groups displayed a suggestive nonsignificant trend, so Pearson product-moment correlations were calculated for medication dosage and each of the five dependent variables. The correlation between medication dosage and the sensitivity parameter was found to be significant \( (r = -.370, p<.01) \).

**Analysis of reaction time and error rate.**

Univariate analyses of variance were conducted, using overall reaction time (incorporating responses on positive trials regardless of accuracy), correct response reaction time for positive trials, and error rate as dependent variables. Only data from positive trials were used in these analyses, as trials in which neither peripheral array element matched the criterion provided no information on lateralized processing. Groups (five levels) and sex (two
levels) were the between-subjects variables, and stimulus mode (two levels), visual field of matching stimulus presentation (two levels), and load (four levels) were the within-subjects variables comprising the independent variables in each analysis. Newman-Keuls tests were used to further examine significant effects. Because of the number of repeated measures employed in this design, the possibility exists of a violation of the variance-covariance homogeneity assumption, which can inflate the Type I error rate (Myers, 1979). In order to control for this possibility, all effects involving repeated measures which emerged as significant from the initial analysis of variance were re-evaluated using the conservative F test of Greenhouse and Geisser (1959). This test assumes maximum violation of the variance-covariance homogeneity assumption. If an effect remains significant by Greenhouse and Geisser criteria, one may be confident that it is not an artifact of assumption violation. If an effect is significant according to the initial analysis, and nonsignificant according to the Greenhouse and Geisser test, it is possible that actual assumption violation is not maximal, and that a Type II error is being made. In such cases, the effect must be further evaluated using an exact F test. In the present study, the exact F test of Collier, Baker, Mandeville and Hayes (1967) was used. According to Kirk (1983), Collier et al.'s procedure yields the least biased available statistic for this purpose.
The analysis of variance for overall reaction time indicated several significant effects (see Table 2). Significant main effects for groups and load were overshadowed by a three-way interaction involving groups, visual field and load \((F(12,180) = 2.25, p=.01)\) (see Figure 1). The Greenhouse and Geisser test of this interaction was nonsignificant, but the exact \(F\) test was significant \((\epsilon = 0.53, p<.05)\). Further analysis revealed that the psychiatric groups differed from the normal groups at all values of field and load. The paranoids were slower than the psychiatric controls at the second and fourth load levels in the left field, and at the second and third load levels in the right field. The nonparanoids were slower than the psychiatric controls at all values of field and load; and were slower than the paranoids at the first and third load levels in the left field, and the fourth load level in the right field. The three control groups did not differ at any load level across fields. The paranoids were slower at the fourth load level in the left field compared to the right field; and the nonparanoids were slower at the third load level in the left field relative to the right field. The nonparanoids responded significantly more slowly at the third load level relative to the second level in the left field. (See Table 3).

The analysis of overall reaction time also revealed a significant interaction between stimulus mode and visual field \((F(1,60) = 26.92, p<.01)\) (see Figure 2). The Greenhouse and Geisser test for this interaction was
Table 2. Analysis of variance summary table (dependent variable = overall reaction time).

<table>
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<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
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<tr>
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<tr>
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<td>1.252</td>
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Note: *** indicates p < 0.001, ** indicates p < 0.01, * indicates p < 0.05.
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<th>Mean SQ</th>
<th>F</th>
<th>p-value</th>
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* = p < .05
** = p = .01
*** = p < .01
**Figure 1:** Interaction between groups, visual field and load (dependent variable = overall reaction time)
Table 3. Selected values from Newman-Keuls analyses of groups x visual field x load interaction (dependent variable = overall reaction time). NS = nonparanoid schizophrenics; PS = paranoid schizophrenics; PC = psychiatric controls; GC = general controls; L = left visual field; R = right visual field.

<table>
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<td>&lt;.01</td>
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<td>&lt;.01</td>
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<tr>
<td>NS/L/2 - NS/L/3</td>
<td>4.6</td>
<td>4,180</td>
<td>&lt;.01</td>
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</table>
FIGURE 2: INTERACTION BETWEEN STIMULUS MODE AND VISUAL FIELD (DEPENDENT VARIABLE = OVERALL REACTION TIME)
significant ($p < .01$). Words evoked faster responses than pictures in the right field ($q(4, 60) = 7.06, p < .01$); word trials were faster in the right field than the left field ($q(3, 60) = 6.47, p < .01$); picture trials were faster than word trials in the left field ($q(2, 60) = 4.12, p < .01$); and picture trials were faster in the left field than the right field ($q(3, 60) = 4.71, p < .01$). It is noteworthy that the interaction of groups, mode and field did not approach significance ($F(4, 60) = 1.32, p = .27$).

Concerning correct response reaction time, significant main effects for groups and load, an interaction of groups and load, and one involving field and load, were subsumed under an interaction of groups, visual field and load ($F(12, 180) = 1.82, p < .05$) (see Table 4). This interaction was found to be nonsignificant according to the Greenhouse and Geisser test and the exact F test ($t = 0.53, p < .1$). The interactions of groups and load, and of field and load, were also nonsignificant according to these tests. The main effect for groups ($F(4, 60) = 7.69, p < .01$) was attributable to the students being faster than the psychiatric groups (for students and psychiatric controls, $q(3, 60) = 4.42, p < .01$; for students and paranoids, $q(4, 60) = 4.42, p < .01$; for students and nonparanoids, $q(5, 60) = 5.67, p < .01$), and the general controls being faster than the schizophrenics (for controls and paranoids, $q(3, 60) = 3.92, p < .05$; for controls and nonparanoids, $q(4, 60) = 5.17, p < .01$). The main effect for load ($F(3, 180) = 114.54, p < .01$) was
Table 4. Analysis of variance summary table (dependent variable = correct response reaction time).

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<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
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</tr>
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<td>0.257</td>
<td>1.109</td>
</tr>
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<td>0.312</td>
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<td>0.192</td>
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<td>S x L</td>
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<td>Interaction</td>
<td>df</td>
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<td>F Ratio</td>
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<tr>
<td>G x M x L</td>
<td>12</td>
<td>0.037</td>
<td>0.188</td>
</tr>
<tr>
<td>S x M x L</td>
<td>3</td>
<td>0.153</td>
<td>0.772</td>
</tr>
<tr>
<td>G x S x M x L</td>
<td>12</td>
<td>0.182</td>
<td>0.919</td>
</tr>
<tr>
<td>S x M x L</td>
<td>180</td>
<td>0.198</td>
<td></td>
</tr>
<tr>
<td>V x L</td>
<td>3</td>
<td>0.184</td>
<td>2.739</td>
</tr>
<tr>
<td>G x V x L</td>
<td>12</td>
<td>0.122</td>
<td>1.816</td>
</tr>
<tr>
<td>S x V x L</td>
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<td>0.074</td>
<td>1.099</td>
</tr>
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<td>12</td>
<td>0.066</td>
<td>0.977</td>
</tr>
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<td>S x V x L</td>
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</tr>
<tr>
<td>M x V x L</td>
<td>3</td>
<td>0.193</td>
<td>2.330</td>
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<tr>
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<td>0.102</td>
<td>1.232</td>
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<td>0.033</td>
<td>0.395</td>
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<td>0.032</td>
<td>0.386</td>
</tr>
<tr>
<td>S x M x V x L</td>
<td>180</td>
<td>0.083</td>
<td></td>
</tr>
</tbody>
</table>

* = p < .05  
** = p = .01  
*** = p < .01
significant according to Greenhouse and Geisser's test
(p<.01). This effect arose from each load level producing
significantly slower responding than the preceding level
(for one and two, q(2,180) = 3.00, p<.05; for two and three,
q(2,180) = 4.50, p<.01; for three and four, q(2,180) =
21.00, p<.01).

The analysis of correct response reaction time also
found an interaction between stimulus mode and visual field
(F(1,60) = 10.41, p<.01), which was significant according
to Greenhouse and Geisser's procedure (p<.01) (see Figure
3). The effect was attributable to response during word
trials in the right field being faster than picture trials
in the right field (q(3,60) = 3.50, p<.05) or word trials
in the left field (q(4,60) = 4.00, p<.05).

The error rate analysis of variance found a main effect
for groups (F(1,60) = 11.01, p<.01) (see Table 5). This
effect comprises greater accuracy of the normal groups
relative to the psychiatric groups (for students and
psychiatric controls, q(3,60) = 3.33, p<.01; for students
and paranoids, q(4,60) = 4.67, p=.01; for students and
nonparanoids, q(5,60) = 6.67, p<.01; for general controls
and psychiatric controls, q(2,60) = 3.00, p<.05; for general
controls and paranoids, q(3,60) = 4.33, p=.01; for general
controls and nonparanoids, q(4,60) = 6.33, p<.01), and
greater accuracy of the psychiatric controls relative to the
nonparanoids (q(3,60) = 3.33, p=.05).

Error rate analysis also revealed main effects for
stimulus mode, visual field and load, and an interaction
Figure 3: Interaction between stimulus mode and visual field  
(Dependent variable = Correct response reaction time)
Table 5. Analysis of variance summary table (dependent variable = error rate).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups (G)</td>
<td>4</td>
<td>1.629</td>
<td>11.015***</td>
</tr>
<tr>
<td>Sex (Sx)</td>
<td>1</td>
<td>0.175</td>
<td>1.182</td>
</tr>
<tr>
<td>G x Sx</td>
<td>4</td>
<td>0.164</td>
<td>1.108</td>
</tr>
<tr>
<td>Subjects (S)</td>
<td>60</td>
<td>0.148</td>
<td></td>
</tr>
<tr>
<td>Stimulus Mode (M)</td>
<td>1</td>
<td>0.425</td>
<td>6.289*</td>
</tr>
<tr>
<td>G x M</td>
<td>4</td>
<td>0.027</td>
<td>0.399</td>
</tr>
<tr>
<td>Sx x M</td>
<td>1</td>
<td>0.013</td>
<td>0.196</td>
</tr>
<tr>
<td>G x Sx x M</td>
<td>4</td>
<td>0.070</td>
<td>1.041</td>
</tr>
<tr>
<td>S x M</td>
<td>60</td>
<td>0.068</td>
<td></td>
</tr>
<tr>
<td>Visual Field (V)</td>
<td>1</td>
<td>0.202</td>
<td>2.963</td>
</tr>
<tr>
<td>G x V</td>
<td>4</td>
<td>0.028</td>
<td>0.416</td>
</tr>
<tr>
<td>Sx x V</td>
<td>1</td>
<td>0.001</td>
<td>0.020</td>
</tr>
<tr>
<td>G x Sx x V</td>
<td>4</td>
<td>0.096</td>
<td>1.409</td>
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<tr>
<td>S x V</td>
<td>60</td>
<td>0.068</td>
<td></td>
</tr>
<tr>
<td>Load (L)</td>
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<td>52.531***</td>
</tr>
<tr>
<td>G x L</td>
<td>12</td>
<td>0.022</td>
<td>0.998</td>
</tr>
<tr>
<td>Sx x L</td>
<td>3</td>
<td>0.022</td>
<td>1.007</td>
</tr>
<tr>
<td>G x Sx x L</td>
<td>12</td>
<td>0.030</td>
<td>1.349</td>
</tr>
<tr>
<td>S x L</td>
<td>180</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>M x V</td>
<td>1</td>
<td>0.557</td>
<td>18.704***</td>
</tr>
<tr>
<td>G x M x V</td>
<td>4</td>
<td>0.023</td>
<td>0.779</td>
</tr>
<tr>
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<td>0.014</td>
<td>0.463</td>
</tr>
<tr>
<td>G x Sx x M x V</td>
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<td>0.048</td>
<td>1.605</td>
</tr>
<tr>
<td>S x M x V</td>
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<td>0.030</td>
<td></td>
</tr>
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<td>M x L</td>
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<td>0.408</td>
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<td>F</td>
<td>p-value</td>
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<td>----</td>
<td>-----</td>
<td>---------</td>
</tr>
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<td>0.027</td>
<td>1.180</td>
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<tr>
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<td>0.333</td>
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<td>0.007</td>
<td>0.329</td>
</tr>
<tr>
<td>S x M x L</td>
<td>180</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>V x L</td>
<td>-3</td>
<td>0.041</td>
<td>2.542</td>
</tr>
<tr>
<td>G x V x L</td>
<td>12</td>
<td>0.022</td>
<td>1.348</td>
</tr>
<tr>
<td>S x V x L</td>
<td>3</td>
<td>0.017</td>
<td>1.026</td>
</tr>
<tr>
<td>G x S x V x L</td>
<td>12</td>
<td>0.028</td>
<td>1.703</td>
</tr>
<tr>
<td>S x V x L</td>
<td>180</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>M x V x L</td>
<td>3</td>
<td>0.055</td>
<td>3.043</td>
</tr>
<tr>
<td>G x M x V x L</td>
<td>12</td>
<td>0.016</td>
<td>0.897</td>
</tr>
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<td>S x M x V x L</td>
<td>3</td>
<td>0.015</td>
<td>0.821</td>
</tr>
<tr>
<td>G x S x M x V x L</td>
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<td>0.007</td>
<td>0.402</td>
</tr>
<tr>
<td>S x M x V x L</td>
<td>180</td>
<td>0.018</td>
<td></td>
</tr>
</tbody>
</table>

* = p<.05
** = p=.01
*** = p<.01
between mode and field. These effects were subsumed under a three-way interaction involving mode, field and load \((F(3,180) = 3.04, p < .05)\). However, both the Greenhouse and Geisser test and the exact F test determined that this interaction was nonsignificant.

The significance of the error rate main effect for load \((F(3,180) = 5.25, p < .01)\) was upheld by the Greenhouse and Geisser test \((p < .01)\). Subsequent analyses revealed that error rate at each incrementing load level was significantly greater than the preceding level, with the exception of levels one and two, in which case level two responding was nonsignificantly less accurate than that of level one (for levels two and three, \(q(2,180) = 5.0, p < .01\); for levels three and four, \(q(2,180) = 7.0, p < .01\)).

The error rate interaction between mode and field \((F(1,60) = 18.7, p < .01)\) was significant according to Greenhouse and Geisser's test \((p < .01)\) (see Figure 4). This significance arose from error rate for words in the right field being significantly lower than that for the other combinations of mode and field (for word trials in the right field and word trials in the left field, \(q(3,60) = 7.1, p < .01\); for words and pictures in the right field, \(q(4,60) = 8.3, p < .01\); for words in the right field and pictures in the left field, \(q(2,60) = 6.6, p < .01\)).

**Signal detection analyses**

False alarm and hit rates were calculated for each subject's responding at each load level for each stimulus...
FIGURE 4: INTERACTION BETWEEN STIMULUS MODE AND VISUAL FIELD
(DEPENDENT VARIABLE = ERROR RATE)
mode and visual field, and values of $d'$ (representing sensitivity) and $B$ (representing response bias) were derived from P.R. Freeman's (1973) table. These measures were used as dependent variables in univariate analyses of variance, employing the same configuration of independent variables as that in the analyses of reaction time and error rate. Also, similar statistical cautions were taken concerning possible violations of the variance-covariance homogeneity assumption.

Concerning sensitivity, a main effect for groups was found ($F(4,60) = 8.79$, $p<.01$) (see Table 6). This effect was overshadowed by an interaction involving groups, sex, field and load ($F(12,180) = 2.07$, $p<.05$), which failed to attain significance according to the Greenhouse and Geisser and exact F tests. The groups effect comprised significantly greater sensitivity of the normal groups relative to the psychiatric groups (for students and psychiatric controls, $q(3,60) = 5.36$, $p<.01$; for students and paranoids, $q(5,60) = 7.14$, $p<.01$; for students and nonparanoids, $q(4,60) = 6.43$, $p<.01$; for general controls and psychiatric controls, $q(2,60) = 2.86$, $p<.05$; for general controls and paranoids, $q(4,60) = 4.64$, $p<.01$; for general controls and nonparanoids, $q(3,60) = 3.93$, $p<.05$).

Main effects for stimulus mode, visual field, and load, and interactions between mode and field, and mode and load, were subsumed under an interaction of mode, field and load ($F(3,180) = 8.22$, $p<.01$), which was also significant.
Table 6. Analysis of variance summary table (dependent variable = sensitivity).

<table>
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<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>( \eta^2 )</th>
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<td>8.788 ***</td>
</tr>
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<td>17.915</td>
<td>1.032</td>
</tr>
<tr>
<td>G x Sx</td>
<td>4</td>
<td>6.164</td>
<td>0.355</td>
</tr>
<tr>
<td>Subjects (S)</td>
<td>60</td>
<td>17.360</td>
<td></td>
</tr>
<tr>
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<td>189.249</td>
<td>32.961 ***</td>
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<td>4</td>
<td>2.991</td>
<td>0.521</td>
</tr>
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<td>Sx x M</td>
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<td>0.865</td>
<td>0.151</td>
</tr>
<tr>
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<td>2.176</td>
<td>0.379</td>
</tr>
<tr>
<td>S x M</td>
<td>60</td>
<td>5.742</td>
<td></td>
</tr>
<tr>
<td>Visual Field (V)</td>
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<td>9.846</td>
<td>4.489 *</td>
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<td>0.262</td>
</tr>
<tr>
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<td>0.224</td>
</tr>
<tr>
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<td>4</td>
<td>3.096</td>
<td>1.411</td>
</tr>
<tr>
<td>S x V</td>
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<td>2.194</td>
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</tr>
<tr>
<td>Load (L)</td>
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<td>87.090 ***</td>
</tr>
<tr>
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<td>4.095</td>
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<td>0.153</td>
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<td>G x Sx x L</td>
<td>12</td>
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<td>0.569</td>
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<td>S x L</td>
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<tr>
<td>M x V</td>
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<td>22.763</td>
<td>18.435 ***</td>
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<td>0.991</td>
</tr>
<tr>
<td>S x M x V</td>
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<td>1.235</td>
<td></td>
</tr>
<tr>
<td>M x L</td>
<td>3</td>
<td>13.896</td>
<td>4.916 ***</td>
</tr>
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<td>Interaction</td>
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<td>Mean 2</td>
</tr>
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<td>-----</td>
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<td>--------</td>
</tr>
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</tr>
<tr>
<td>V x L</td>
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<td>2.180</td>
<td>2.424</td>
</tr>
<tr>
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<td>1.216</td>
</tr>
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<td>1.311</td>
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</tr>
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<td>7.352</td>
<td>8.219</td>
</tr>
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<td>G x M x V x L</td>
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<td>0.999</td>
<td>1.116</td>
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<td>0.051</td>
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<td>0.487</td>
</tr>
<tr>
<td>S x M x V x L</td>
<td>180</td>
<td>0.894</td>
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</tbody>
</table>

* = p < .05
** = p = .01
*** = p < .01
according to Greenhouse and Geisser criteria (p<.01) (see Figure 5). Word trials displayed greater sensitivity than picture trials in both fields, except for a nonsignificant difference at the first load level in the left field. Word trials displayed greater sensitivity in the right field compared to the left field, except for a nonsignificant difference at the fourth load level. A large peak of sensitivity at the second level in the right field for words is a noteworthy feature. For pictures, the left field at load level two shows greater sensitivity than the corresponding level in the right field. (See Table 7).

In the response bias analysis, a main effect for groups was detected, which was subsumed under interaction effects (see Table 8). One of these was an interaction between groups and sex (F(4,60) = 3.13, p<.05) (see Figure 6). This effect arose from the nonparanoid females responding more conservatively than the other subjects (e.g., for nonparanoid females and psychiatric control males, the next most conservative group, q(2,60) = 2.98, p<.05).

A main effect for load, and interactions between groups and stimulus mode, and mode and load, were overshadowed by an interaction between groups, mode and load (F(12,180) = 2.22, p=.01) (see Figure 7). Greenhouse and Geisser's test indicated that the interaction was not significant, but the significance was upheld by the exact F test (ξ = 0.83, p<.05). All groups were not significantly different at all load levels for picture trials. For word trials, groups did not differ for the lower two load
FIGURE 5: INTERACTION BETWEEN STIMULUS MODE, VISUAL FIELD AND LOAD (DEPENDENT VARIABLE = SENSITIVITY)
Table 7. Selected values from Newman-Keuls analyses of stimulus mode x visual field x load interaction (dependent variable = d'). W = word trials; P = picture trials; L = left visual field; R = right visual field.

<table>
<thead>
<tr>
<th>Comparison (mode/field/load)</th>
<th>q</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
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<td>4.3</td>
<td>6,180</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>W/R/2 - P/R/2</td>
<td>17.5</td>
<td>10,180</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>W/R/3 - P/R/3</td>
<td>13.5</td>
<td>9,180</td>
<td>&lt;.01</td>
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<td>4,180</td>
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<tr>
<td>W/L/2 - P/L/2</td>
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<td>4,180</td>
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<tr>
<td>W/L/3 - P/L/3</td>
<td>9.2</td>
<td>7,180</td>
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<td>P/R/2 - P/L/2</td>
<td>4.5</td>
<td>5,180</td>
<td>&lt;.05</td>
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Table 8. Analysis of variance summary table (dependent variable = response bias).

<table>
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<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
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* = p<.05  
** = p=.01  
*** = p<.01
FIGURE 6: INTERACTION BETWEEN GROUPS AND SEX (DEPENDENT VARIABLE = RESPONSE BIAS)
FIGURE 7: INTERACTION BETWEEN GROUPS, STIMULUS MODE AND LOAD (DEPENDENT VARIABLE = RESPONSE BIAS)
levels; for the third load level, nonparanoids were more conservative than other groups (e.g., for nonparanoids and psychiatric controls, the next most conservative group, \(q(3, 180) = 3.83, p < .05\); for the fourth level, the nonparanoids were more conservative than the general controls \(q(37, 180) = 5.12, p < .05\) and paranoids \(q(36, 180) = 5.12, p < .05\). Groups did not differ across modes, with the exception of the nonparanoids, who were more conservative at load level three with words than with pictures \(q(30, 180) = 7.82, p < .01\).

The analysis of response bias also uncovered an interaction between sex and stimulus mode \(F(1, 60) = 6.02, p < .05\), which was significant according to Greenhouse and Geisser's test \(p < .05\) (see Figure 8). This effect was attributable to males' responding more liberally to pictures than to words \(q(4, 60) = 3.78, p < .05\), and to males' responses to pictures being more liberal than that of females \(q(3, 60) = 3.74, p < .05\).

A main effect for load, and interactions between mode and visual field, were subsumed under an interaction of mode, field and load \(F(3, 180) = 7.87, p < .01\), which was confirmed as significant by Greenhouse and Geisser's test \(p < .01\) (see Figure 9). In the left field, word trials were more conservative than picture trials at the second \(q(12, 180) = 7.38, p < .01\) and third \(q(7, 180) = 6.69, p < .01\) load levels. There were no differences within loads, across groups in the right field. Picture trials
FIGURE 8: INTERACTION BETWEEN SEX AND STIMULUS MODE (DEPENDENT VARIABLE = RESPONSE BIAS)
Figure 9: Interaction Between Stimulus Mode, Visual Field, and Load (Dependent Variable = Response Bias)
were equivalent across fields. Word trials at load two in the left field were more conservative than those in the right field ($q(10,180) = 7.29, p<.01$).

**Secondary analyses**

Subjects' scores on the Magical Ideation Scale were used as the dependent variable in an analysis of variance, with groups and sex as independent variables. A main effect for groups was found ($F(4,60) = 4.05, p<.01$). Subsequent analyses revealed that the effect was attributable to the psychiatric controls scoring lower than the paranoids ($q(4,60) = 4.01, p<.05$) and nonparanoids ($q(5,60) = 4.36, p<.05$), the normal groups' scores falling between those of the psychiatric controls and paranoids. (Mean scores were as follows: university students, 5.86; general controls, 6.21; psychiatric controls, 4.79; paranoid schizophrenics, 10.57; nonparanoid schizophrenics, 11.07).

The state and trait scale scores of the State-Trait Anxiety Inventory were employed as dependent variables in univariate analyses of variance, with groups and sex as independent variables. While the analysis of trait scores was entirely nonsignificant, the state score analysis revealed a marginally significant groups effect ($F(4,60) = 2.49, p<.05$). The psychiatric groups showed somewhat higher scores than the normal groups (students, 32.6; general controls, 33.8; psychiatric controls, 42.4; paranoids, 41.4; nonparanoids, 41.2).

All psychiatric patients were diagnosed as
schizophrenic or nonschizophrenic according to the Research Diagnostic Criteria and the Symptom-Sign Inventory, and the degree of congruence of these instruments was assessed. It was found that, of the 28 RDC-diagnosed schizophrenics employed in the study, 20 were diagnosed as schizophrenic according to the SSI, and 8 were not. Of the 14 RDC-diagnosed nonschizophrenic psychiatric patients, 12 were diagnosed as nonschizophrenic according to the SSI, and 2 were diagnosed as schizophrenic. A phi-coefficient analysis indicated that the diagnostic congruence was significant ($X^2(1) = 12.22, p<.01$).

A series of Pearson product-moment correlations involving the response bias measure were calculated. The correlation between the mean response bias value for each schizophrenic patient and his/her Premorbid Adjustment Scale score proved not to be significant ($r = -.15$), nor was the correlation between the former variable and duration between the first contact with health professionals concerning schizophrenic symptoms and the date of testing (in months) ($r = .09$). As significantly conservative responding was restricted to nonparanoid females, and to nonparanoid responding on word trials, further correlations were undertaken. A correlation between the mean response bias scores and Premorbid Adjustment Scale scores for schizophrenic females was not significant ($r = .124$); nor was the correlation between the former variable and duration ($r = .109$). A correlation between the mean response bias score for schizophrenics on
word trials and Premorbid Adjustment Scale score was not significant \( r = -.06 \); neither was the correlation between the former variable and duration \( r = -.124 \).
DISCUSSION

Task Characteristics

In order to correctly interpret differences in responding to the battery of tasks, it is important to assess the validity of these tasks, and the ways in which aspects of processing associated with task performance are reflected in the various dependent variables. In the following paragraphs, the effects found in the main analysis concerning which groups did not differ are discussed, so as to map out the general response parameters.

The task battery was intended to measure informational processes for which the cerebral hemispheres are differentially specialized. Hemispheric functional specialization can be understood in two senses. In the first sense, one hemisphere is more efficient (in the sense of speed and/or accuracy)—at processing words than pictures, and the other is more adept at processing pictures than words. In operational terms, specialization in this sense would appear as lowered reaction time or error rate, or heightened sensitivity, for word tasks relative to picture tasks in the right visual field, and the reverse in the left visual field. Another sense of hemispheric specialization involves each hemisphere being superior to the other in performing a specific function. This situation would be observed as word trials being more efficiently performed in the right field than the left, and picture trials showing the opposite pattern. These senses
are distinct, and can occur in the absence of the other - for example, picture trials can be faster than word trials in the left field and words can be faster than picture trials in the right field, and both picture and word trials in the right field can be faster than either kind of trial in the left field. They can also occur in conjunction with each other. The task battery appears to be sensitive to hemispheric specialization in both senses.

Hemispheric specialization in the first sense is supported by several results. For overall reaction time, word trials are significantly faster than picture trials in the right field, and picture trials are significantly faster than word trials in the left field. For correct response reaction time, the same pattern is evident: word trials are significantly faster than picture trials in the right field, and picture trials are faster than word trials in the left field, although the latter difference falls short of significance. For error rate, word trials are nonsignificantly less accurate than picture trials in the left field, and word trials are more accurate than picture trials in the right field. For sensitivity, the pattern does not hold - word trials are more sensitively perceived in both fields. The general configuration of results suggests hemispheric specialization in the first sense, especially concerning the word trials/left hemisphere, with some variables (particularly overall reaction time) being more sensitive to this factor than others.
Concerning hemispheric specialization in the second sense, there is some evidence that it is the case in the present study. In the overall reaction time data, word trials are significantly faster in the right field than the left field, and picture trials are faster in the left field than the right field. The correct response reaction time data exhibit the same pattern, although the difference between picture trials across fields does not reach significance. Regarding error rate, word trials were more accurate in the right field than the left field. Picture trials were more accurate in the left field than the right field, although not to a significant degree. Significantly more sensitivity was demonstrated for word trials in the right field relative to the left field at three of the four load levels; picture trial responding was significantly more sensitive in the left field than the right field at the second load level.

It is evident from the findings reviewed above that the task battery measures informational processes which are lateralized, and sensitive to stimulus mode. The question arises as to whether the lateralization could be an artifact of an oculomotor scanning strategy. In the case of the word tasks, this possibility is eliminated by the short exposure duration for the stimulus array (20 msec), which is considerably below the time required for the initiation of eye movements (see Sergent, 1983). Regarding the picture tasks, exposure duration (200 msec) was closer to the threshold at which eye movements have been observed—
on some tasks. The scanning strategy of greatest concern is a tendency to scan from left to right, which is thought to be the result of experience with the conventional arrangement of printed matter; this strategy should produce an advantage for the right visual field, and yet the general tendency on the picture tasks was a left field superiority. Furthermore, J. Fisk (personal communication, November 1983) directly monitored the eye movements of subjects who were presented with bilateral stimuli exposed for 200 msec, and reported that eye movements in this task were rare. Therefore, it appears that the lateralization effects observed in the present study were not due to motor strategy artifacts. The association of left field superiority with pictorial stimuli and right field superiority with verbal stimuli is consistent with the general literature on laterality, which regards such effects as indications of hemispheric functional specialization.

Another characteristic of the task battery is its responsiveness to changes in concurrent load level. All five dependent variables exhibited effects involving load. The general pattern was one of increasing reaction time and error rate, and decreasing sensitivity, with increasing load, which suggests that the concurrent loads were competing for attentional resources from the same pool as the main tasks, and that incrementing loads tended to increase demand on these resources, as predicted.
(Qualifications of this general pattern are discussed below). Overall reaction time, sensitivity and response bias showed interactions of visual field and load; the latter two dependent variables displayed interactions of mode, field and load, suggesting that the resource pools affected by load were hemispherically specialized.

When considered in detail, these interactions yield further information. (The overall reaction time interaction involving load also involved groups, and so will be considered in a later section). The sensitivity interaction involving mode, field and load shows a tendency toward a decrease in sensitivity with increasing load, but with an increased sensitivity at the second load level, especially for words in the right field. This effect may represent the priming of the left hemisphere. Such an occurrence may or may not be mediated by attentional resources, as sensitivity effects have not conventionally been interpreted in terms of resources. As was noted in the Introduction, priming effects have been observed in other studies (e.g. Hellige et al., 1979).

The most striking feature in the response bias interaction of mode, load and field is the marked increase in conservative responding for word trials at middle load levels in the left field. As word trials are generally more efficiently processed in the right field, this heightened conservatism seems to represent a response strategy adopted under suboptimal conditions - at moderate load levels, when the matching stimulus is presented to the
less efficient hemisphere. Word trial responding in the right field is significantly more liberal, as it is at the first load level in the left field, suggesting that a relatively liberal response strategy is adopted for less difficult conditions. Responding at the fourth load of the left field is also relatively liberal, indicating that liberal responding is characteristic of very difficult conditions also. The liberal responding characteristic of picture trials at all load levels in both fields suggests that all picture trial conditions were regarded as relatively difficult.

Another general task characteristic, which involved neither lateralized factors nor load effects, was the response bias interaction between sex and stimulus mode. The marked liberality of male responding in picture trials may be related to the widely documented male superiority in the processing of visuospatial and quantitative information (e.g. Droege, 1967). As this effect did not differ across groups, it will not be further considered.

A comparison of some of the features manifested by the different dependent variables rounds off the examination of task characteristics. In comparing the overall reaction time and correct response reaction time data, it appears that the overall measure is more sensitive to laterality and load effects. The overall trials comprise those responses in which a match was erroneously reported as not occurring, in addition to the correct positive trial
responses. These erroneous trials could represent the operation or one (or more) of the following factors: speed-accuracy tradeoff, in which accuracy was sacrificed in order to control response time; greater difficulty of the erroneous trials; and a loss of attentional control on these trials, unrelated to task difficulty. A speed-accuracy tradeoff explanation can be ruled out, as overall reaction time tended to be slower than correct response reaction time. The same general patterns exist in the two (overlapping) sets of data. This similarity suggests that the greater number of significant effects in the overall reaction time data is not the result of factors operating only during erroneous trials, but rather to the greater number or overall trials constituting a larger sample of behaviour, which increased the power of the analysis.

The striking increase in conservative responding for word trials at middle load levels in the left field indicates a shift in response strategy. It is noteworthy that this shift is not obviously reflected in either the reaction time or error rate data, aside from a slight decrease in the slope of the error rate graph at that point. It is possible that the shift in strategy was ineffective in influencing the deterioration of performance; conversely, perhaps it was effective in preventing even more deterioration than actually occurred. Some caution is in order concerning these comparisons, as the calculation of the response bias variable required consideration of the trials in which the criterion did not
match an element in the array, unlike the reaction time and error rate variables, and so was based on a different set of data.

The pattern of results in the data for sensitivity and response bias are not closely related. This disparity is expected, as these variables are thought to be independent.

As the general controls did not differ from the students regarding task performance on any dependent variable, it appears that the lateralized functions measured by the task battery characterize a range of people of different backgrounds and lifestyles, and not just university students. This finding permits greater confidence in the utilization of material from the literature of cognition based on experiments involving university students in explaining the results of the present study.

In summary, performance on the task battery was measured using a set of five dependent variables, which provided a rich array of information concerning underlying cognitive processes. All five variables were influenced by a lateralized factor. In general, the characteristics of this factor are consistent with the notion of attentional resource pools associated with the cerebral hemispheres, although this consistency is clearer with some variables than with others. The dependent variables were differentially sensitive to other features of task performance, such as load effects and strategy effects.
GROUP DIFFERENCES: CONSIDERATION OF SOME NON-PATHOLOGICAL EXPLANATIONS

The main analyses uncovered several effects involving group differences. Before considering the implications of these effects for our understanding of schizophrenia, it seems prudent first to examine the extent to which they can be comprehended without recourse to explanations involving pathological processes.

As groups did not differ concerning social status, this variable cannot be responsible for group effects. Psychiatric groups did not differ regarding premorbid adjustment, medication dosage, age, education, IQ, or duration of hospitalization, indicating that these variables cannot account for performance differences between the hospitalized groups.

Regarding age, the university students were found to be younger than the other groups. The general controls did not differ from the psychiatric groups in this respect, and as the general control group tended not to differ from the students in group performance, age appears not to be a serious confound.

The university students were more highly educated than the psychiatric control group, and had higher IQ scores than the nonparanoid schizophrenics. The general controls did not differ from other groups on these variables, and showed the same performance differences compared to the psychiatric controls and nonparanoids as the university
students, indicating that IQ and education differences were not responsible for the anomalous performance of the psychiatric patients.

The psychiatric groups unavoidably differed from the normal groups in that the former groups were receiving pharmacological treatment and were living in a hospital environment. These factors may be involved in the differences between the psychiatric and normal groups. It should be noted, however, that some researchers (e.g. Strauss, 1973) have contended that evidence for the detrimental effects of hospitalization on cognitive processes is lacking. Concerning medication effects, the significant correlation between dosage and sensitivity suggests a relationship between these variables, and it is possible that medication effects may contribute to the significant difference in sensitivity between the normal groups and psychiatric groups. Few studies have found a relationship between medication level and reaction time or error rate in schizophrenics (Neufeld & Broga, 1981), and those which have detected such a relationship have tended to report that the medication appears to ameliorate, rather than increase, schizophrenic cognitive deficits (e.g. Braff & Saccuzzo, 1982). The differences between normals and psychiatric patients concerning these variables found in the present study may therefore have occurred despite, and not because of, the medication factor. Regarding medication and schizophrenic laterality effects, the literature is inconsistent. For instance, D'Elia,
Jacobsson and Von Knorring (1977) reported a marked increase in right hemisphere electroencephalographic amplitude relative to that of the left hemisphere following a course of antipsychotic drug therapy for schizophrenics; O. Johnson and Crockett (1982) found no evidence of correlation between neuroleptic drug dosage and changes in schizophrenics' changes over time on a set of cognitive tasks which purportedly tapped hemispheric functional differences; and Hammond and Gruzelier (1978) found a decrease in the asymmetry of auditory vigilance performance as a function of antipsychotic drug dosage and treatment duration. Regardless of these apparently conflicting findings, however, the fact that the psychiatric control group and schizophrenic groups did not significantly differ with respect to medication dosage or duration in the present study, and only the schizophrenics showed unusual lateralization effects in the overall reaction time data, suggests that these effects were not caused by medication.

Concerning the nonparanoid response bias effects, the schizophrenic subtypes did not differ on any of the measured potentially confounding variables. The schizophrenic subtype differences in response bias thus appear to reflect some feature(s) intrinsic to the nonparanoid schizophrenic process.

**GROUP DIFFERENCES IN REACTION TIME: IMPLICATIONS FOR UNDERSTANDING OF PATHOLOGICAL PROCESSES**

**GENERALIZED DEFICIT:** It was hypothesized that the
schizophrenic patients would display a general impairment in functioning relative to the normal subjects. This hypothesis was supported by the results of the present study. The fact that the performance of the psychiatric controls was not significantly different from that of the schizophrenics under most conditions indicates that much of the schizophrenic generalized deficit may be attributable to factors shared with other psychiatric patients, such as hospitalization or a general psychopathology effect (cf. Hemsley & Zawada, 1976). The nonparanoid schizophrenics displayed the worst general deficiency, followed by the paranoids and the psychiatric controls (although the paranoids only differed significantly from the psychiatric controls under some conditions, their performance was at least slightly slower, less accurate and less sensitive under every condition).

LATERALITY EFFECTS: The load/mode theory advanced in the Introduction made predictions concerning lateralized behaviours in the present study. Specifically, it was hypothesized that paranoid performance on the verbal tasks, representing left hemisphere functioning, might display a priming effect under low or moderate load levels, but would show a marked deterioration under higher load levels relative to the nonparanoids. It was also predicted that such an effect would not occur in picture task performance, representing right hemisphere functioning. The testing of these predictions was contingent on validating the
assumption that the resource composition of the word tasks
draws primarily from the left hemisphere, and that of the
picture tasks draws mainly from the right hemisphere. As
was elaborated earlier in the Discussion, this assumption
is supported by the results. In view of this validation,
and the absence of significant group effects involving
stimulus mode for either reaction time or error rate, it is
evident that the load-mode theory is not supported by the
present findings.

This negative finding may not be without significance
for our understanding of schizophrenia. Maher (1974)
concisely outlined the conditions under which a failure to
reject the null hypothesis may be meaningful:

Generally speaking, reports of "no difference" between
experimental groups or "no significance" in a
correlation are of interest under certain
circumstances. The first of these is when an established
theory unambiguously predicts that a difference or a
correlation should be found. It is essential that the
theoretical deduction be made explicit by the investigator
and not left to "common sense" or "intuition". Thus,
negative results lacking a theoretical context are
basically uninterpretable. Even when the theoretical basis
for the prediction is made clear and is defensible, the
burden of methodological precision falls heavily on the
investigator who reports negative results. This burden is
heavier the greater the corpus of methodologically sound
results reported in the literature supportive of the theory
(p.2).

The absence of significant group effects involving stimulus
mode for either reaction time or error rate in the present
study meets these conditions. A prediction of group
differences, based on explicit deductions from the
load-mode theory, was presented in the Introduction. In
addition, predictions of group differences under the
conditions of the present experiment can be deduced from many current positions concerned with schizophrenic processes, as will be discussed below. The requirement of methodological precision is met in the present study by the measures taken to attenuate the influence of confounding variables and decrease the probability of alternative explanations. Therefore, we are left with the finding that, in terms of hemispheric sensitivity to stimulus characteristics, the schizophrenics perform like slow and inaccurate normals.

There are, however, significant laterality effects involving groups in the overall reaction time data, which merit closer consideration. Superimposed on the pattern of generalized deficits interacting with increasing load, lateralized distortions of this pattern were evident for the schizophrenic subjects. For the paranoids, performance at the fourth load level was significantly slower in the left field than the right field. This difference could be caused by a factor either exacerbating the curve of deteriorating performance in the left field, or ameliorating the deterioration in the right field. It is suggested that the latter case is most likely, for the following reason. As load levels increase and performance deteriorates, one expects the most deficient groups to approach the performance ceiling first. As they do so, they will tend to cluster together. The less impaired groups will tend to continue at discriminable levels of performance until they approach the cluster of groups near
the ceiling. The situation at the fourth load level in the left field is consistent with this description — the schizophrenic groups are converging, whereas the other groups are not. In the fourth level in the right field, paranoid performance appears to be converging with that of the less impaired psychiatric control group, which is not simply explained by an interaction of generalized deficits and loads. The alternative possibility — that paranoid left field performance is being adversely affected — does not account for this puzzling premature convergence in the right field. A possible explanation for this effect is that paranoids are manifesting a small priming effect due to some factor consuming left hemisphere resources, which is not shared by the nonparanoids. (As was noted in the Introduction, hemispheric priming effects in response to an increase in processing demand at moderate load levels have frequently been observed by researchers in hemispheric functioning — e.g., see Hellige et al., 1979). This suggestion implies that at higher load levels the paranoids would again diverge from the performance levels of the psychiatric controls, and deteriorate to the level of the nonparanoids. Unfortunately, these higher levels were not sampled in the present study.

The nonparanoids performed significantly slower at the third load level in the left field relative to that of the right field. Again, there are two possible explanations — exacerbation in the left field, or amelioration in the
right field. The data suggest the former possibility. In comparing the slopes of the graphs between the second and third load levels, it is noteworthy that in the right field the nonparanoids’ slope is similar to those for the other groups. In the left field, the nonparanoids’ slope is much steeper than those of the other groups, representing the only significant increase in reaction time between second and third load levels of any group in either field. This finding suggests that the locus of the effect is the left field. The nonparanoid performance picture suggests a premature depletion of task-relevant resources in the right hemisphere, possibly attributable to an extra load on that hemisphere, superimposed on a rather severe generalized deficit. If this was the case, one might expect to find evidence for a nonparanoid priming effect at lower levels in the left field. The slight decrease of nonparanoid reaction time between the first and second load levels in the left field may represent this effect.

The present study has uncovered evidence suggestive of two lateralized factors, as reflected in the overall reaction time data. One of these factors is sensitive to changes in load level and mode of stimulus presentation, and appears to be the factor associated with hemispheric functional specialization as described in the general literature. It seems to function in a qualitatively similar manner in normals, general psychiatric patients, and schizophrenics. The other factor is also sensitive to load level, but is insensitive to changes in stimulus-
characteristics as represented in the present study. This second lateralized effect is evident only in the performance of the schizophrenics, and suggests anomalous functioning in the left hemisphere in paranoids and the right hemisphere in nonparanoids. The lateralized factors are independent, as they are reflected in orthogonal effects in the analysis of variance of overall reaction time. A similar pattern of results was found for correct response reaction time, but the interaction failed to achieve significance on the exact F test, probably because of the smaller amount of sampling per subject. Some of the possible relationships of this finding of two lateralized effects to the research areas of schizophrenic sensitivity to stimulus characteristics, attentional functioning and hemispheric functional asymmetry are discussed in the following paragraphs.

Concerning the stimulus characteristics area, the curious feature of the present study is the absence of reaction time/error rate effects involving groups and stimulus mode. As was documented in the Introduction, such effects have been found in many other studies. The present failure to reject the null hypothesis therefore does not support positions which predict that schizophrenic subtypes may manifest relatively enduring anomalies associated with specific stimulus characteristics (e.g. George & Neufeld, 1984). It may be a significant coincidence that the second lateralized factor, while not displaying a sensitivity to
stimulus mode, was associated with a paranoid left hemisphere anomaly and a nonparanoid right hemisphere anomaly. The left hemisphere is often associated with verbal processing, whereas the right hemisphere is usually more involved with pictorial processing; and the majority of previous studies have found verbal processing deficits in paranoids, and nonverbal processing deficits in nonparanoids. Viewed together, these facts suggest the speculation that the second lateralized factor might affect processes sensitive to stimulus mode, but only under certain conditions which were not met in the present study. This effect could be mediated by one of several factors. For instance, the second lateralized factor may indeed be sensitive to features of the stimulus, but the stimulus modes employed in the present study may not have differed with respect to these features. It was stated in the Introduction that the verbal - pictorial dichotomy does not represent the fundamental difference in hemispheric functioning - rather, it is a methodological feature which allows researchers to probe more intrinsic differences in hemispheric sensitivity. It has been shown that varying the parameters of word and picture stimuli can produce the elimination or reversal of the usual lateralized responses (e.g. Sergent, 1982). If the two lateralized factors are sensitive to different stimulus parameters, it is possible that the use of a different kind of verbal and pictorial stimulus might cause the second lateralized factor to produce the patterns of schizophrenic subtype responding
found in other studies. Another possibility is that the second lateralized factor is relatively insensitive to such stimulus characteristics, but that under certain conditions it might interfere with the functioning of the first lateralized factor. In paranoids, this interference might tend to affect left hemisphere functioning, and verbal processing; and the reverse may be true for nonparanoids.

Regarding the area of schizophrenic attentional processes, several features of the second lateralized factor suggest that it is linked with attentional resources. First, attentional functions are known to be lateralized (e.g. Friedman et al., 1982). Second, attention comprises multiple entities, which can be synchronized or desynchronized (Parasuraman & Davies, 1984), as may be the case with the lateralized factors under present consideration. Third, certain characteristics of attentional functioning are detectable in schizophrenics and not in normals (e.g. Cegalis & Sweeney, 1981), as is the case with the second lateralized factor in the present study. Fourth, some of the changes in schizophrenic reaction time performance across fields and loads can be interpreted in terms of priming and depletion effects associated with attentional resources, as was described above.

The present results tend to confirm the suspicion, formulated in the Introduction, that some of the inconsistencies and disagreements in the literature on
schizophrenic hemispheric functional asymmetry may arise from simplistic assumptions and neglect of relevant variables. For instance, the majority of researchers in the area write of schizophrenic cerebral functioning as if the lateralized anomalies are relatively stable, and do not address the question of the conditions under which these anomalies may or may not express themselves in behaviour. The results of the present study indicate that in terms of hemispheric sensitivity to stimulus features, schizophrenics are not functioning in a qualitatively different fashion from normals, suggesting either that the anomalies found by other researchers in this regard are only transiently present, or that their expression is dependent on relatively fine-grained details of the experimental situation. Either of these possibilities implies a greater degree of fluctuation in functioning than is usually taken into account by contributors in this area. Also, the finding of a second lateralized factor in schizophrenics suggests a more complex picture of schizophrenic asymmetrical functioning than is normally considered. For instance, the notion of a globally overactivated left hemisphere (e.g. Gur, 1979) cannot easily explain the paranoids' qualitative normality on the word task and apparent anomaly in right visual field processing. A third point is that the sensitivity to load levels of lateralized behaviour in general, and the schizophrenic lateralized factor in particular, indicates that load may indeed be a significant uncontrolled variable
in schizophrenic asymmetry research. If schizophrenic lateralized abnormalities, including subtype-specific effects, appear and disappear depending on the load associated with the task, then the confusion seen in the literature, which is composed almost entirely of single-load task studies, is understandable.

Nine characteristics of the second lateralized factor have been mentioned. This factor manifests in the overall reaction time data; it is found in the performance of the schizophrenics, and not in that of the other groups; it differs across schizophrenic subtypes; it appears as a pattern superimposed on indications of generalized deficit; it is lateralized; it is independent of the first lateralized factor; it displays different stimulus sensitivity parameters than the first factor; it appears to be associated with attentional resources; and it is conceivable that it differentially affects the processing of verbal and pictorial stimuli under certain conditions. To summarize, the second lateralized effect may represent an element of visual information processing which is normally integrated into the hemispheric system, but which in schizophrenics has become functionally dissociated, constituting a distinct resource consumer. Alternatively, the factor responsible for the effect may not be a dissociated structure, but an entity (structure or strategy) which was never associated with the larger system in the first place, being either absent or functionally
different in nonschizophrenics. This factor makes demands on resources, and affects reaction time, independent of the general hemispheric system. The effect is focussed in the right hemisphere in nonparanoids, and in the left hemisphere in paranoids.

The results of the main analysis raise three major questions. First, given the relative intactness of hemispheric processing structures in schizophrenics under the conditions of the present study, whence arise the pronounced schizophrenic lateralized anomalies and stimulus mode effects reported in other studies? Second, what is the nature of the second lateralized effect associated with schizophrenia? Third, what is the nature of the relationship between the two lateralized effects, if any exists?

In order to begin addressing these questions it is necessary to be somewhat speculative, so as to generate new, testable hypotheses. Initially, one can examine the various levels of functioning in the human cognitive system - sequential structures, attentional resource structures, strategies, and informational content - and ask which level (or combination of levels) is most likely to circumscribe the nexus of anomaly responsible for schizophrenic lateralized effects.

It is suggested that a fruitful level at which to begin this quest is that of processing strategies. The term "processing strategy" as employed here conforms to the perspicuous definition given by Logan, Zbrodoff and Postey
(1983):

In general terms, a strategy may be defined as an optional organization of cognitive processes that is intended to achieve some goal in some task environment. The strategy chosen for a particular task is probably a compromise between the constraints imposed by the structure of the information in the task environment, by the structure or the subject's cognitive abilities, and by the structure of the goals to be achieved by performing the task. Probably, several strategies can satisfy the constraints for any given task, but only one can be used each trial (p.485).

Strategies are applied at any point in the sequence of information processing at which options occur. The selection of strategies is not necessarily volitional (Underwood, 1978). Essentially, strategies are patterns of attentional deployment.

Several features of the strategy construct suggest that it may be useful in explaining schizophrenic lateralized effects. First, strategies by their nature tend to be more variable than the properties of other elements of the information processing system, such as structures. In the present study, the variability of strategies was demonstrated in the response bias results. Schizophrenic lateralized effects appear to be quite variable. Second, choice of strategy is often sensitively affected by changes in load and stimulus characteristics. This feature is implied in the definition quoted above, in which the choice of strategy is determined by a compromise involving properties of the task environment. This sensitivity is also displayed by schizophrenic lateralized factors. Third, research with normal subjects has
demonstrated that central processing strategies (as distinguished from eye scanning strategies) can produce lateralized behaviour (e.g. Bryden, 1978; S. Schwartz & Kirsner, 1982).

A fourth aspect of the strategy construct which suggests that it may be applicable to the present results is that it has been used to account for a wide variety of other characteristics of the schizophrenic process. Many psychodynamically oriented psychologists regard schizophrenic symptomatology as arising in large part not from defects in cognitive structure, but from strategies implemented to achieve some goal, such as the restitution of object relations (e.g. Frosch, 1983). In the experimental cognition literature, several studies have indicated that schizophrenic memory deficits result from nonoptimal strategies rather than intrinsically defective memory structures (e.g., for short term memory, Marusarz & Koh, 1980; Neufeld, 1978; Oltemans, 1978; for long term memory, Hamlin & Folsom, 1977; Koh, Kayton & Peterson, 1976; Neufeld, 1976b). Specific processing strategy differences between paranoid and nonparanoid schizophrenics have been implicated in performance differences between the subtypes (e.g. Cromwell, 1968; McCormick & Broekema, 1978; Shean, 1982). The sporadic reports in the literature indicating a schizophrenic performance superiority relative to normal subjects (e.g. Brennan & Hemsley, 1984; LaRusso, 1978; Sarbin, Juhasz & Todd, 1971; Snyder, Rosenthal & I.A. Taylor, 1961) are also more suggestive of unusual strategy
effects than defective cognitive structures. (An observation by Wood (1978) may be relevant in this regard. He noted that subjects with less structural efficiency regarding a particular task may be motivated to develop more efficient strategies to compensate for the relative structural inefficiency, resulting at times in better task performance than that of subjects with greater structural efficiency).

One possible (and quite speculative) explanation of how schizophrenic strategies could produce the second lateralized effect and a transient subtype-specific interference of word- and picture-processing runs as follows. Several theorists of schizophrenia (e.g. Cameron, 1943; Silverman, 1964) have stated that a common strategy of paranoid schizophrenics is hypervigilance. This preference is usually described as resulting from a childhood need to anticipate aversive events, and produces an increased probability of perceiving threatening aspects of the environment. These perceptions may form the experiential basis for delusions of persecution and self-reference. It seems reasonable to speculate that hypervigilance may be reflected in an effort to engage in extra monitoring of fine-grained details of stimuli in a search for subtle threatening cues. The processing of high frequency spatial information is undertaken by the left hemisphere (e.g. Sergent, 1982). It is possible that the hypervigilant response strategy consumes the left
hemisphere resources which are thought to be responsible for the second lateralized effect in paranoiacs. It seems unlikely that paranoiacs constantly engage in hypervigilance to the same degree; like other strategies, its deployment depends on an array of continually changing factors. Perhaps, under conditions of extensive scanning for threat, the left hemisphere resource pool may become depleted to the extent that fine-grained attention to task-relevant stimulus characteristics may become impaired. This impairment would usually be more evident in word tasks than picture tasks.

Regarding nonparanoiacs, the production of hallucinations may be tale-telling in this context. While the presence of hallucinations is not an exclusion criterion for a diagnosis of paranoid schizophrenia, it is more predominant in the clinical picture of the nonparanoiacs according to both the RDC and Maine Scale criteria. It has been suggested that hallucinations result from an increase in the task-irrelevant retrieval of material from long term memory, and its conscious representation as mental imagery (George & Neufeld, in press). Some studies have found that vivid mental imagery is reported by schizophrenics who tend to hallucinate (e.g. Mintz & Alpert, 1972; Slade, 1976); and schizophrenics have been shown to display deficits in the ability to control their imagery (J. Chapman, 1967; Yu & J.J. Johnson, 1979). As processes involving mental imagery are associated with right hemisphere functioning (e.g. Day, 1977; Ley &
R.J. Freeman, 1984), and long term memory retrieval is a consumer of attentional resources (Kinchla, 1980), processes associated with hallucinations may be involved in the extra right hemisphere load for nonparanoids suggested by the present results. The occurrence of hallucinations is not constant in most schizophrenics who experience them. Perhaps, nonparanoids may show a specific impairment in the processing of coarse-grained stimuli such as pictures when the hallucination-generating processes are especially active, if these processes consume the right hemisphere resources required for adequate picture task performance. It may be argued that this effect is not a strategy effect, as the production of hallucinations is not a strategy. However, strategic processes may be involved in hallucinations to the extent that this symptom comprises optional (not necessarily consciously volitional) patterns of attentional deployment, and is goal-directed (the latter point is a time-honoured speculation in the psychodynamic literature—see, e.g., Freud, 1917/1957).

The notion that schizophrenic lateralized effects may result from anomalous strategies is testable to the extent that the relevant strategies can be identified, measured and manipulated, and correlated with the lateralized effects. It does not account for why schizophrenics would employ anomalous strategies, but the broader context of schizophrenic cognition research might provide such an explanation. The occurrence of anomalous strategies does
not preclude the existence of structural alterations as well — indeed, the strategies may arise partially in response to such alterations. The schizophrenic laterality effects found in the present study occurred against a background of generally deficient responding — perhaps the former effects derive from strategies, and the latter from more enduring defects. It may be noteworthy that Broga and Neufeld (1981), using multidimensional analyses of schizophrenics' and normals' responses on a battery of cognitive tasks, discovered two performance dimensions: one which maximally separated paranoids and normals (with nonparanoids falling in between), representing a general, enduring processing inefficiency; and one which maximally separated paranoids and nonparanoids (with normals falling in between), and representing the effect of response strategies.

It bears reiterating that the preceding explanations of schizophrenic lateralized effects are speculations, and serve to exemplify one possible approach to the problem. Several other perspectives could prove to be equally or more fruitful than that involving strategies. For instance, the schizophrenic lateralized behaviours found in other studies may have no direct relationship with the second lateralized effect observed in the present experiment. The robustness of the second lateralized effect is undetermined, and it may prove not to be a significant phenomenon for schizophrenics in general. Alternatively, it is possible that the second lateralized
factor is a dissociated or schizophrenia-specific structure, sensitive to different stimulus parameters than the first factor, and that if two sets of stimuli were presented which differed along the appropriate dimensions, the reaction time anomalies of the second lateralized effect would interact with stimulus mode. A third alternative suggests that the second lateralized factor is a cognitive structure which directly interferes with the functioning of the first factor, but only under certain circumstances. For example, if the two factors were regarded as lateralized cortical control centres in the sense of Kinsbourne and Hicks' (1978) functional cerebral space model, interference between factors would be expected under conditions of high activation of at least one of the centres. Greater resolution of these possibilities awaits further research.

Recently, Magaro (1980, 1981) proposed a theory of schizophrenia based on a postulated disruption of the integrated functioning of the cerebral hemispheres. It is important to outline some differences between Magaro's "integration theory" and the findings and speculations advanced in the present Discussion, as the concern with hemispheric functioning and schizophrenic subtypes is common to both, and so may conceal important divergences between the two approaches. First, Magaro regards the troublesome dissociation in schizophrenia as being between the hemispheres. The present results are more suggestive
of a dissociation of subsystems within hemispheres (the two possibilities are not mutually exclusive). Second, Magaro contends that the interhemispheric dissociation causes schizophrenics to rely on processing strategies associated with one hemisphere to the relative exclusion of those of the other hemisphere. While the concept of processing strategy might help to explain the present findings, Magaro's use of it cannot easily account for the occurrence of two intrahemispheric resource-consuming functions in schizophrenics. Third, Magaro holds that paranoids are most impaired in right hemisphere functioning, and nonparanoids tend to be more deficient in left hemisphere functioning. The present results indicate a paranoid left hemisphere anomaly and nonparanoid right hemisphere anomaly.

**GROUP DIFFERENCES IN RESPONSE BIAS**

The response bias analysis yielded two effects involving groups: an interaction of groups and sex; and one involving groups, stimulus mode and visual field. A general point of note is that the main effect for groups reveals a significant conservatism for nonparanoids, a finding consistent with those of several other studies (e.g. McDowell et al., 1975; Broga & Neufeld, 1981). The current findings indicate that this effect pertains specifically to females, and to the processing of verbal stimuli under certain load conditions. (Note that these two effects are orthogonal). A previous study by Broga and
Neufeld (1981) found that schizophrenic response bias effects on a Sternberg reaction time task tended to occur at lower memory set sizes, which was attributed to a combined effect of lower appraised proficiency among the schizophrenics and greater appraised task simplicity. The present findings complement and extend the previous ones by further demonstrating the dependence of the effect on subject and task parameters. As response bias is generally regarded as a strategy-mediated variable, this dependence is not surprising, given the "compromising" nature of strategy selection as mentioned in the passage by Logan et al. (1983) quoted in the previous section.

Regarding the finding that female nonparanoids engage in a conservative response strategy, one must consider whether there are any distinctive characteristics either of female or of nonparanoid schizophrenic cognition which might explain it. The literature on normal female cognition suggests neither a general tendency toward conservative and conforming behaviour (Sistrunk & McDavid, 1971) nor a prevalence of conservative response biases on signal detection tasks (Bryden, 1979; Gordon & Clark, 1974a, b). Regarding the interaction of gender and the schizophrenic process, it is unclear how any of the characteristic features of female schizophrenics could be directly related to the present finding (see Lewine, 1981; Loranger, 1984; for a recent criticism of claims of gender differences among schizophrenics, see Leventhal, Schuck & Rothstein, 1984). It appears that more research is
necessary before the compromise determining the strategy selection or female nonparanoids in the present study can be understood.

In the interaction of groups, mode and field, the nonparanoids were more conservative than all other groups at the third load level, and were more conservative than the paranoids and the general controls at the fourth level, for word trials. This finding may be explained if one considers the following factors. First, nonparanoids have displayed a tendency toward adoption of a conservative response strategy under a variety of conditions in previous studies. Second, there are indications that the picture tasks were generally found to be more difficult than the word tasks in the present study. Third, the present results also suggested that in general subjects adopt a conservative strategy for moderately difficult tasks, and a more liberal approach for very difficult tasks. Bearing these observations in mind, it is evident that a general nonparanoid tendency toward conservatism may have been suppressed in the picture trials because of their difficulty, which may have evoked more liberal responding. The word tasks were generally less difficult, the higher load levels perhaps being in the moderately difficult range. By the third level, when all of the groups were responding more conservatively than they were at the first level, the nonparanoid conservative tendency could be fully expressed.
Secondary analyses

Eckblad and L.J. Chapman's Magical Ideation Scale purports to be a measure of schizophrenia-proneness. The present work extended the population sampling of previous studies investigating the instrument by administering it to all five experimental groups. It was found that the schizophrenic groups scored significantly higher than the psychiatric control group, with the normal groups falling in between. This curious result suggests that the scale is sensitive to characteristics which distinguish schizophrenics from other psychiatric patients, but not to those distinguishing schizophrenics and normals. As the psychiatric controls and schizophrenics did not differ on any of the demographic variables, explanations in these terms are unlikely. If the validity of the scale is accepted, the finding suggests that the presence of some magical thinking is not necessarily maladaptive, as it characterizes the normal groups. Perhaps too little (as in the psychiatric control group) or too much (as in the schizophrenics) may be associated with pathology. It is tempting to speculate that magical thinking may under some circumstances be related to creative processes, as in the psychodynamic notion of regression in the service of the ego (Kris, 1952). A deficit in this capacity may reflect a pathological inflexibility of adaptive responding, whereas a surfeit, without adequate modulation, may be equally disruptive. It is noteworthy that Dykes and McGhie (1976)
reported that schizophrenics were similar to highly creative normals, and dissimilar from equally intelligent low creative normals, in their attentional functioning. Dykes and McGhee suggested that the difference between highly creative normals and schizophrenics lies in the relative lack of cognitive control in the latter group. Perhaps the increased magical thinking among schizophrenics in the present study reflects the element they share with highly creative normals.

Regarding the State-Trait Anxiety Inventory findings, it appears that the psychiatric groups were somewhat elevated in their state anxiety relative to the normal groups, but did not differ from each other in this respect. The validity of the measure as used in this study is open to question, as its psychometric properties have not been calibrated using pathological populations. Bearing this caution in mind, it may be stated that the data do not support the hypothesis of increased anxiety in paranoids relative to nonparanoids. One is left, however, with the greater association of anxiety with the paranoid diagnosis in the DSM-III and the clinical literature. If the psychiatric groups displayed equivalent anxiety in the present study, it is not necessary that these patients retain this equivalence under all conditions, nor that all three groups were using the same strategies to cope with their anxiety. If the schizophrenics have particular difficulty with cognitive control, as was suggested above, they may have more frequent coping failures, and thus show
heightened anxiety relative to other psychiatric patients, but only at certain times. Paranoid schizophrenics may tend to be more anxious than nonparanoids (perhaps because of their hypervigilance for threat), but when coping strategies are functioning this difference may be eliminated. One could speculate that, under conditions which prevented adequate anxiety control, the role of anxiety as hypothesized in the Introduction might then obtain—that is, the paranoids, experiencing greater anxiety, might have an increased left hemisphere load relative to nonparanoids, and this might have consequences for the paranoids' processing of high frequency stimuli such as words. It should be underlined, however, that the results of the main analysis suggest the occurrence of schizophrenic subtype-specific, hemispheric resource dependent effects, and the results of the STAI analysis indicate that the subtypes do not differ with respect to anxiety. Regardless of the role of anxiety in schizophrenia in other respects, the present results taken together indicate that anxiety differences are not necessary to produce subtype-specific behavioural lateralities.

Concerning the comparison of the RDC and SSI, it appears that the instruments display a relatively high degree of convergence. This finding supports the convergent validity of the measures, and indicates that relatively direct comparisons of results across studies
using these instruments may be undertaken with some confidence that differences are not due to disparities in their discriminative properties.

Regarding the correlations of response bias with Premorbid Adjustment Scale scores and duration of pathology, the absence of significant results suggests that experience of pathology may not be the cause of the nonparanoids' proclivity toward conservative responding. This finding therefore does not support the hypothesis of Fisk and Neufeld (1984). The etiology of the response bias anomalies in schizophrenia thus remains a matter for speculation, and further research.

**Suggestions for future research**

Many questions have been raised by the present study which could be pursued using empirical methods. All of the speculations presented in this work assume some degree of robustness for the findings, so the most important suggestion for future research is to garner support for this assumption through conceptual replications and converging studies.

Concerning schizophrenic laterality effects, a continuing search for the variables controlling their occurrence is warranted. It is important to expand the sampling of the load continua for both stimulus modes, in order to confirm whether this lateralized behaviour is mediated by attentional factors. For instance, if the paranoid right visual field effect in overall reaction time
does represent priming, a significant reaction time increase, reflecting premature resource depletion, should occur in the adjacent higher load levels. The paranoids and nonparanoids would be expected not to differ significantly at lower levels in the left field, if the observed nonparanoid left field effects result from right hemisphere priming and resource depletion.

Earlier in this Discussion, it was suggested that the investigation of schizophrenic strategies might illuminate the mechanisms underlying schizophrenic laterality effects. Further examination of strategy models involves generating hypotheses concerning the nature of the strategies producing the lateralized effects, and measuring the association of these strategies with the lateralized effects. One strategy hypothesis—that paranoid hypervigilance and nonparanoid hallucinogenic processes may be involved—was presented above. Some features of this hypothesis could be evaluated by varying the degree of threatening content in the stimulus materials. If the presence of threatening content tends to evoke paranoid hypervigilance, tasks performed with threatening materials might amplify the paranoid left hemisphere anomaly. Alternatively, attempts could be made to develop state measures of hypervigilance, perhaps involving a detailed assessment of current paranoid symptomatology, and to determine whether schizophrenics showing a greater current tendency toward hypervigilance also tended to manifest the left hemisphere effect. Concerning the right hemisphere
effect, while nonparanoids generally tend to be more hallucination-prone than paranoids, the association between subtype and symptom is not perfect. Schizophrenics could be grouped as to whether or not they are currently prone to hallucinate, and it would be predicted that the hallucinators would more likely display a right hemisphere anomaly.

The notion of anomalous schizophrenic strategies is not only relevant to investigations of laterality effects, but is also germane to the present response bias findings, and has been implicated in a variety of schizophrenic performance disturbances. It is clearly a heuristically valuable concept, and should be further investigated. One issue meriting further research is that of the etiology of the deviant strategies. Earlier in this Discussion, it was suggested that the anomalous strategies may arise in response to some more enduring (structural) deficit in the information processing system. From this perspective it would be predicted that indications of anomalous strategies should vary with the severity of the structural deficit. The present finding that paranoids and nonparanoids showed distinct forms of the second lateralized effect, and also displayed different degrees of generalized deficit, is consistent with this notion. (Perhaps nonparanoid hallucinations are the result of the threat of complete loss of object relations, which provokes the generation of hallucinated objects, whereas paranoid hypervigilance may
arise from being in better contact with a more stable, albeit threatening, external world). The prediction could be further evaluated by measuring the task battery performance of remitted schizophrenics. If the second lateralized effect and the generalized deficit both diminish in these subjects, a direct relationship is not contradicted; if, however, the second lateralized effect persists, the direct relationship hypothesis would not be supported. The latter result would suggest that the generalized deficit may be an episode marker, and the laterality effect may be a vulnerability marker (see Zubin & Spring, 1977).

The increasing concern with the developmental context of information processing disturbances (see Nuechterlein & Dawson, 1984) suggests another avenue of research into schizophrenic strategies. Strategies develop over time, as task demands change and the relative efficiencies of various strategic approaches are learned (Pressley & J.R. Levin, 1983). It might be fruitful to examine the use of strategies at various ages among populations regarded as at risk for schizophrenia, such as first degree relatives of schizophrenics and those scoring high on measures of psychosis-proneness, in order to see if the temporal parameters of preference development could be discovered. Nuechterlein and Dawson (1984) reviewed several studies in which attentional tasks were administered to children of schizophrenics, ranging in age from 9 to 16 years. It was consistently reported that the children at risk showed
decreased values of the signal detection sensitivity parameter relative to a control group, whereas no significant group differences regarding response bias were found. Longitudinal studies could be undertaken to determine when response bias anomalies begin to appear in the (pre)schizophrenic. An analysis of such studies involving gender and diagnostic subtype for the subjects who ultimately became schizophrenics might shed light on the puzzling interaction between groups and sex in the response bias findings of the present study.

The choice of processing strategy is partially determined by the characteristics of the task environment. Outside of the laboratory, the term "task environment" seems a rather tame one in reference to the seething ocean of relationships through which we navigate, but it cannot be forgotten that schizophrenics spend most of their time in this ocean, and developed the elements of their strategic repertoire there. One of the great arenas of strategic learning is the family, and the relationships between schizophrenia and family context have been the subject of speculation since Sullivan (1927). More recently, some success has been reported in isolating family variables associated with schizophrenic relapse (for a review, see Parker, 1982). Few studies have empirically examined the relationship of schizophrenic cognitive dysfunctions as they are measured in the laboratory and family characteristics, and strategic variables may provide
a link by which a bridge could be built. It has been suggested, for example, that paranoid hypervigilance arises from a need to anticipate threat within the early family setting (e.g. Cameron, 1943). Perhaps correlations can be found between a measure of schizophrenic hypervigilance and a measure such as Vaughn and Leff's (1976) scale of parental expressed emotion. This approach assumes that such present state indices of family interaction represent relatively enduring situations - a notion still under debate (see Seeman, 1983).

A schizophrenic global deficiency in processing resources has been postulated (e.g. Knight & Russell, 1978), and such a deficit may account for the widely observed impairment of strategy construction (e.g. Hamlin & Folsom, 1977). Logan et al. (1983) recently demonstrated that strategy construction requires attentional resources, by presenting a response-demanding probe during concurrent strategy construction activity in a speeded discrimination task. This application of the dual-task paradigm to strategy construction could be used to study schizophrenic strategy construction, particularly to assess whether schizophrenics appear to allocate the same amount of resources to this activity as normals, and whether schizophrenic strategy-building is more susceptible to disruption.

The present findings concerning group differences on the Magical Ideation Scale suggest that further study of this instrument may be worthwhile. It was hypothesized
that magical ideation may be related to creativity, and that high magical ideation in schizophrenics may represent a common element with creative normals. These notions could be evaluated by administering the Magical Ideation Scale and a measure of creativity, such as Christensen, Guilford, Merrifield & Wilson's (1960) Alternate Uses Test, to groups of normals, psychiatric controls and schizophrenics. A significant correlation between the measures would be predicted. The use of a battery of creativity tests in such a study, to allow for the mapping of changes on multiple dimensions of the creativity construct, would be preferable to the use of a single instrument, as some creativity measures (such as Rothenberg's (1983) timed word association tests) appear to distinguish between highly creative normals and psychiatric patients.

Inconsistencies in the study of schizophrenic anxiety need to be further explored, given the widespread importance given to this construct by theorists of schizophrenia (e.g. Frosch, 1983). A problem with investigating anxiety using a single measure is that anxiety comprises multiple systems, which can become desynchronized (see Lang et al., 1983). A convergent measures approach, involving diverse types of instruments such as cognitive tasks, psychophysiological monitors and questionnaires, should be used. Another complicating factor, discussed above, is the evidently fluctuating nature of schizophrenic anxiety. Measures
taken during a single testing session may not adequately
detect complex patterns of change over time. A
longitudinal approach, involving multiple measures repeated
over several sessions, may be required to elucidate anxiety
patterns differentiating types of psychiatric patients.

**General Conclusions**

The present work illustrates the value of a
multifaceted approach to the problems of schizophrenic
cognition. Several aspects of psychological functioning
were discussed, and it was evident that many of the
mysteries of schizophrenia may be more adequately addressed
by studying relationships between aspects rather than
restricting one's view to a single facet. For example,
some of the features of schizophrenic hemispheric
functioning become more intelligible when non-physiological
variables such as attentional structures are considered;
our understanding of schizophrenic attentional resource
pools is enriched by taking strategy effects into account;
the choice of strategies may be partially determined by
stimulus characteristics which are differentially processed
by the cerebral hemispheres; and it was suggested that the
schizophrenic mind may profitably be viewed within the
context of its developmental history and interpersonal
field.

It was noted in the Introduction that many researchers
and therapists are currently promoting a multidimensional
approach to schizophrenia. For this effort to bear fruit,
it may be necessary for students of schizophrenia to be on

guard against prevalent bad habits in the realm of

explanation. One of these habits is reductionism. As

Cromwell (1984) defines it, "Reductionism is the tendency
to move scientific explanations toward more molecular

levels of description rather than to the level having the

optimal range of convenience for predictive utility (p.

114)". There is a persistent tendency among some writers

on schizophrenia to grant terms incorporating physiological
descriptors a sort of epistemological privilege, so that if

these terms enter an explanation, it is no longer necessary
to consider other levels. Other forms of reductionistic

error, such as contentment with an overly narrow

"psychologism", are also found, but physiological

reductionism seems to be the dominant motif in the popular

media, most of psychiatry and much of clinical psychology
today. (Not that this is a novel state of affairs, as the

following passage by Janet (1906/1929) attests:

... one can make, nowadays, a so-called physiological
definition at smaller cost. It is enough to take the

most commonplace psychological definitions and replace
their terms with words vaguely borrowed from the

language of anatomy and the current physiological

hypotheses. Instead of saying, 'The function of language
is separated from the personality,' one will proudly say,
'The centre of speech has no longer any communication with
the higher centres of association.' Instead of saying,
'The mental synthesis appears to be diminished,' one will
say, 'The higher centre of association is benumbed,'
and the feat will be done. ... I again observe to you that
I consider the pretended physiological definitions as mere
translations of the psychological ideas (pp. 322-323).

It is evident that the promise of a multiperspectival

approach cannot be fully realized if the issue of an
optimal level of analysis is thus simplified and prematurely closed.

A similar point can be made concerning the therapy of schizophrenia. A multifaceted view of schizophrenia suggests the need for a multifaceted treatment approach. While most psychiatric hospitals do provide a variety of services, there is usually a disproportionate emphasis on psychopharmacological interventions. Research concerning the efficacy of more balanced multifaceted approaches is promising (e.g. Falloon & Liberman, 1983), and hopefully the refinement of multifaceted research and therapy will continue together.

In the terms of the Zen story which opened the Introduction, rather than designating one of the research or treatment options as intrinsically superior to all the rest, students of schizophrenia can state, "Everything in my shop is the best". We can then proceed to explore in what specific ways each piece of meat is the best, and hopefully, by examining the pieces together, we may someday catch a glimpse of the cow.
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(presented at the American Association for the Study of Mental Imagery conference, Vancouver, June 1983).
Attentional processes in schizophrenia and meditation
(presented to the Department of Psychology, University of Western Ontario, February 1984).

Works in Preparation
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