PERSEVERATION ERRORS IN THE PERFORMANCE OF DICHOTIC LISTENING TASKS BY SCHIZOPHRENICS: THE ROLE OF STIMULUS FUSION

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Diane M. Gard, M.S.
Denton, Texas

December, 1995

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Past studies have shown that schizophrenic patients perform poorly on some consonant-vowel dichotic listening (CV-DL) tasks and that these perseverations correlate with measures of executive functioning (i.e. Wisconsin Card Sort Test (WCST), Stroop Test, Goldberg Test (GBT). The purpose of the present study was to compare the number of perseverations on fused (no delay) versus unfused (0.5 msec delay) CV-DL tasks with measures on a battery of executive functions across three groups: Schizophrenics (SCZ), Manic-Depressives (MD), and normal controls (NC). The SCZ perseverated more on DL-CV tasks than did either the MD or the NC groups while MD and NC groups did not differ. For the SCZ perseverations remained the same for fused and unfused stimuli. They made also more perseverative errors on Trails B, WCST and Goldberg test than either control groups. Results are discussed in light of attentional versus core deficit models.

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INTRODUCTION

Manifestations of the schizophrenia disease include positive signs of delusions and sensory hallucinations and/or negative signs of flattened affect, alogia, avolition, apathy, anhedonia and social isolation (Andreasen, 1981). Impaired frontal lobe functions involve motor speed and strength, mental flexibility and inhibition, with behavioral loss of motivation, impaired attention, and emotional blunting. These most often preclude effective executive functioning such as planning, abstraction, and problem-solving. Theorists have long pondered the biological circuitry that results in these deficits.

Early Theories

The early theories of schizophrenia varied substantially. Following Kraeplin's (1919) hypothesis that this dementia praecox was caused by a physical disorder, Bleuler (1924) named this condition schizophrenia to denote the metaphorical concept he used to describe the "breaking of associative threads" (Neal & Oltmanns, 1980). He further proposed the famous "Four A's" as hallmarks of this illness; Associative disturbance, Autism, Affective disturbance, and Ambivalence. Also important was his dichotomy between

primary and secondary categories. Primary referred to the associative disturbance which Bleuler assumed to be the result of an organic disease processes. Secondary symptoms he believed resulted from the interaction between the disease process and other environmental and life stressors. In the 1960-1970s this dyad was developed into a process versus reactive dimension, separating schizophrenics according to their premorbid psychosocial and sexual development.

Structural Abnormalities and Physiological Imaging Studies

In recent years, the schizophrenic syndrome denotes a distinct clinical picture or group of related symptoms though etiology is unknown. With the advent of modern technology, schizophrenic processes are believed to broadly evolve from dysfunction in the areas of the frontal lobes, the parietal cortex, cingulate gyrus, the thalamus and the hippocampus (Psychology Today, 1992). PET scans indicate that in comparison to normal brains schizophrenics have lower front-to-back ratios of blood flow (Mirsky & Duncan, 1986; Paulman et al, 1990). Brain mapping studies have further indicated that while schizophrenia affects many areas of the brain, particularly pertinent cortical areas are the mesiotemporal lobe and the prefrontal cortex (Weinberger, 1993). Post mortem studies have generally supported these in vivo findings, emphasizing the relevance of comparative changes in the mesial temporal cortex, and

the neural connections between deeper limbic structures and prefrontal cortex, believed to have resulted from abnormal developmental processes (Abkarian et al, 1993; Arnold, Hyman, Van Hoesen, & Damisio, 1991; Jakob & Beckman, 1986).

MRIs comparing cranial size and frontal lobe measures have shown mixed results (Andreasen et al, 1986; Kelsoe, Cadet, Pickar, & Weinberger, 1988). While some have found structural abnormalities in the temporal lobe of schizophrenic patients (Rossi, Stratta, Gallucci, Amicarelli, Passaniella, & Cassaccia, 1988) others have found mixed results (DeLisi et al, 1988, Kelsoe et al, 1988). Nonetheless, MRI studies have generally corroborated the importance of the mesial temporal and limbic involvement, finding enlarged ventricles and consistent changes in the mesial temporal lobe, particularly the temporal surface around the hippocampal formation (Hyde, Casanova, Kleinman, & Weinberger, 1991). Twin studies have also confirmed relatively enlarged ventricles and smaller mesial temporal and hippocampus surface area in the affected twin versus the unaffected identical twin (Weinberger, 1993).

Carol A. Tamminga and colleagues (1992) at the University of Maryland have detected significantly reduced rates of glucose metabolism in the subcortical hippocampus and the cingulate gyrus. This indicates reduced energy utilization in the areas that control memory and emotions,

offering explanation to the observation that schizophrenics have reduced or impaired memory and labile affect and/or inappropriate mood states for events. These researchers further found that certain schizophrenics with thought paucity and deficits in social interaction evidenced reduced glucose metabolism in their thalamus, frontal and parietal areas in comparison to nondeficit schizophrenics. Because tracts extending from the cortical areas to the thalamus are involved in reception and processing of sensory input from the environment many scientists believe that abnormalities in these communications may alter or blunt the importance of external stimuli and alter the schizophrenic's experience and perception of the world around them.

Mirsky and Duncan (1986) found that schizophrenic (SCZ) individuals evidence reduced cerebral blood flow in the frontal regions (hypofrontality) under passive as well as active (task-related) conditions. Further, they found that SCZ patients showed reduced metabolic activity in the frontal lobes as compared to posterior cortical areas. Since the dorsolateral areas of the prefrontal cortex operate via the substantia nigra and striatal pathways, it has been suggested that dopamine may be dependent on Ach interaction and/or GABA inhibitory functions in the substantia nigra. Imbalances in these system are seen to be related to disorders of schizophrenia positive symptoms, obsessive-compulsive behaviors, anxiety and autism.

Postmortem studies of schizophrenics have found the amygdala to be smaller in size than normal. The amygdala affects apathy, spontaneity and blunted affect. According to Kirkpatrick and Buchanan (1990), the frontal lobes as well as the amygdala and periamygdalar area appear involved in this SCZ syndrome. They stated that the dorsal lateral prefrontal area is associated with cognitive flexibility and integration of social cues while orbital areas are associated with irritability, altered response to frustration and inhibition.

Weinberger (1993) hypothesized that the "cytoarchitectural maldevelopment " of structures serving a communication connections between mesial temporal cortical areas and the neocortex provides the key neurobiological basis to this illness but lacks, at present, a conceptual model. He suggested that these connections consist of primarily long, projecting glutamatergic neurons, since none of the neurons that communicate across these areas are dopaminergic. This supersedes and contradicts the traditional dopamine hypothesis of schizophrenia.

Neurobiological Models

The basic premise of schizophrenia hinges on the finding that more dopamine is secreted in the brains of schizophrenics. This may result from the hyperactivity in the dopaminergic synapses or may result from the excess synthesis of dopamine, an increase in number of dopamine

receptors, disruption of the normal dopamine release or receptor functions or another, as yet unknown, variable. Competitive binding studies have demonstrated that all antipsychotic drugs have an affinity for D1 and D2 dopamine receptors. The result of a dopamine imbalance is the presence of positive and negative symptoms. Positive symptoms include delusions, hallucinations, and thought disorders while negative symptoms include flattened affect, poverty of speech, loss of drive, and social withdrawal.

The dopamine hypothesis holds that if mesolimbic and mesocortical neurons, projecting from the ventral tegmental area to the basal forebrain, limbic cortex, and neocortex are overactive, then these will result in schizophrenic positive signs. While the etiology of negative signs is unclear, it is believed to be a concomitant effect of the disorder that may result from long term neural damage to brain cells. Too little dopamine, as when medications block dopamine receptors, in the caudate nucleus can result in Parkinsonian type symptoms. Too much dopamine activity can result in Tardive Dyskinesia, a late-developing disorder believed to result from too much long term neuroleptic treatment.

Recent Related Theories

A recent attentional theory of schizophrenia suggests that this illness results from a deficiency in attentional selectivity. That is, schizophrenia is conceptualized as a

surplus of indiscriminate attention which may be attributed to changes in reinforcement systems causing behaviors to be inappropriately reinforced. Similar to attention deficit disorder (ADD), these individuals are very distractible and may be hyperactive. However, schizophrenia differs from ADD in that drugs effective in treating ADD (dopamine agonists) intensify schizophrenia and can cause SCZ symptoms in normal people.

In schizophrenics one finds left hemisphere lateralization of dopamine processes. Mintz also found high left hemisphere activation leading to fragmented attentional abilities. Flor-Henry (1985) believes that psychopathological manifestations are related to hemispheric dysfunction. That is, schizophrenic disorganization results from pathological processes of left hemisphere dysfunction, whereas a negative symptom such as depression results from right hemisphere dysfunction. This is supported by Mirsky and Duncan's (1986) findings regarding the increased left hemisphere cerebral blood flow in schizophrenics in comparison to normals while at rest. Interestingly, these researchers found increased right hemisphere cerebral blood flow for SCZ during verbal tasks whereas for normals this occurred during spatial tasks.

Further, the question of depression is raised as a query of subdiagnoses of schizophrenia since negative signs are hard to distinguish from depression. Min and Oh (1992)

compared schizophrenics with diagnosed depressive patients and found schizophrenia to be associated with impairment in the left hemisphere while depression was associated with impairment in the right hemisphere.

Extending the theories of hemispheric hyperarousability, Tucker and Williamson (1984) differentiated the components of arousal and activation into hemispheric and separate, specialized entities. In this model the left hemisphere localizes dopaminergic (DA) operations of activation, wherein input is loaded on verbal, sequential processing. In contrast, the right hemisphere pertains to holistic perception wherein information is processed in parallel. These noradrenergic (NE) functions of activation are loaded on nonverbal input and are sensitive to emotional communication, facial expression and tone of voice.

In this model, the left hemisphere processes information linearly and restricts information processing and therefore attention. It pertains to tonic, dopaminergic systems affecting motor readiness to respond. With the increase in motor readiness there is an increase in motor restriction which, with redundancy, forms the basis of our stereotypic behaviors and allows us to build a repertoire of routines. This motor organization regulates internal control and affords attentional vigilance. The dorsolateral frontal cortex is believed to be key in maintaining redundancy and

internal control while the posterior association cortex works to minimize redundancy.

According to Tucker and Williamson's theory, right hemisphere NE mechanisms, on the other hand, are phasic rather than tonic. They function under an habituation bias wherein increased NE activity occurs to novel stimulus and arousal quickly decrements neural activity. Therefore, there is an increased orientation to novelty, and controlled by external factors. Repetition quickly leads to perceptual habituation. The right hemisphere, then, governs more general organismic arousal and attention. Further, the parallel perceptual processing affords novelty in problem-solving by generating multiple ways of representing the available information. Interestingly, while the left hemisphere redundancy would facilitate memory storage, right hemisphere arousal would saturate the memory with new data at the expense of retention.

Researchers have found that when NE is higher in the right versus left hemisphere this leads to mood changes and affective disorders. The important pathways here are in the frontal cortex which sends signals to the amygdala, then to the hypothalamus which modulates arousal mechanisms. Right frontal lesions result in decreased NE activity in the locus correleus. Other confirmatory evidence to right hemisphere arousal mechanisms comes from knowledge regarding lithium and serotonin activity. Lithium (prescribed for manic-

depressive disorders) is seen to alter EEG patterns in the right hemisphere. Also, serotonin (which lifts mood) is found important in right versus left hemisphere functions.

In schizophrenia the Tucker and Williamson (1984) concept would tend to indicate an overactivity of left hemisphere functions producing possible positive symptoms. An imbalance of other neurochemicals such as NE in the right hemisphere would produce impaired memory, problem-solving and mood dysregulation and, thereby, the negative symptoms of schizophrenia. In total, this model serves to explain the attentional and arousal peculiarities of schizophrenics and suggests that the frontal cortex plays an integral role in the control of both left and right hemisphere functions.

Miller (1988) has proposed that schizophrenia is a progressive disease in which both the positive and negative symptoms are part of the same process. Positive symptoms would be due to the overactivity of dopamine while negative symptoms would result from long term damage of brain neurons. As outlined by Heinrichs (1993), more recent functional neuroimaging research supports theories to suggest that SCZ is a result of enhanced rather than diminished brain activity with dopamine hyperactivity producing positive signs and hypoactivity producing negative signs as commonalities to psychopathology. For example, hallucinations and delusions are like psychotic symptoms sometimes seen in temporal lobe epilepsy. This transient

overactivation model suggests that, akin to seizures seen in epilepsy, perhaps excessive or sudden changes in neural activity represent the intermittent and fluctuating nature of SCZ symptoms. Carpenter and Stephens (1979) have observed that catatonic, hebephrenic and paranoid features may all be seen in the same patient at different point in their SCZ disease, suggesting that these are not separate disorders but dimensions of the same disorder over time.

Weinberger (1987), moreover, holds that schizophrenia occurs early in life and that the negative symptoms result from the hypoactivity in the frontal lobes. Mirsky and Duncan (1986) found that schizophrenics do, in fact, evidence hypofrontality of blood flow under passive as well as active conditions. Further, they found that SCZ subjects showed reduced metabolic activity in the frontal lobes as compared to posterior cortical areas. Weinberger (1987) associated the dorsolateral prefrontal cortex (DLPFC) functions with preadolescent development, wherein this area is the last to begin myelination. He pointed out that humans cannot do the WCST until this time. Chelune and Baer (1986) added that children cannot perform frontal lobe tasks as measured by the WCST until after age 10. Golden (1981) went further in saying that frontal lobe cognitive abilities do not develop until adolescence and therefore "disorders of the frontal area can be symptomless until ages 12-15, or even older." (p.292).

Following the dopamine hypothesis, Weinberger (1987) maintained that important neural tracts include the prefrontal cortex, which has DA projections to the DA bodies in the midbrain, and to the mesocortical terminal fields in the amygdala, nucleus accumbens, hypothalamus and hippocampus. Adulthood is a time of maximum DA activity in the brain. This model serves to explain the neurodevelopmental course of schizophrenia and that frontal function, as well as affect modulation and memory, would be affected.

Assessment of Frontal Lobe Involvement

Anatomically, Kolb and Whishaw (1990) summated that the frontal lobes are generally defined as all brain tissue in front of the central sulcus, to include the primary motor cortex, the premotor cortex, supplementary motor cortex, Broca's area, medial cortex and prefrontal cortex (dorsilateral and orbital). These areas are responsible for controlling fine hand, finger and facial movements, limb and eye movements, temporal organization of behavior, inhibition and olfaction. The left frontal lobe controls movement primarily related to language and the right frontal lobe controls behaviors primarily related to nonverbal abilities.

The frontal lobes are vital to attention, abstract thought, planning, and flexibility, such that the negative symptoms of schizophrenics hold many parallels with patients who have frontal lobe impairments (Levin, 1984). Goldberg,

Berman and Weinberger (1989) supposed that the prefrontal areas are key to short term memory representation and the ability to use present information for later delayed responses. The loss of this capacity leads to distractibility, responding to stimulus of the moment, poor integration of means and ends and, therefore, impaired planning and persistence. Further, they suggested that deficits in the prefrontal cortex may lead to perseverative responses. They view these as responses to reinforcement of internal or external stimulus-response (S-R) pairings. Perseverations are seen as a deficits in the suppression of these responses. Animal research indicates that dysfunction of this area results in: social withdrawal; timidity; poor competitiveness for food, shelter, and sexual partners; a fall in social rank; and altered emotional expression, suggesting a parallel with the social inadequacies observed in schizophrenics.

Prefrontal surgery in humans is associated with severe apathy, negative symptoms, and impaired associative learning. A review of studies indicates that damage to the dorsolateral area produces impairments in initiative, flattened affect, impaired abstraction and set-shifting, and social withdrawal (Goldberg, Berman & Weinberger, 1989). Damage in the orbitofrontal regions is seen to produce distractibility, disinhibition, labile affect, and poor social judgement (Goldberg, Bilder, Jaeger, & Podell, 1989).

Human frontal lobe functioning has received recent focus since these areas are integral to mental flexibility, problem-solving and even employability. In general, schizophrenics do more poorly on frontal lobe assessment tasks. Morrison-Stewart, Williamson, Corning, and Kutcher (1992) found that SCZ performed worse on frontal versus nonfrontal tests in comparison to normals. These frontal tests included the Wisconsin Card Sort Test (WCST), the Chicago Word Fluency test and the Design Fluency Test (a test of right frontal function). No significant differences were found for nonfrontal tests such as the Wonderlic I.Q. and the Weschler Memory Scales (WMS) were found to positively correlated with negative symptoms. Both the WMS and WCST scores correlated inversely with positive symptoms. Bornstein (1986) also found oral fluency to be related to frontal lobe functioning.

With the development of test batteries to assess frontal lobe functions, Goldberg and coworkers (1989) warned that such tests may actually be testing executive functions because other areas may be damaged that hold tracts to the frontal lobes, such as the mesencephalic tegmentum.

Nonetheless, to further Kirkpatrick and Buchanan's theory (1990), Berman, Zec and Weinberger (1986) found a dorsal lateral prefrontal cortex (DLPFC) deficit in 24 neuroleptically controlled SCZ subjects during a WCST versus a number matching control task as measured by xenon

inhalation and cerebral blood flow. No other differences in blood flow were seen in comparison to normals. While Paulman and colleagues (1990) found both frontal and bifrontal increases in the regional CBF (rCBF) of schizophrenics, frontal flow deficits were found to be most prominent in paranoid patients. Further, right temporal deficits were seen to be most prominent with nonparanoid patients. In testing, the decrease in left frontal rCBF was associated with impairment on the WCST and Luria-Nebraska Neuropsychological Battery. With the WCST, left frontal hypoperfusion was associated with more errors and fewer categories completed. Also, right hand finger tapping was found to be relatively more impaired in comparison to controls. Increased hemispheric CBF was also associated with positive symptoms, especially for paranoid Sc.

It is notable that I.Q., as measured by the WAIS, is not often found to be significantly lowered by frontal lobe lesions (Milner, 1964; Stuss et al, 1983). Stuss and colleagues (1983) suggested in their study of leucotomized versus schizophrenics that the lower I.Q. scores of the schizophrenics may result from the differences in pathology. The lower frontal pathways connect to orbitomedial areas while more superior connections go to dorsolateral cortex.

In areas of intellectual assessment it is noted that schizophrenics do more poorly on WAIS verbal subtests of digit span, comprehension and similarities attesting to

reduced levels of attention, concentration and social effectiveness. As well, they have greater difficulties in visual performance tasks, especially block design and object assembly. It is of import that Faas (1992) has found that the scores on comprehension, similarities and block design are related to ones adaptability and employability.

Dichotic Listening Tasks

Research findings suggest that frontal lobe schizophrenic deficits lie in either the right hemisphere, left hemisphere or the interhemispheric communication (Nachson, 1988). To investigate the perception utilization of information, neuropsychological investigation of frontal lobe functioning utilized dichotic listening (DL) tasks. Dichotic listening tasks involve the presentation of words, numbers or sounds presented simultaneously. First employed by Kimura (1961), it was found that most people tend to report what is heard in their right ear versus their left ear. Each ear conducts information to the contralateral hemisphere and weakly to the ipsilateral hemisphere. Therefore, the prevalence of right ear advantage (REA) determines that there is a left hemisphere speech dominance for dichotically presented speech.

As determined by Rosenzweig (1951), contralateral pathways to auditory cortices are more efficient than the ipsilateral pathways. Therefore, for right handed individuals, auditory input to the right ear would normally

be recognized more accurately than competing input delivered to the left ear. While this premise has been generally accepted by researchers, Harshman and Lundy (1988) have suggested that laterality may be more of a continuum measure than a "dichotic" one. That is, the laterality of responses may be derived from the formula: the number of correct left responses subtract right responses divided by the total number of responses, (LH-RH)/(LH+RH). For example, clinical studies indicate that 95-99% of right-handers have left-hemisphere speech (Segalowitz & Bryden, 1983) but only 80% have REA.

While REA is fairly well established for right handed normals (Kinsbourne, 1983), schizophrenics present a more complicated picture. Though some DL studies have found that schizophrenics demonstrate greater REA than normals (Lerner et al, 1977) many have not (Johnson & Crockett, 1982; Kiyota, 1987). Notably, there is a higher percentage of left handedness and an associated greater nonREA in this population (Poreh, 1994). Even when only right handed schizophrenics are considered, their expected REA percentages fall markedly below average (Nachson, 1988). It was hypothesized by Nachson (1988) in his review of the literature that the lack of REA in schizophrenics results from both neural differences and process differences. That is, the left hemisphere dysfunction lends to greater utilization of the right hemisphere. Also, the schizo-

phrenic's inability to properly direct attention (left hemisphere function) offsets potential benefits normally realized with REA. This directly questions the meaning of the left hemisphere overactivation model of schizophrenia, and whether this contradicts or contributes to the right hemisphere utilization.

Magaro (1981) has suggested that within the nomenclature of schizophrenia one must consider schizophrenia subtypes. For example, paranoid schizophrenics are seen to process information differently and have been found to have greater REA than nonparanoid schizophrenics (Bruder, 1988; Karney & Nachson, 1988). Further, Frith and Done (1983) found that schizophrenics with positive symptoms performed similar to normals on a two-choice task while schizophrenics with negative symptoms and impaired intellect produced more recurrent perseverative responses. This ties in with the parallels found between SCZ with negative symptoms and frontal lobe syndrome.

Regarding positive and negative sign measures, Bustillo and colleagues (1995) have suggested that measures such as the PANS and BPRS are insufficient for determining a deficit syndrome and have preliminary findings to support the use of core deficit criteria as outlined by Carpenter, Heinrichs, and Wagner (1988). These criteria Florence, Tandon, Goldman, DeQuando, Jibson, & Taylor (1995) have further outlined and found that "deficit" versus "non-deficit" schizophrenics are

generally older, have a longer duration of illness and had higher negative symptom scores.

To reduce the confound of short term memory effects, researchers have employed only pairs of words or syllables. However, several procedural variations have proven that dichotic ear advantage could still be altered by attentional manipulations (Bryden, Munhall, & Allard, 1983; Hugdahl & Andersson, 1986). Further methodological improvements were borne out of the use of fused consonant-vowel (CV) syllables. Studdert-Kennedy and Shankweiler (1970) were able to produce high quality syllables perfectly aligned temporally such that the subject perceived only one sound. The subject was asked to give one response per stimulus pair, eliminating problems such as the order of report and attentional manipulations. This removed both the temporal memory factors, any stimulus dominance effects (Harshman & Lundy, 1988) and, in effect, secured suppression of ipsilateral input (Hugdahl, 1989).

In a study of schizophrenics using fused dichotic stimuli, Poreh (1993) found that these patients performed normally on fused digits, but with fused CV stimuli they made numerous perseverative and nonperseverative errors. As well, they were unable to shift their attention to either ear when directed to do so, and their ear preference did not correlate with a measure of handedness. Studies have found that the greater REA holds for tasks of dichotic digits or

words but not with CV syllables (Bruder, 1988; Nachson, 1988) and suggests that these tasks may involve different functional systems representing meaningful and nonmeaningful stimuli (Wexler, 1986).

A prior study by Poreh (1993) found that the number of perseverative responses on the CV tasks was positively correlated with the number of perseverative responses on the WCST. Such studies have been criticized on several counts. First, appropriate control groups are needed, stimuli presentation need to be counterbalanced and number of trials extended. It has also been suggested that Grimshaw, McManus and Bryden's (1994) lambda correction utilized in consideration that ear dominance falls on a continuum to include bilaterality. Lambda is a log-linear equation which yields laterality index and which is used to control for stimulus dominance or noise effect which is created in the fusion procedure.

Perseveration

The phenomenon of perseveration has long been known and associated with frontal lobe deficits, as discussed on the WCST. While there are numerous types and definitions of perseveration, Sandson and Albert (1984) have proposed a taxonomy of three major classifications; continuous, recurrent, and stuck-in-set. Continuous perseveration is defined as the inappropriate repetition of current behavior. Recurrent perseveration is the unintentional repetition of a

previously emitted behavior to a subsequent stimuli, after cessation of that behavior. It may be immediate or delayed. Lastly, stuck-in-set perseveration denotes those responses that maintain the current framework or set of thinking strategy.

As reviewed by Sandson and Albert (1984), continuous perseverations can be observed in patients with subcortical involvement. Patients with frontal lobe deficits perform poorly on tasks such as the WCST, requiring cognitive flexibility, demonstrating perseverations typically of the stuck-in-set variety wherein they cannot give up one strategy in favor of a new one.

In dichotic listening tasks recurrent perseverations are seen, wherein the patient responds correctly to one stimulus but then repeats this response, inappropriately to subsequent stimuli. While these errors are also related to frontal lobe deficits, there has been poor correlation between these errors and those found on the WCST (Poreh, 1993).

In all cases, attention is required and raises questions regarding the etiology of the phenomena. Wepman (1972) proposed that an attention deficit was the underlying cause of perseverations. He found the selection of verbal information to be processed was slowed in aphasics, and, when under time constraints would produce the previously emitted response, thereby producing recurrent perseveration

errors. Alternatively, Poreh (1994) suggested that these responses result from over stimulation of a neural response or "node" such that there is a reflexive quality initiated. This may relate to the short term memory confounds discussed earlier. Along this line, Hudson (1969) proposed that memory traces activated by stimuli must actively be inhibited. It has been suggested that this post-activation of memory traces is extended in aphasics and confuses patients on subsequent trace stimulations and may reflect varying degrees of interference in each of the three types of perseverations (Buckingham et al, 1981; Yamadori, 1981).

On the WAIS-R NI, Kaplan and colleagues (1991) pointed out that clients can demonstrate several types of perseverations to include continuous, recurrent and set perseverations. Continuous perseverations or "motor persistence" can be seen on continued rotations on block design, and in repeated tracing of a symbol on the digit symbol task. Recurrent perseverations may occur when the client gives repeated verbal responses on information or vocabulary subtests. Set perseverations can be seen when clients have difficulty in switching from digits forward to digits backward.

Context and Frontal Lobe Functioning

Another area of frontal lobe functioning that also requires mental flexibility and strategy switching are studies concerning the use of context or sentence

arrangement. Cohen and Servan-Schreiber (1992) recently found that schizophrenics perform better on sentences where the context is set close, temporally, at the end of the sentence and have difficulty determining proper nondominant word meaning when context is presented earlier in the sentence. For example "The farmer needed a pen for his cattle". Here pen was more often defined as a writing instrument. This is believed to occur because the patient focuses on the most common meaning of the word and later has difficulty giving this up in favor of a second meaning of the word.

In review of the literature, Cohen and Servan-Schreiber (1992) further proposed that stuck-in-set perseverations that occur on the WCST are often realized as they are made by the patient, indicating a dissociation between declarative or short term memory on one part versus the internal representation of the context to control the response on the other part. These authors suggest that lesions of the frontal lobe affect the internal representation of context. They suggest that these processes go beyond attentional processes to include language and response pathways which become activated or "sensitized" during the initial information processing - response sequence. These pathways are more easily triggered in future handling of input. Here, attentional selection is a mediating component only.

Similarly Kaplan and colleagues (1991) have suggested that persons with frontal lobe deficits do poorly on the WAIS-R NI Sentence Arrangement (SA) subtest because they are easily hooked into, or "captured" by, commonly paired word such as "hair" and "brush" such that the separation of these words to form the sentence "long hair covered the brush" becomes difficult. This suggests that there is as well a deficit in the use of context to be explored with schizophrenia.

Other Factors Affecting Performance

In terms of other variables which may impact performance on cognitive functioning, the effects of patient medications needs to be considered in terms of their effect on individual and group performance. Katsanis and Iacono (1991) found no differences in neuropsychological performance between subjects taking anti-Parkinsonian medications or minor tranquilizers and those who were not. However, since drugs such as Lithium and Prolixin are frequently used in combination with antipsychotic medications in order to potentiate drug benefits (Schou, 1986), an effort must be made to utilize patients on one type of medication protocol or to use a chlorpromazine (CPZ) equivalence analysis to counterbalance these effects.

The client history of and current use of alcohol or street drugs can significantly compromise their cognitive and intellectual functioning. Frankenburg (1993) reported

that, in a study of 200 inpatients of which 20% were schizophrenic, 40% schizoaffective and 23% bipolar disorder, 33% were determined to be active substance abusers, chief of which was alcohol use. There is diffuse cortical atrophy suffered by chronic alcohol consumption, most often affecting the frontal and parietal lobes (Brewer & Perrett, 1971; Nielsen et al., 1966). In a study of alcoholics with possible brain damage versus normals, Chandler, Vega and Parsons (1972) found that alcoholics failed to demonstrate right ear superiority on dichotic listening tasks using digits. They also demonstrated more errors of commission and perseveration. In a study of psychopaths, Hare (1984) found that ratings of alcohol use were positively correlated with WCST perseverative errors. Alcoholism is therefore an important factor to be considered in the study of brain function.

Age factors also require consideration. This factor has been found to interact with drug dosage effects and general decline of executive functions (Friedman & Lanon, 1989; Scholz & Dichgans, 1985). Therefore age differences were analyzed in this study.

Test order effects have been examined and found to effect subject performance on some frontal lobe tasks. Whenever tests tapping overlapping skills or processes are administered sequentially there presents a risk of practice

effects. Therefore, the dichotic listening tasks was administered in counterbalanced format.

Gender and education issues have been largely skirted in the drug research in relation to performance differences. Commonly, groups are simply randomly assigned or counterbalanced in sex and education ratios. While sex differences are well documented in terms of specific relative cognitive strengths, sex differences in problem-solving do not appear until after puberty (Kimura, 1992). Men generally do better on spatial tasks and tasks of mathematical reasoning. Women tend to do better on skills of perceptual speed and verbal fluency. Regarding language functioning, while it is generally thought that females have a less lateralized cerebral development of language, dichotic listening studies have not found any appreciable sex differences for REA (Bryden, 1988; Hugdahl, 1989).

Educational history bears important significance in the establishment of premorbid functioning. In line with process versus reactive SCZ, this level of education may relate to the neural processes involved in each type of schizophrenia. Regardless, any comparison groups would require the regulation of premorbid I.Q. levels either through randomization, counter-balancing, matching or the use of covariate analyses.

With regard to motivational factors there are mixed findings. Recent studies on the use of monetary feedback to

schizophrenics doing the WCST has shown to produce positive and enduring changes (Summerfelt et al., 1991). However, Bellack and associates (1990) and Tompkins, Golden and Axelrod (1991) found that SCZ patients were able to improve their performance on the WCST after cuing and determined that this was not due to emotional factors.

Current Study

In sum, numerous studies have shown that schizophrenic patients perform poorly and with perseverations on some consonant-vowel dichotic listening (CV-DL) tasks but within normal limits on dichotic digit listening tasks (Poreh, Mitchell and Green, 1993) and that these perseverations correlate with measures of executive functioning. Whereas some researchers attribute these differences to the quality of the presented stimuli (fused versus unfused), others propose that the increased errors on dichotic consonant-vowel (CV) performance is due to a disinhibition syndrome associated with frontal-lobe deficits in this population.

The present study examined these hypotheses by using two types of dichotic listening tests (fused and unfused CV) and a battery of frontal lobe and executive function measures. The purpose was to better determine the attentional and perseverative qualities of errors made by schizophrenics. The scope of this study was limited to the areas of dichotic listening, attention, concentration, intellectual, executive and frontal lobe functioning and symptom ratings.

The intercorrelation of the tests given in this study was utilized in order to understand the nature of perseveration produced by dichotic listening tapes and the relation of these errors with other measures.

It was hypothesized that schizophrenics would make significantly more recurrent perseverative errors in the fused condition than would manic depressed (MD) and normal controls (NC). It was also predicted that MD patients would make more nonperseverative errors than normals due to their general relative state of diffused or reduced attention. Normals were expected to better direct their attention to either left or right ear stimuli than the MD patients. Further, both these groups were expected to perform better than SCZ group in directing their attention.

In the unfused condition versus the fused condition, it was predicted that normals and MD controls would demonstrate increased right ear advantage (REA) for the first sound presented while schizophrenics would not. For schizophrenic patients, if a significant number perseverative errors occurred during unfused condition as well as the fused condition, then this would support the theory that the perseveration reflects a "core deficit" associated with executive functioning. If they did not perseverate significantly during the unfused condition versus the fused condition, it would provide partial support for the fusion hypothesis, which argues that errors result from an

attentional deficit unrelated to frontal lobe functioning. Errors made would be seen to result from the "blend" of the stimuli. It was hypothesized that the former would be the case.

To elaborate upon the distinction between these two types of deficits, a "core deficit" may parallel aspects of an attentional deficit in that they are both are incorporate in functions of the frontal area. However, with an attention deficit, behavioral outcomes may include distraction, nonresponse to stimuli, or a lack of ear switching. These would be seen as a deficit in the frontal lobes to maintain attention to stimuli and direct attention to more than one ear, or sensory input. With a core deficit, stimuli would be perceived and processed in the frontal area and then further processed along pathways of executive functioning and those involved in the formulation of an appropriate response. These additional processes or pathways would then become hyperstimulated or fixated such that further stimuli would trigger the same cognitive-behavioral response path or "node". Persons with this type of deficit give the same repeated response regardless of varying stimuli input (Gard et al., 1995). The resultant continuous perseverative response incorporates additional speech-motor based processes, perhaps signalling overactivation of certain neural pathways. As discussed by Cohen and Servan Schreiber (1992), the activation of neural pathways in the

brain may sensitize certain sequential processing units which then fire more readily on subsequent information processing. Therefore, a core deficit represents a higher level of information processing which goes beyond the attentional processes and spans the executive functions and motor response processes.

In scrutinizing the cognitive demands of each item of the Kaplan and colleagues' (1991) SA subtests, sentences number 1, 2, 3, 5, 7, and 8 required adjective to noun shifts (SA-AN items), sentence number 4 required noun to verb shift (SA-NV item) and the remaining longer sentences required little or no shifting (tasks 6, 9, and 10; SA-INT). An adjective-to-noun shift required that a word presented with a dominant adjective meaning, due to its temporal closeness to a commonly associated word, must be taken out of that context and used as a noun in order to grammatically form a proper sentence. For example, in "THE DUST PAN COVERED THICK", the word "DUST" was strongly linked as an adjective to "PAN." However, it must be temporally distanced from pan and switched to a noun in order to form "THICK DUST COVERED THE PAN." Similarly, the noun-to-verb shift was one in which the nound "HAND" (dominant use paired with "RIGHT") must be unpaired and used as a verb in order to correctly convert "THE RIGHT HAND CHANGE HIM" to "HAND HIM THE RIGHT CHANGE." The remaining longer sentences required a recognition and incorporation of social

relationships and may have drawn more on memory and abstractions abilities. While all items required the subject to consider many possibilities at one time, it is possible that the SA-AN and SA-NV items more specifically measure one's cognitive flexibility and particularly the tendency to be "stuck in set."

It was hypothesized that the SA-AN and SA-NV items would correlate with other measures of frontal lobe functioning. Further, because the SCZ group processes information sequentially it was hypothesized they would have the greatest difficulty with these items. In contrast, it was hypothesized that the MD group, who are believed to process information in parallel would be superior on these items, with normals somewhere in the middle. The SA-Int may be more a measure of general cognitive capacity and was expected to correlate best with I.Q. measures.

CHAPTER II

METHOD

Subjects

Group 1. Twenty five patients admitted to Chicago area residential psychiatric facilities who met the criteria for the diagnosis of schizophrenia comprised Group 1. Of the 25 SCZ patients recruited 2 were unable to participate secondary to paranoia; one of which would not don the headphones and the other engaged in extraneous conversations with himself. The latter of these patients had also received a head injury between testing sessions and had to be excluded. Another subject refused to do the block design subtest. One additional subject did not pass the hearing screen. The last just refused to participate after testing commenced. The remaining group was comprised of 15 undifferentiated-type and 5 disorganized-type schizophrenics.

Group 2. Group 2 was comprised of 20 manic depressives according to DSM-IIIR criteria who were recruited through the Chicago and Toronto areas Depressive and Manic Depressive Associations. On three or more occasions the subjects were in a stable or energized phase when they signed up to be screened but experienced a depressed mood

states before the testing was initiated. These subjects became too depressed and anergic to participate. Another subject became to irritable complete the test protocol.

Group 3. An additional control group of 20 normal subjects were recruited from hospital staff at University Hospital in Chicago as well as area volunteers.

All subjects were ages 20-55. None of the subjects had a documented or self-reported history of previous head trauma or cardiovascular accident, identifiable neurological condition, a medically diagnosed or self-reported hearing impairment, current alcohol dependence, unprescribed drug use or seizures for past 6 months.

As an incentive to participate in the study, Group 1 participants were paid $2.00 for their participation while MD and Normal controls were paid $10.00 for their completion of the research protocol. Since both MD and Normal controls were generally employed and/or had to transport themselves to the test lab these monetary reinforcers were judged to have roughly equivalent motivation value for each subject's time and effort. All participants were screened by a certified audiologist or trained assistant to verify adequate hearing.

Materials

Executive Functions Tests

Trails A & B (Reitan, 1955) is a test of visual scanning, vigilance, and mental flexibility. It requires

attention, concentration and is considered to be a measure sensitive to global brain impairment (Reitan, 1955, 1958).

Stroop Test (Golden, 1978) is a test of concentration and provides a measure of global brain impairment. Golden suggested that this test taps the dimensions of cognitive flexibility, resistance to interference, and ones ability to cope with cognitive stress and to process complex input.

Executive Control Battery- Revised Sections (Goldberg et al, 1989) is a test of inhibition wherein the subject is directed to draw a series of crosses, circles, and squares in alternating sequence. This battery is designed to elicit perseverations and other manifestations of executive dyscontrol for nonverbal stimuli.

Controlled Oral Word Associated (COWA; Benton & Hamsher, 1976) test. This measure requires subjects to produce as many words as they can which begin with a given letter, in a 60 second period. Lezak (1983) reviewed a number of studies on the COWA and concluded this measure is sensitive to brain dysfunction, particularly in the left-sided frontal regions.

Design Fluency Test (Jones-Gotman & Milner, 1977) This task assesses the ability of subjects to generate novel visual forms under time constraint. Authors have found this test to be most sensitive to lesions in the right frontal and right fronto-central areas.

Wisconsin Card Sort Test (WCST; Heaton et al., 1993) This card-sorting task was originally developed to assess abstract reasoning ability and the ability to shift cognitive sets in response to changing contingencies. Recent studies have found the WCST to be specifically sensitive to frontal lobe impairments (Weinberger, Berman, & Zec, 1986). The WCST is a measure specific to frontal lobe deficits in that it requires concept formation, utilization of feedback, inhibition and planning, and "cognitive shift". Schizophrenics have well documented difficulties with the WCST similar to leucotomized and other frontal lobe patients (Stuss et al, 1983; Drewe, 1974; Robinson et al, 1980; Pendleton & Heaton, 1982).

Weschler Adult Intelligence Scale - Revised

Neuropsychological Inventory (WAIS-R NI) (Weschler, 1981; Kaplan et al, 1991) Vocabulary, Block Design and Sentence Arrangement Subtests is a neuropsychologically administered I.Q. test with supplementary tasks to determine quality of errors.

Annett Hand Reference Questionnaire (Annett, 1970) consists of a set of 11 questions. The resulting scores (ranging from 0 to 55) are analyzed as an ordinal laterality quotient developed by Annett (1985) to increase sensitivity and power as a test of hand preference.

Dichotic Listening Tests

Dichotic CV test, developed by Audiotech Laboratories, contains 40 pairs of digitized and fused consonant-vowel syllables (/ba/,/pa/, /ga/, /da/, /ta/, /ka/) and 40 pairs of CV separated by 5 msec (unfused).

Two consecutive tapes were played on a Sony stereo cassette player at a constant sound level. Three trials comprised of CV stimuli were presented to both ears; 30 trials of unfused DL CV pairs to the left ear first; 30 trials unfused DL CV pairs to the right ear first; and 60 trial of fused DL CV pairs. On the dichotic trials, the subject was asked to state the one CV sound they heard best.

To confirm that subjects understood the instructions and were able to attend to the task, each subject was given a trial of 10 stimuli in each of these three conditions. They had to meet the criteria of 8 out of 10 in order to proceed with the experimental DL tasks. They were allowed up to three attempts on each trial in order to meet criteria. In order to track patient responses to stimuli, headphones were double jacked, allowing the experimenter to hear the stimulus presented. The experimenter placed the headphones on the periphery of her ears such that the CV stimuli were detectable but not discernable. To eliminate recorder anticipation or acquiescence when recording responses the dichotic choices, the answer sheet was covered such that the two choice responses could not be seen.

Lambda (Grimshaw et al, 1994) is an numerical index resulting from a log linear analysis of the response data for ear dominance independent of stimulus dominance. The formula is:

z(lambda) = Rt - Lt responses / RT + LT responses.

The lambda index is the log odds ratio of right ear responses to left ear responses after stimulus dominance has been controlled.

Psychiatric Screening Inventories

Structured Clinical Interview for DSM-IIIR (SCID; American Psychiatric Association) is used for the diagnosis of schizophrenia and manic-depression while ruling out any other Axis I psychiatric diagnoses such as mania, substance abuse.

Brief Psychiatric Rating Scale (BPRS) (Overall & Gorham, 1962) is a 18 item rating scale of positive psychiatric systems, using a likert style 7 (1=absent, 7=severe) digit scale .

Positive and Negative Syndrome Scale (PANS) (Andreasen, 1981) is a 31 item assessment of positive and negative symptoms related to schizophrenia. Each item is rated from 1 (absent) to 7 (extreme).

Design and Procedure

Prior to participating in the study, subjects were given an explanation of the procedures to be performed and signed a consent form. Patients were first screened by one

of two trained interviewers using the SCID. Those who met the criteria of either schizophrenia or manic depressive disorder were asked to participate in the study. Interviewers were trained and tested to 95% intrarater reliability. Normal controls were also screened using both the SCIDI and SCIDII to rule out personality disorders.

Following the above preliminary screening, subjects who were chosen to participate in the study were screened for hearing impairment. The subjects completed the aforementioned neuropsychological test battery in familiar residential testing areas or in a hospital testing lab. The order of the two dichotic listening tapes were counter-balanced.

CHAPTER III

RESULTS

Groups varied in mean age (F = 7.33 df(2) p = .001). The schizophrenic (SCZ) group did not differ significantly from the manic depressive (MD) group (p = .27) or the normal controls (NC) (p = .07) using Newman Keuls analysis (see Table 1). However, the MD group was found to be significantly older than the NC group (p < .001).

Gender distribution also varied between the SCZ and MD groups (X^2 (N = 40) = 3.6, p = .058) with the SCZ group having more males and the MD group having more females (see Table 2). Likewise the NC group had significantly more females while the SCZ had more males (X^2 (N = 40) = 3.60, p = .058). The MD and NC groups did not differ in gender distribution (X^2 (N = 40) = .05, p = .8320). Racial background of groups varied with the majority of each group being Caucasian or African American (see Table 2).

The MD group had the highest education (F = 20.85, df = 2,62, p < .0001) compared to other two groups (see Table 1). Newman Keuls analysis indicated significant differences between MD (p < .001) and NC groups (p < .05). Both MD and NC groups held significantly greater years of schooling than the SCZ group (p < .0001 and p < .001 respectively).

Similarly, groups varied significantly in I.Q. (F = 20.87, df = 2,62, p < .0001). The SCZ had a significantly lower I.Q. than either the MD group (p < .001) and the normals (p < .001). The MD and NC groups did not differ significantly on I.Q. (p = 1.72). Handedness did not differ between groups (F = 0.12, df = 2,62, p = .89) (see Table 1).

On the dichotic listening tasks, there was a significant effect of group for number of errors (F = .62, df(10,114), p < .001) (see Table 3). Newman Keuls analysis showed significantly more errors were made by the SCZ group in all conditions; unfused left first (F = 17.02, df(2,61), p < .0001), unfused right first (F = 13.10, df(2,61), p < .0001) and fused stimulus condition (F = 11.16, df(2,61), p < .0001). MD and NC groups did not differ significantly across conditions. There were no main effects for gender (F = 0.99, df(3,51), p = 0.92) or race (F = 0.98, df(3,51), p = .82) nor any interaction effects.

The SCZ group also made significantly more perseverative errors (F = 0.64, df(6,118), p < .0001) across DL conditions than either the MD (p = .0001) or Control Group (p = .0001) while MD and NC control groups did not significantly differ, according to Newman Keuls analysis (see Table 3). The SCZ group made significant more perseverative errors for the unfused DL left first (F = 9.95, df(2,61), right first (F = 6.24, df(2,61), p = .003) and fused DL trials (F = 14.59, df(2,61), p < .001) than

either the MD ($p < .0001$) or the NC ($p < .0001$) groups as shown in Figure 1. MD and NC group did not vary significantly. These significant patterns remained the same when covaried for age ($F = 0.63$, df(6,116), $p < .01$) and I.Q. neared significance ($F = 0.80$, df(6,110), $p = .056$). When the SCZ group was presented with unfused versus unfused test stimuli, the number of perseverations remained the same ($t = -0.64$, df = 23, $p = .53$).

There were no differences in ear preference between groups across DL conditions (using lambda) ($F = .87$, df(6,118), $p = .21$). However, there was a bigger difference in ear preference between the SCZ and MD group ($p = .054$) with SCZ having the lowest right ear preference and MD demonstrating the greatest right ear preference while NC held a moderate right ear preference (see Table 3).

Schizophrenics made significantly more perseverative errors than either control group for Trailmaking Test Part B ($F = 50.74$, df = 2, $p < .0001$), the WCST ($F = 21.76$, df = 2, $p < 0.0001$) and Goldberg test ($F = 17.96$, df = 2, $p < .0001$) than either control group. Per Newman Keuls, the SCZ group took significantly longer to complete Trails B than either the MD ($p<.001$) or NC ($p<.001$)(see Table 4). Also the SCZ made significantly more perseverative errors on the WCST ($F = 21.76$, $p < .001$) than the MD ($p < .001$) and NC ($p < .001$) group while MD and NC groups did not differ significantly ($p=.17$). On the Goldberg test schizophrenics made

significantly more perseverations than do either control groups (F = 21.76, df(2,59), p < .001), MD (p < .001) or NC (p < .001). Again MD and NC groups did not differ significantly (p = .81).

On the DFTI the SCZ group produced fewer drawings (F = 12.35, df = 2,59, p < .001) compared to the MD group (p < .01) and the NC group (p < .001) and made more perseverations (F = 3.93, df(2,59), p < .05) than the MD (p < .05) and NC groups (p < .05). MD and NC groups did not differ significantly in number of drawings (p = .95) nor perseverations (p = .92). On DFT II the SCZ produced fewer drawings on DFTII (F = 24.02, df(2,59), p < .001) than both the MD (p < .001) and NC (p < .001) groups and made significantly more perseverations (F = 3.92, p < .05) than the MD (p < .05) and the NC (p < .05) groups. The NC group drew more designs than the MD group on DFTII (p=<.05) but did not differ in number of perseverations. There were no overall significant differences between groups on the Stroop T score (F = .043, df(2,60), p = .96) nor for the Stroop Interference Score (F = .048, df(2,60), p = 0.95) (see Table 4).

Pearson r analysis for all groups indicated significant correlations (p < .05) between the 60 trial unfused and fused DL task perseverations, and each of these two conditions with Trails B, Goldberg perseverations, COWA percentile score, and I.Q. (see Table 5). In addition, the

unfused DL perseverations correlated ($p<.05$) with Sentence Arrangement total score ($r = .33$). The fused DL perseverations also correlated ($p = .05$) with WCST perseveration errors and DFTII perseverations.

For the schizophrenic group significant Pearson r correlations were found between the number of perseverations in the fused DL condition and Trails B, Goldberg perseverations, and 60 trial unfused DL perseverations. The number of perseverations on the fused stimulus correlated negatively with I.Q. ($r = -.42$, $p = .06$). Total (60 trial) unfused DL perseverations were not significantly correlated with executive measures. However, right-first unfused DL perseverations were correlated with the Stroop total score ($r = -.46$, $p < .05$) and Stroop Interference score ($r = .46$, $p < .05$) while left-first unfused DL perseverations were not. There were also no significant correlations found between DL scores and handedness, the PANS positive symptom score nor the PANS negative symptoms score.

For the manic depressive group several significant correlations were noted. First, the total number of perseverations across fused and unfused DL conditions was positively correlated with the number of Goldberg perseverations ($r = .36$), I.Q. ($r = .54$) and WCST ($r = .37$). Number of perseverations in the 60 trial fused DL condition was correlated with Goldberg perseverations, COWA percentile, DFT II perseverations, and WCST perseverative

errors (see Table 6). The unfused, left-first DL perseveration score was significantly related to the Goldberg perseverations (r = .41) and I.Q. (r = .34) only. There were no significant correlations noted for the normal control group.

Data from the WAIS-R NI Sentence Arrangement task indicated significant group effects for total score, SA-AN (adjective to noun) items, SA-NV (noun to verb) item and SA-INT (no shift,longer sentences). Neuman Keuls analysis verified that the SCZ group scored significantly lower on the total task than did the MD group ($p < .001$) and the normal control group ($p < .001$) (see Tables 7 and 8). It was also noted that the MD group perform better than the NC group ($p < .05$) on overall SA score. For SA-AN, the SCZ group performed poorly in comparison to the MD group ($p < .001$) and the NC group ($p < .001$). There was no significant difference for MD and NC groups on these items ($p = .67$). For SA-NV, the SCZ group score significantly worse than the MD group ($p = .007$) and the NC group ($p = .02$). Again the MD and NC group did not differ significantly ($p = .44$). Lastly, for the SA-INT (longer items) the SCZ group also scored worse than the MD ($p < .001$) or NC group ($p < .001$), while the MD and MC groups did not differ ($p = .76$).

Pearson r correlation analysis for all groups indicated significant ($p < .05$) positive relationships between the I.Q. and SA total score, SA-AN, SA-NV, and SA-INT (see Table

9). The COWA percentile scores correlated ($p < .05$) with SA total score, SA-AN, and SA-INT. Both DFTI and DFTII correlated ($p < .05$) with SA total score and SA-AN. Significant negative correlations at $p < .05$ were found between Trails B and SA total score, SA-AN, SA-NV, and SA-INT. The Goldberg perseveration score correlated ($p < .05$) with SA total score, SA-AN, SA-NV, and SA-INT. The WCST perseverative errors correlated ($p < .05$) with SA total score, SA-AN, SA-NV, and SA-INT. The Fused DL perseverations correlated ($p < .05$) with SA total score, SA-AN, SA-NV, and SA-INT. The unfused DL perseverations correlated ($p < .05$) with SA total score, SA-INT and neared significance for SA-AN, and SA-NV.

CHAPTER IV

DISCUSSION

As predicted, the SCZ group was found to make more perseverative errors on the DL tasks than either the MD or NC groups. Further, the SCZ group data supported more significant correlations between their DL perseverations and frontal lobe and executive measures such as the Goldberg, COWA, WCST, DFTII, Sentence Arrangement as well as I.Q. than did the MD or NC group. This suggests that DL tasks may utilize executive functions as well. However, there were no correlations found with the PANS, BPRS or handedness. Neither PANS positive symptoms nor PANS negative symptoms correlated with WCST, DFT, or COWA measures.

The data do not support Morrison-Stewart and group's (1992) findings that positive symptoms are inversely correlated with performance on these frontal lobe measures. While there are studies that find such trends, this null finding may infer that DL perseveration represent a core deficit which may not be adequately measured by these instruments. The data supports Tucker and Williamson's theory (1984) that, if the SCZ group have left frontal impairment, then they would engage in more sequential and restricted processing, with more redundant activity, lower

I.Q. and executive functioning scores, and significantly more perseverative errors. In contrast, Manic Depressives would be seen to have emotional imbalances associated with right hemisphere dysfunction and data supported the hypothesis of concomitant parallel information processing and problem-solving, with relatively fewer perseverative errors than the NC or SCZ group and higher scores on tasks of executive functioning.

In light of the belief that the Design Fluency Test represents a right frontal test, this suggests that the SCZ group has impairment bilaterally or that the left frontal may preclude the available pathways on which the right frontal lobe may operate (Nachson, 1988). Certainly, the MD group had little problem with this task and so, along Goldberg's philosophy, may support an hypothesis that an intact left PFC precludes the level of other executive and PFC operations.

Further research may wish to record the accuracy of groups attempting to report both stimuli. While SCZ subjects appear to function sequentially on one track, MD subjects appear to function more holistically. In fact, many MD participants appeared to have little difficulty in attending to either or both ears and occasionally inquired whether the examiner would like to know both stimuli heard. They could often report these accurately. It may be this information processing deficit is causal to the memory deficits, lack of

incorporation of social cues and contextual information noted by researchers that would limit the schizophrenic's social skills and abilities. While the DL task does not require more than immediate memory retrieval, further studies may also wish to pursue the connection between delayed and other memory factors across these populations.

Furthermore, no significant differences were found between the fused and unfused conditions for the schizophrenics in terms of number of perseverations. This is not consistent with the fusion theory in which these errors are seen to be a mere "blending" of stimuli to cause an error. Rather, these findings support the theory of a core deficit in stimulus perception related to executive processes. The finding that, for the SCZ group, the Stroop Interference score correlated with perseverative errors on right-first unfused CV stimuli but not left-first CV stimuli, supports the hypothesis that SCZ processing deficits lie in the left frontal area of the cerebral cortex.

There were no differences in ear preference across DL conditions nor between groups; however the SCZ group had the lowest right ear preference, the MD group demonstrated the greatest right ear preference, while the NC group held a relatively moderate right ear preference. This trend toward "less right dominance" is consistent with the idea of an earedness continuum (Naschon, 1988; Poreh, 1994) and may be

related to the hypothesized core deficit. However, contrary to our hypothesis, the MD and NC groups did not differ significantly in earedness between either the unfused or fused DL condition. This suggests that if there were an attention deficit in the MD patients it does not effect the executive processing of stimuli received. This may also lend indirect support to the idea of a core executive processing deficit in the SCZ group versus an attentional deficit. Future studies may wish to consider further delineation of current mood state for the MD subjects in conjunction with DL stimuli perception.

In response to Bustillo and colleagues' (1995) model for determining a deficit syndrome there data suggest support for the use of core deficit criteria as outlined . According to Florence and colleagues (1995), "deficit" versus "nondeficit" schizophrenics were generally older, have a longer duration of illness and had higher negative symptom scores. If this sample had fit the criteria of deficit syndrome by Carpenter and workers (1988), as is suspected, given a higher mean of negative symptoms ($\underline{M}$ = 21.65) compared to positive symptoms ($\underline{M}$ = 15.6), then it is possible that significant correlations between negative deficits and higher executive function would also have been borne out. As well, due to the nature of the attrition of SCZ patients as described in the methods section, it is suspected that at least 2 or more of the drop outs were

paranoid schizophrenics. Therefore, the remaining sample, comprised chiefly of disorganized and undifferentiated types of SCZ with fewer positive or paranoid features. If so, subjects with more extreme positive signs may have been deleted and resulting in less of an REA finding. According to Carpenter and group (1988) this may have assisted in "purifying" this group towards more of a true "deficit syndrome" population and less of a REA group.

Further, superiority by the MD group may have been related to their suspected higher composition of manic features. Generally MD participants were either stable or entering their energetic cycle when they signed up and participating in this study and may have cycled towards depression or irritability and sometimes dropped out before testing could be done. Due to attrition then, the majority of these subjects would have theoretically met the criteria for "nondeficit" group. This may suggest a continuum of increasing executive abilities from the SCZ group to normals to MD group, with the SCZ group having overactive left prefrontal lobe activity limiting their ability to focus on the overall picture, and MD subjects having an advantage with their right hemisphere overactivity, allowing them to think and problem-solve from several perspectives.

In conclusion, this study's use of fused versus unfused DL stimuli demonstrated that schizophrenics make more perseverative errors than either MD or NC control groups.

This suggests that the correct perception and processing of DL stimuli represents a core deficit in executive or frontal lobe functions inherent to this group. Future studies may wish to use a more stringent "deficit syndrome" criteria for the selection of SCZ patients.

For purposes of future research, several technical and procedural suggestions were made. First, the incorporation of the deficit syndrome criteria was recommended. Secondly, during the recruitment phase of the MD patients it was found that mood states were key to completion of the testing for this study. Therefore it was recommended that testing proceed as soon as possible.

Thirdly, during the recording of DL responses it was noted that SCZ subjects were often more difficult to understand. This was not a problem in the MD or NC groups. Many were noted to speak softly and did not respond to experimenter prompts to speak louder nor to raise their chins so that lip movements could be used to assist in CV distinction. Only those responses clearly determined to be a true perseveration were recorded as such. As a result, some under recording of perseverations may have occurred.

An attempt was made to record subject verbal responses on a tape recorder. Unfortunately, the tapes were even more difficult to discern than the live response due to air noise and lack of visual mouth movements. Future researchers may consider the use of a high quality audiovisual tapes and two

raters to better amplify and determine the occurrence of subject perseverations and to perform interrater reliability checks. Also, the tape player headphones were double-jacked such the experimenter could follow along with the client to make sure the correct response was placed in the correct DL response slot. Often the SCZ clients were slow to respond and would skip a pair response such that recording could become "off line". Future researchers should devise a system whereby the DL CV pair stimuli are signalled by a visual light or meter number on the tape player system and answer sheets should be paired in some labelled fashion. Response differentiation and recording was not considered a problem in the MD and control groups.

APPENDIX A

GROUP MEANS AND STANDARD DEVIATIONS

Table 1

Group Demographics

	Means					
	SCZ		MD		NC	
Category	1	(SD)	2	(SD)	3	(SD)
Age	38.3	(7.6)	42.0	(7.8)	33.0	(7.2)
Education (yrs)	11.6	(2.2)	15.3	(1.9)	14.0	(1.7)
I.Q.	80.0	(11.9)	109.8	(13.4)	100.7	(19.3)
Handedness	42.2	(10.2)	45.6	(8.5)	44.2	(11.8)

Table 2

Group Demographics for Gender and Race

Category	SCZ 1	MD 2	NC 3
No. of Males	12	7	7
No. of Females	8	13	13
Caucasian	7	17	8
African American	12	2	9
Hispanic	0	0	3
East Indian	1	1	0

Table 3

Dichotic Listening Means

	Means		
	SCZ	MD	NC
TEST	1 (SD)	2 (SD)	3 (SD)
DL Left-first Errors	7.1 (4.1)	2.6 (2.2)	2.4 (2.2)
DL Right-first Errors	6.2 (4.2)	2.2 (1.9)	2.4 (2.1)
DL fused errors first half	6.7 (3.8)	3.4 (2.2)	3.1 (1.6)
DL total fused errors	13.2 (8.3)	6.1 (4.1)	6.1 (3.1)
DL Left-First Persev	1.9 (2.1)	0.4 (0.6)	0.2 (0.6)
DL Right-First Persev	1.7 (2.2)	0.4 (0.9)	0.4 (0.6)
DL Fused first half	2.0 (1.9)	0.4 (0.7)	0.2 (0.4)
Total DL Fused Persev	4.0 (3.8)	0.8 (1.1)	0.6 (0.7)
Total DL Persev	7.6 (6.4)	1.6 (2.2)	1.2 (1.1)
Ear Preference	-.36 (.48)	-.56(.21)	-.44 (.22)

Table 4

Group Means for Tests of Executive Functioning

TEST	Means SCZ 1	(SD)	MD 2	(SD)	NC 3	(SD)
Trails B (sec)	266.8	(106.3)	81.6	(41.2)	78.6	(34.3)
Stroop T Score	48.0	(9.5)	47.5	(7.8)	47.2	(7.9)
Goldberg Perseverations	5.6	(5.1)	0.9	(1.7)	0.6	(1.0)
COWA Percentile	24.5	(30.0)	60.6	(24.7)	58.7	(30.8)
DFTI number of drawings	10.5	(9.9)	22.7	(10.1)	29.4	(16.7)
DFTI Perseverations	3.9	(7.9)	0.4	(0.8)	0.2	(0.6)
DFTII number of drawings	7.7	(7.2)	21.4	(8.1)	29.1	(14.1)
DFTII Perseverations	4.0	(7.2)	1.0	(1.6)	0.5	(0.9)
WCST Perseverations	57.3	(24.8)	18.8	(14.3)	27.6	(18.6)

Table 5

Pearson r Correlations of Fused and Unfused Trial DL Perseverations with Tests of Executive Functioning

TEST	GROUP					
	All Groups		SCZ		MD	
	Unfused	Fused	Unfused	Fused	Unfused	Fused
Unfused	--	.69***	--	.49*	--	.48*
Trials B	.42***	.66***	-.08	.44*	.31	.22
Goldberg	.37**	.63***	.15	.55*	-.05	-.09
COWA Percentile	-.34**	-.34**	.17	-.13	.45*	.30*
IQ	-.37**	-.49***	-.06	-.37	.07	-.38
DFTI Per	.07	.16	-.08	.01	.13	.48*
DFTII Per	.11	.39**	.00	.36	.15	.03
WCST Per Errors	.31	.37**	.10	.07	-.21	.18

Note. Per = perseveration(s)

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 6

Pearson r Correlations of Tests with Total Perseverations Across Dichotic Listening Tasks

TEST	GROUP		
	SCZ	MD	NC
Trails B	.27	-.09*	.29
Stroop T	-.09	-.32	.07
Goldberg	.44*	-.08	-.03
COWA Percentile	-.17	.45*	-.14
DFTI Perseverations	-.03	.33	-.22
DFTII Perseverations	.24	-.08	-.05
Sentence Arrangement	-.15	-.25	-.44*
WCST Perseverations	-.10	-.04	-.09
IQ	-.27	-.45*	-.16
PANS	.13	--	--
SANS	.17	--	--

* $p < .05$

Table 7

Group Means for Sentence Arrangement (SA)

Score	Means SCZ 1	(SD)	MD 2	(SD)	NC 3	(SD)
SA Total	5.14	(3.8)	15.9	(4.8)	12.7	(6.0)
SA AN	2.9	(1.6)	5.0	(1.5)	4.8	(1.3)
SA NV	0.3	(0.5)	0.8	(0.4)	0.4	(0.5)
SA-INT	0.6	(0.9)	2.1	(1.0)	2.0	(1.1)

Table 8

Group Effects for Sentence Arrangement

Score	*F* value	df	*p* level
SA Total Score	25.84	2,58	.001
SA-AN	13.64	2,58	.001
SA-NV	5.37	2,58	.01
SA-INT	13.97	2,58	.001

Table 9

Pearson r Correlations between SA Score and Executive Function Test Scores ($p < .05$)

Test	SA score	SA-AN	SA-NV	SA-INT
IQ	.80	.69	.49	.58
COWA	.54	.39	.55	--
DFTI	.54	.50	--	--
DFTII	.59	.50	--	--
Trails B	-.76	-.60	-.36	-.58
Goldberg	-.51	-.31	-.36	-.46
WCST Per Errors	-.57	-.54	-.30	-.39
Fused DL Per	-.44	-.30	-.29	-.35
Total Unfused DL Per	-.28	-.33	-.24	-.24

Note: Per = Perseverations; -- means correlation not significant at $p = .05$ level

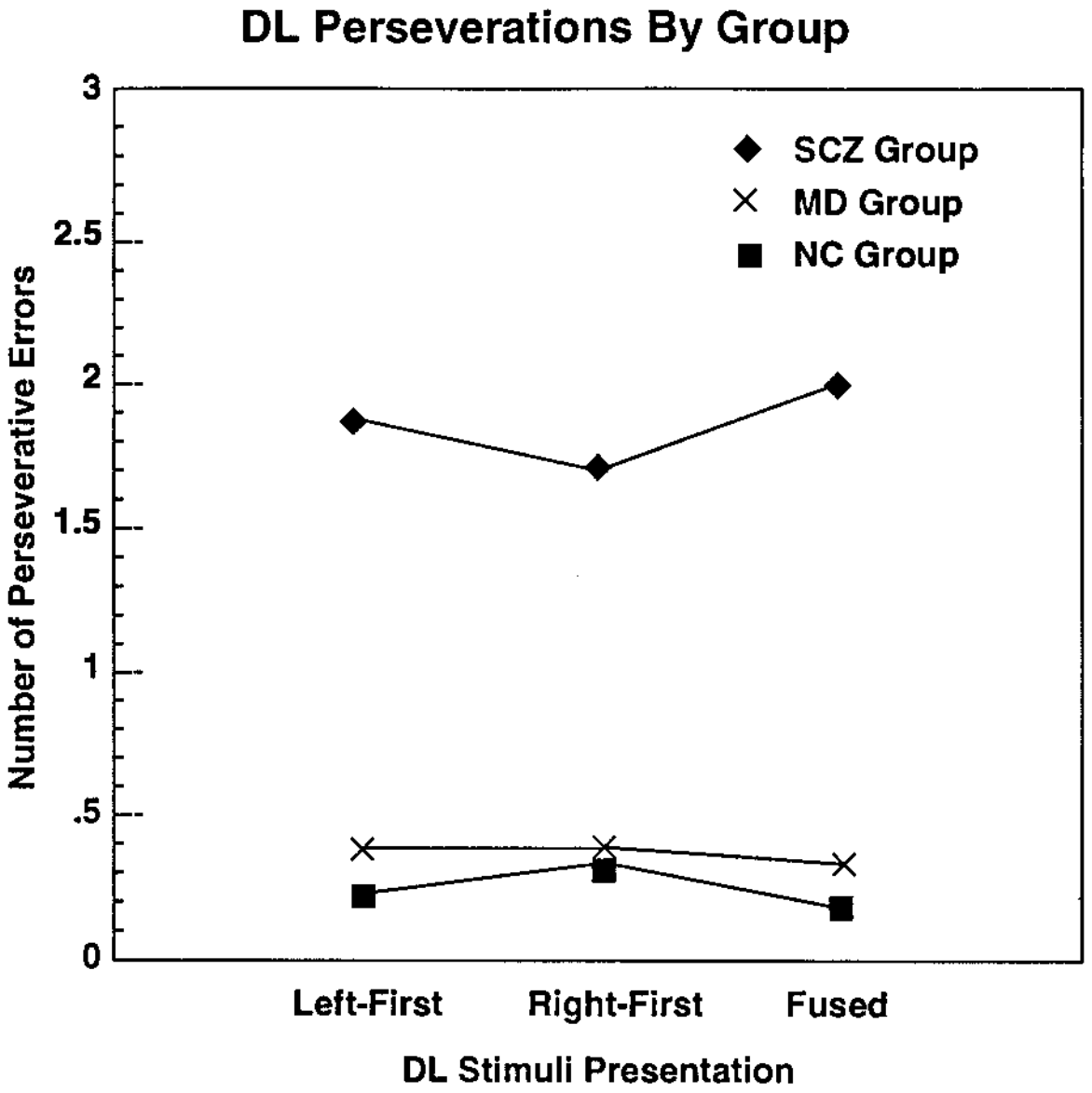

Figure 1. Group mean perseverative errors for fused and unfused dichotic listening conditions

APPENDIX B

ALL GROUP MEANS AND STANDARD DEVIATIONS

Table 10

Group Means and Standard Deviations

Category	Means SCZ 1	(SD)	MD 2	(SD)	NC 3	(SD)
No. of Males	17		7		7	
No. of Females	8		12		13	
Caucasian	11		17		8	
African American	13		2		9	
Hispanic	0		0		3	
East Indian	1		1		0	
PANS Pos	15.7	(4.6)	--		--	
PANS Neg	21.7	(7.6)	--		--	
BPRS	47.7	(10.4)	--		--	
Handedness	42.2	(10.2)	45.6	(8.5)	44.2	(11.8)
Age	38.3	(7.6)	42.0	(7.8)	33.0	(7.2)
Education (yrs)	15.3	(1.9)	11.6	(2.2)	14.0	(1.7)
WAIS-R Vocabulary SS	6.7	(2.6)	12.1	(2.6)	10.3	(3.5)
Block Design SS	5.6	(2.3)	10.0	(2.8)	9.3	(3.5)
I.Q.	80.0	(11.9)	109.8	(13.4)	100.7	(19.3)
DL Left-First Errors	7.1	(4.1)	2.6	(2.2)	2.4	(2.2)
DL Right-First Errors	6.2	(4.2)	2.2	(1.9)	2.4	(2.1)

(Table continues)

Category	Means SCZ 1	(SD)	MD 2	(SD)	NC 3	(SD)
DL Fused Errors First Half	6.7	(3.8)	3.4	(2.2)	3.1	(1.6)
DL Total Fused Errors	13.2	(8.3)	6.1	(4.1)	6.1	(3.1)
DL Left-First Persev	1.9	(2.1)	0.4	(0.6)	0.2	(0.6)
DL Right-First Persev	1.7	(2.2)	0.4	(0.9)	0.4	(0.6)
DL Fused First-Half Persev	2.0	(1.9)	0.4	(0.7)	0.2	(0.4)
Total DL Fused Persev	4.0	(3.8)	0.8	(1.1)	0.6	(0.7)
Total DL Persev	7.6	(6.4)	1.6	(2.2)	1.2	(1.1)
Ear Preference	-.36	(.48)	-.56	(.21)	-.44	(.22)
Trails A (sec)	71.7	(31.6)	35.3	(20.1)	30.2	(11.6)
Trails A Errors	0.3	(0.8)	0.5	(0.2)	0.2	(0.4)
Trails B (sec)	266.8	(106.3)	81.6	(41.2)	78.6	(34.3)
Trails B Errors	3.3	(3.0)	0.3	(0.8)	0.3	(0.6)
Stroop Interf T Score	48.0	(9.5)	47.5	(7.8)	47.2	(7.9)
Goldberg Persev	5.6	(5.1)	0.9	(1.7)	0.6	(1.0)

(Table continues)

Category	Means SCZ 1	(SD)	MD 2	(SD)	NC 3	(SD)
COWA Total Responses	26.0	(12.8)	41.0	(9.6)	41.2	(10.9)
COWA Percentile	24.5	(30.0)	60.6	(24.7)	58.7	(30.8)
DFTI number of drawings	10.5	(9.9)	22.7	(10.1)	29.4	(16.7)
DFTI Persev	3.9	(7.9)	0.4	(0.8)	0.2	(0.6)
DFTII number of drawings	7.7	(7.2)	21.4	(8.1)	29.1	(14.1)
DFTII Persev	4.0	(7.2)	1.0	(1.6)	0.5	(0.9)
WCST No. of Categories	1.3	(1.8)	5.1	(1.3)	4.2	(1.8)
WCST Persev	80.5	(30.6)	36.8	(19.1)	46.0	(21.3)
WCST Persev Errors	57.3	(24.8)	18.8	(14.3)	27.6	(18.6)
WCST Errors	78.1	(20.0)	31.9	(22.9)	40.1	(25.3)
SA Total	5.14	(3.8)	15.9	(4.8)	12.7	(6.0)
SA AN	2.9	(1.6)	5.0	(1.5)	4.8	(1.3)
SA NV	0.3	(0.5)	0.8	(0.4)	0.4	(0.5)
SA-INT	0.6	(0.9)	2.1	(1.0)	2.0	(1.1)

Note. Persev = Perseverations, Interf = Interference

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