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Neuropsychology and Psychopathology: A Progress Report

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This paper summarizes and discusses the contributions of neuropsychological assessment to various forms of psychopathology. Emphasis is placed upon studies done with the Halstead–Reitan battery and the Wechsler Adult Intelligence Scale, but studies done with other neuropsychological test procedures are also reviewed. The conclusions reached are that neuropsychological tests are sensitive to functional regional brain disorganization in psychopathology, and that they are useful in the diagnostic process for a number of disorders including schizophrenia, psychopathy, mood disorders, and other psychiatric conditions.

KEY WORDS: psychopathology; Halstead-Reitan battery; schizophrenia.

INTRODUCTION

In this article I will review the rapidly accumulating body of evidence indicating that neuropsychological approaches are of great importance in the study of the detailed patterns of cerebral disorganization in psychopathology. I will restrict the discussion to the contributions made by neuropsychological test batteries, essentially North American batteries derived from Halstead–Reitan and more recently the Luria–Nebraska battery, a quantification of the qualitative style of Luria. Also the importance of psychometrics (Wechsler Adult Intelligence Scale; WAIS) patterns of verbal/peformance discrepancies and of particular subscale clustering in various disorders will be examined. Only the neuropsychological–psychometric correlates of the major endogenous psychoses will be considered here: depression, mania, and schizophrenia.

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NEUROPSYCHOLOGICAL STUDIES DERIVED FROM THE HALSTEAD-REITAN BATTERY

After 1960, psychiatric subjects have been increasingly subjected to neuropsychological studies. Heaton *et al.* (1978) have reviewed 94 studies published between 1960 and 1975 that compared the test scores of adult psychiatric patients with brain-damaged groups, or against established norms. Only 6 of the published studies during this period utilized the full Halstead-Reitan battery, and only 4 incorporated the Wechsler scales. The majority of studies employed only 1 or 2 tests—often the Trail Making test, Bender Gestalt Test, or Memory For Designs. Excluding chronic schizophrenia, the test(s) discriminated with a median hit rate of 75% between all the psychiatric categories and the brain-damaged groups. In the case of chronic schizophrenia the hit rate of 54% was essentially at chance level. Heaton and Crowley (1981), in a similar review of studies published between 1975 and 1978 (24 studies), found a median hit rate of 56% for chronic schizophrenia and of 76% for the other psychiatric categories.

Heaton and Crowley emphasized the methodological defects present in most of the investigations they considered. For example, all but 7 studies in their first review had three or more of the following inadequacies: the psychiatric populations were not operationally defined; it was not specified how subjects were selected and if they were clinically representative, the neurological bases for the diagnosis of organicity in the brain-damaged groups were not given, the formal exclusion of brain disease in the psychiatric groups was not done, chronicity was not controlled for, and no age or education correction was undertaken. As Goldstein (1984) pointed out in his review: "The failure of much of the differential diagnosis research in regard to discrimination between brain-damaged and schizophrenic patients with neuropsychological tests may now be viewed less as a disappointment" (p. 63). "In the past, it was assumed that although the schizophrenic patient looked like the brain-damaged patient on tests, the similarity was superficial. The brain-damaged patient was seen as demonstrating impairment because of an inability to perform the task, while the schizophrenic patient was viewed as a patient who really could perform the task but failed to do so because of difficulties with maintaining attention, interference by intruding thoughts, or failure of motivation" (pp. 61–62). Goldstein, who in his own neuropsychological lab found that schizophrenics are more efficient with right hemispheric tasks requiring gestalt perception and synthesis than at left hemispheric cognitive processes requiring analysis and sequencing, concluded that "there is evidence coming from many settings that a specific neuropsychological deficit in schizophrenia is some form of dysfunction of the left cerebral hemisphere" (p. 64). Others, such as Goldberg and Weinberger (1986),

focusing on attentional processes, memory, and perception have preferred to emphasize frontal lobe dysfunction as the central deficit in schizophrenia revealed by impairment on tests of set shifting, category formation, mental flexibility, and vulnerability to interference. It is clear that these two alternatives are not mutually exclusive!

The now well-established fact that different psychopathological syndromes show, statistically, different patterns of selective deficits indicates that the patterns of cerebral disorganization characteristically found in the various psychiatric disorders cannot be—as some would have it—merely nonspecific consequences of motivation, distractibility, or psychomotor retardation. Distinctive cognitive profiles have been found within the schizophrenias. Robertson and Taylor (1985b) investigated 61 schizophrenic men, compared to 41 men without psychiatric disorder. They were divided into four subgroups: the first, "delusional" i.e., essentially with positive symptomatology (delusions and hallucinations), were neuropsychologically similar to normals; the second, with "mixed" symptoms (delusions, expressive thought disorder, and flat affect in 32%) were impaired when compared to normals on a large number of variables, verbal and nonverbal; the greatest deficit occurred in the third group, insidious onset "simple" schizophrenia with no record of delusions or hallucinations. The psychometric picture was one "of deficiency in functions which are associated with the left hemisphere and with the frontal lobes (p. 96). The fourth "atypical" group with very severe, chronic tension and anxiety and obsessional traits was superior to the normals in IQ., significantly so for Block Design, but were inferior in verbal fluency and visual retention. Robertson and Taylor concluded that these cognitive differences "reflect real differences in the disorder and type of illness being experienced . . . and that each group showed a distinctive cognitive profile" (p. 81).

Utilizing Reitan's modification of the Halstead Wepman Aphasia Screening test, Taylor *et al.* (1979) found, in 22 strictly defined schizophrenics, 105 affective psychotics and 99 age-matched normal controls that the schizophrenics made dominant temporal/temporo-parietal errors at more than three times the frequency of these errors observed in the affective group. Taylor *et al.* (1981), later using Smith's neuropsychological test battery[2] in 17 schizophrenics, 9 depressives, and 43 manics, observed bilateral dysfunction in schizophrenics and primarily nondominant dysfunction in the affective disorders. The schizophrenics were significantly more impaired for dominant

[2]*Dominant test:* WAIS verbal IQ; right-hand errors simultaneous discrimination; right-hand pegboard performance; sentence repetition; Peabody picture vocabulary. *Nondominant tests:* WAIS performance IQ; left-hand errors simultaneous discrimination; left-hand pegboard performance; Benton Visual Retention; Raven's Progressive Matrices; Hooper Visual Organization.

functions than the affectives. Taylor and Abrams (1983), selecting items from various batteries, found that global impairment is more severe in schizophrenics ($n = 62$) than in affective disorders ($n = 97$) and that the schizophrenics were significantly more impaired for dominant hemisphere variables. Compared to 42 normal controls (Taylor and Abrams, 1984), the 62 schizophrenics "exhibited bilateral cognitive impairment that was relatively worse than that of controls on tasks of dominant frontotemporal function" (p. 198).

Overall, the neuropsychological investigations of the endogenous psychoses that we have carried out at the Alberta Hospital Edmonton in the last 12 years are in excellent agreement with the parallel studies of Taylor and Abrams. In a first series of 54 schizophrenics and 60 affective psychoses the pattern of cerebral dysfunction, on an extensive neuropsychological battery, showed clearly that schizophrenia was characterized by bilateral frontotemporal dysfunction (left > right) and the affective group by bilateral frontotemporal dysfunction (right > left). As Taylor *et al.* had observed, the two groups were similarly impaired on nondominant variables such as Memory For Design, Tactual Formboard, Purdue Pegboard, and constructional apraxia. The schizophrenics were significantly more impaired than the affectives on dominant hemisphere functions such as Speech Sounds Perception, Tactual Formboard for the preferred hand, Oral Word Fluency, or Aphasia Screening test (Flor-Henry *et al.*, 1975; Flor-Henry, 1976).

A more detailed analysis of this material (Flor-Henry and Yeudall, 1979) showed that when the depressed ($n = 13$), manics ($n = 26$), schizophreniform psychoses ($n = 26$), and nuclear schizophrenics ($n = 26$) were compared to each other and to normal controls ($n = 46$) in several analyses of covariance, with age, Full-Scale IQ and age and IQ as covariates, "the neuropsychological characteristics of depression, mania and schizophrenia... suggest a continuum of increasing cerebral disorganization which is non-dominant frontotemporal (and weakly bifrontal) in depression; in mania, the non-dominant hemispheric dysfunction becomes much more extensive and is associated with more definite bilateral disorganization. The schizophrenias have a deficit of non-dominant frontotemporal functions which is comparable to that seen in mania (although more severe) together with a great degree of dominant frontal and temporal dysfunction" (p. 361).

There were interesting differences in dynamometric hand strength in the four groups; normals, depression, mania, and nuclear schizophrenia. In the three psychoses the grip was bilaterally weaker than in the healthy controls. In the normals, however, the left hand was weaker than the right by 3 kg; similarly in the depressed, but in both mania and schizophrenia the left hand was weaker than the right by a factor of 6 kg (analysis of covariance controlling for age indicated that right- and left-hand differences for the groups were all significant).

Table I. Dynamometric Hand Strength: Means for Males and Females[a]

Schizophrenia $n = 86$, age = 33	Mania $n = 61$, age = 39	Psychotic depression $n = 81$, age = 37	Neurotic depression $n = 48$, age = 34
P hand 36	36	36	34
Non-P hand 33	35	33	30

[a]P hand: preferred hard; Non-P hand: nonpreferred hand.

Table II. Dynamometric Hand Strength: Means for Females

Schizophrenia $n = 34$, age = 37	Mania $n = 29$, age = 29	Psychotic depression $n = 43$, age = 36	Neurotic depression $n = 28$, age = 36
P hand 23	26	26	27
Non-P hand 20	24	24	22

In a new sample consisting of 86 schizophrenics, 61 manics, 81 depressive psychoses and 48 neurotic depressions, all unmedicated, the grip strength was as in Table I. In Tables II and III the values for females and males, respectively, are shown. In normals the means for the age range of 31–40 years are as shown in table IV.

The dynamometric means for normals, collected by Yeudell *et al.* (1987), are similar to the only other published norms for hand strength stratified by age—those of Dodrill (1978). There is a tendency for male schizophrenics and male manics to exhibit relative left frontal weakness as they are the only groups with a nonsignificant difference of only 1 kg between the two hands. The discrepancy between the two studies on this point is, perhaps, due to the fact that some 50% of the patients in the first investigation were medicated, and there is evidence that neuroleptics selectively improve left hemisphere functions at the expense of right hemisphere efficiency (Tomer and Flor-Henry, 1988). To the extent that the dynamometric hand strength reflects contralateral-dorsolateral frontal convexity functions severe bilateral frontal impairment is implied in the four psychiatric groups. The relative weakness of the left hand is greatest in neurotic depressions (difference of 4 kg), particularly in neurotic women (difference of 5 kg). In normals the average difference in strength between the two hands is on the order of 2–3 kg. Ex-

Table III. Dynamometric Hand Strength: Means for Males

Schizophrenia $n = 52$, age = 30	Mania $n = 32$, age = 37	Psychotic depression $n = 38$, age = 37	Neurotic depression $n = 20$, age = 32
P hand 43	46	47	45
Non-P hand 42	45	44	42

Table IV. Dynamometric Hand Strength: Means for Normals

	Preferred hand	Nonpreferred hand
Males and females (n = 42)	45	43
Males (n = 26)	52	50
Females (n = 16)	33	30

pressed as the right/left ratio of the mean power, the values for schizophrenia are 1, mania 1.09, psychotic depression 1.13, and neurotic depression 1.13 (see Table V).

Merrin (1984) similarly reported relatively similar manual grip strength, right and left, in 49 normals; a relatively greater right-hand strength in 40 affective disorders and in paranoid schizophrenias (but symmetrical in nonparanoid forms). All psychotic groups had bilaterally weaker grip than normals. Goldstein and Halperin (1977) had also found, in the comparison of 67 paranoid and 73 nonparanoid schizophrenics, relatively stronger right-hand grip in paranoids and symmetrical strength in nonparanoids (cited by Merrin, 1984).

In a second series of 28 schizophrenics, 25 manic, 28 psychotic depressives, and 24 neurotic depressives, we were able to confirm and amplify the results of our first study (Flor-Henry *et al.*, 1983). The patients were all unmedicated and subjected to a slightly modified but equally extensive test battery consisting of 15 neuropsychological tests and the WAIS. Frontotemporal dysfunction (left > right) in schizophrenia and (right > left) in depression was again found, with symmetrical dysfunction in mania. When sex was taken into account, however, the predominantly left-sided asymmetry of dysfunction was only true for *male* schizophrenics and the predominantly right-sided dysfunction in *female* psychotic depressions, the dysfunction being bilaterally symmetrical in *female* schizophrenics and *male* depressives. At the level of global neuropsychological functioning the group differences ranged along a continuum of increasing general impairment, with considerable overlap,

Table V. Right/Left Ratios of Mean Power

	Males and females	Females	Males
Schizophrenia	1.06	1.15	1.02
Mania	1.06	1.08	1.02
Psychotic depression	1.09	1.08	1.07
Neurotic depression	1.13	1.22	1.07

from depression to mania to schizophrenia. Across the three psychoses, the males were more dysfunctional than the females for dominant hemispheric functions, but both sexes were comparably impaired on nondominant indices.

A factor analysis of the 30 derived neuropsychological variables for all the psychiatric groups gave rise to seven independent factors, which accounted for 73% of the total variance. Plotting the means of the various groups on these seven factors, quite distinct profiles emerged. Notably, schizophrenia and mania were remarkably similar in configuration, and equally and maximally dysfunctional on the predominantly left frontal factor (Halstead Category, Wisconsin Card Sorting, Written Word Fluency, and Oral Word Fluency), although the overall severity of dysfunction was less in mania than in schizophrenia on the other factors. Psychotic depressions, by contrast, were similar to normals on this left frontal factor, but the most impaired of all groups on a tactual formboard test designed by Yeudall ("LJ Recognition"), which is a modification of the Halstead-Reitan Tactual Formboard, in which the shapes are so constructed that they cannot be given verbal labels; i.e., a purer test of nondominant manipulo-spatial processing.

STRUCTURAL CHANGES AND NEUROPSYCHOLOGICAL TEST RESULTS

Golden *et al.* (1985) found in the simultaneous study of regional cerebral blood flow and of neuropsychological indices of impairment on the Luria-Nebraska battery of 51 (medicated) schizophrenics that reduction of left anterior gray flow was particularly predictive of global neuropsychological deficit.

Nyman *et al.* (1986) calculated from the Swedish version of the Wechsler-Bellevue Intelligence Scale an index of schizophrenic cognitive impairment (the difference between Information score and Arithmetic, Picture Completion, Picture Arrangement) and an index of left hemisphere deficit (difference between Information and Arithmetic, Digit Span, Similarities). Those patients 2 standard deviations below controls were considered impaired. In 23 schizophrenics, patients with left hemisphere impairment had significantly larger third ventricles and wider Sylvian fissures, which was more often visible and wider on the left than on the right side. Schizophrenic and left hemispheric cognitive impairment were both correlated with the size of the third ventricle alone, while Block Design (impairment of which is significantly associated with length of posttraumatic amnesia in head injuries—and with left or right parietal injuries) was positively correlated with third and lateral ventricular size. The implications are that Block Design deficit in schizophrenia relates to central degeneration while the schizophrenic-left hemisphere

cognitive deficits relate more to predominantly left hemispheric cortical neuronal loss.

Pandurangi *et al.* (1986) isolated a subgroup of schizophrenics with ventricular dilatation and patchy cortical hyperdensity, who had an increased incidence of electroencephalogram abnormalities and greatest deficit on the complete Halstead-Reitan battery (impairment index).

Kemali *et al.* (1987) compared the symptomatological characteristics and neuropsychological features of 50 schizophrenics, with and without lateral ventricular enlargement. Twenty-five percent had a ventricular brain ratio (VBR) more than 2 standard deviations than that of the 25 normal controls, the definition of ventricular enlargement. Schizophrenics with ventricular dilatation had a longer illness, more prolonged hospitalization, and more negative symptoms (alogia, affective flattening, attentional impairment), and were significantly more impaired on the Luria-Nebraska scales for rhythm, writing, reading, arithmetic, and left hemisphere—all dominant indicators—than the patients without computed tomography scan evidence of structural cerebral change.

Keefe *et al.* (1987) examined 97 male chronic schizophrenics divided into three groups: (1) The "Kraepelinian" type ($n = 21$) had required for the past five years continuous hospitalization, or were completely dependent on others for the basic necessities of survival; they could not work and had no remission of symptoms. They were the least responsive to haloperidol and had the most severe positive *and* negative symptoms. (2) The "exacerbated" group required hospitalization but did not meet the above criteria, and were responsive to haloperidol. (3) The "stable" group had been functioning out of hospital for at least three months. The VBR of the total schizophrenic population was significantly larger than age-matched normal controls. There was no difference in VBR between the three groups. However, *ventricular asymmetry* was significantly different: the left/right ventricle ratio was larger in the Kraepelin group than in the other schizophrenics (1.17 and 0.99, respectively, $p < 0.02$). It is noteworthy that, once again, the structural pathology of the dominant hemisphere is demonstrated in the malignant core syndrome of schizophrenia, dementia praecox type, in males.

JAPANESE STUDIES

A number of Japanese workers have been active in recent years in the field of neuropsychology and schizophrenia. I will review some of these studies. Hiraguchi *et al.* (1984) evaluated 28 chronic schizophrenics and unilateral brain-damaged patients, right and left sided, with a neuropsychological battery consisting of the WAIS, Visual Memory Test, Word Fluency

Test, Animal Drawing and Kana Word tests. The schizophrenics showed lower scores on WAIS subtests sensitive to left hemisphere functions. On the other neuropsychological tests the schizophrenics were significantly impaired compared to the healthy controls, but not significantly different from the brain-damaged groups; the response patterns on the visual memory test, however, were similar to those of the left brain-damaged group.

Kashima *et al.* (1985) administered a modified (simplified) version of the Wisconsin Card Sorting test to 33 chronic schizophrenics, 27 patients with frontal lesions, 33 patients with cerebral lesions other than frontal, and 19 normal controls. The schizophrenic and frontal patients made significantly more total and perseverative errors than the others, and had more difficulty in maintaining sets. In the frontal lesions group there were no correlations between Wisconsin scores and IQ, whereas in the schizophrenics the Wisconsin scores were significantly correlated with the WAIS IQ and also with the indices of negative symptomatology, notably affective blunting and avolition–apathy.

In a second study Hiraguchi *et al.* (1985) investigated 33 chronic male schizophrenics, all of whom were dextral, looking for possible differences between those with negative symptomatology alone and those with negative and positive symptoms. Overall there was no lateralized difference between the two groups, but on a Thurstone-type verbal fluency task the negative symptomatology group was significantly more impaired with fewer response words. Comparing the schizophrenics on this verbal fluency test with normal controls matched for age and verbal IQ (vocabulary score of the WAIS), the schizophrenics were significantly impaired. Thus a greater degree of dominant frontotemporal dysfunction is suggested both in negative symptomatology vs. negative + positive symptomatology, and in the schizophrenics as a whole, compared to the controls.

In the study of the kinetic and perceptual aspects of mirror writing, Tamai *et al.* (1985) found the schizophrenics similar to left brain-damaged patients because of intact perceptual discrimination, while patients with right hemisphere lesions exhibit mirror writing.

RESEARCH WITH OTHER NEUROPSYCHOLOGICAL BATTERIES

Langell *et al.* (1987) investigated the Luria–Nebraska battery differences between 45 paranoid and 45 nonparanoid schizophrenics, also studying 45 controls. The groups were almost exclusively males, dextral, and (patients) medicated. The nonparanoid group was most impaired; the paranoids were inferior to normals on one right hemispheric task (visual) and on four left hemispheric tasks (Expressive Speech, Writing, Memory, and Intellectual

Processing). The paranoids were superior to the nonparanoids principally on Motor, Rhythm, Receptive Speech, Memory, and Intellectual Processes. Thus, essentially, a gradient of increasing left hemispheric dysfunction is indicated by these results—least in the paranoids and maximal in the nonparanoids. To some extent the distinction between paranoid/nonparanoid resembles that between acute/chronic schizophrenia.

A recent finding of Scarone *et al.* (1987), who found significantly more left-sided extinctions in chronic than in subchronic schizophrenias on the Quality Extinction test, is consistent with the Langell *et al.* report. (Left-sided extinctions are exclusively contralateral with lesions of the right hemisphere, but may be either contralateral or ipsilateral with left hemisphere lesions.) The excess of left-sided extinctions in the chronic patients, however, could also be a neuroleptic effect since all the patients were medicated and the chronic patients would have more prolonged exposure, and would therefore be more susceptible to the neuroleptic related left-sided neglect discussed earlier.

In a complex correlational analysis of the symptomatic and neuropsychological components of the schizophrenic defect state (Bilder *et al.,* 1985) three distinct clusters of symptoms emerged: (1) Alogia, attentional impairment, positive thought disorder, and bizarre behavior were independent of the positive/negative symptomatology dimension. (2) Affective flattening, avolition–apathy, and anhedonia reflected blunting of affect and avolition, (3) Delusions, hallucinations, and "breadth of psychosis" corresponded to the intensity of the psychotic features. Positive and negative symptoms were positively correlated, and did not form a dichotomy corresponding to Type I/Type II schizophrenia. An extremely extensive neuropsychological battery was administered to the 32 chronic schizophrenic patients, and was transformed into scales of motor, somatosensory, perceptual, language, memory, attentional, executive, and global functions. Factor 1 (alogia/positive thought disorder) was most highly correlated with language, memory, and global neuropsychological deficit compared to Factor 3 (delusions/hallucinations); Factor 1 was more highly correlated than Factor 2 (blunting of affect and avolition) with impairments on perceptual, language, and memory scales; and Factor 2 was more highly correlated than Factor 3 (delusions and hallucinations) with deficit on the attentional scale. The authors concluded that their findings suggest that the defect state includes two distinct processes—blunting of affect and avolition on the one hand and cognitive disturbance on the other—and that the global neuropsychological deficit associated with the first factor reflects long-standing static dysfunction, upon which other dysfunctions are later superimposed. No clear "geography" of cerebral dysfunction emerged; however specific patterns of selective neuropsychological deficits distinguished clusters of abnormal mental symptoms in chronic

schizophrenia, with the most profound impairment relating to alogia, attentional impairment, bizarre behavior, and positive thought disorder, and with relatively intact neuropsychological status for the delusional-hallucinatory dimension, suggesting that the former is derivative of structural and the latter of neurophysiological pathological processes.

Liddle (1987) offered the interesting suggestion that "the heterogeneity of schizophrenia arises not from the existence of several discrete types of illness, but rather "from the occurrence of several distinguishable pathological processes, which can occur in association with a putative, fundamental abnormality central to schizophrenia" (p. 49). He identified the syndromes by a correlational analysis of the symptoms, and then examined the correlations between syndrome scores and cognitive performance. In 40 medicated schizophrenics, ill for an average of 10 years, most of whom were males, the symptoms segregated into three syndromes: *reality distortion* (auditory hallucinations, persecutory delusions, and delusions of reference), *disorganization* (inappropriate affect, poverty of content, positive formal thought disorder), and *psychomotor poverty* (poverty of speech, decreased spontaneous movements, and blunting of affect). Thirteen cognitive tests were administered, a majority of which required verbal processing. Distinctive patterns of cognitive performance were associated with each syndrome. The psychomotor poverty syndrome was associated with poor long-term memory, object naming, and conceptual thinking. The disorganization syndrome had poor performance on orientation, concentration, immediate recall, and word learning. The reality distortion syndrome was not associated with cognitive dysfunction, except for poor figure-ground perception. The psychomotor poverty syndrome was related to poor scores on Similarities, a left hemisphere indicator, while the disorganization syndrome was associated with poor visuospatial recall evoking right hemisphere dysfunction. Liddle remarked that these lateral differences between the syndromes would suggest that mediobasal frontal activity might relate to right hemisphere and dorsolateral frontal activity to left hemisphere activation. He cited in this connection the neurometabolic study of Clark *et al.* (1984) in normals where such correlations have been observed. Both the psychomotor poverty and disorganization syndromes were also associated with cortical neurological signs—this was not the case for the reality distortion syndrome, confirming that positive-type symptomatology such as hallucinations or delusions are the reflections of neurophysiological rather than structural alterations, in opposition to the other two syndromes, essentially of deficit symptomatology, which are related to structural brain changes. There is probably a correspondence between the psychomotor poverty syndrome described here and the "psychotic motor syndrome" reported by Günther *et al.* (1986) common to both untreated schizophrenics and endogenous depressions. It consists of disturbance of the

lip and tongue movements, fine and gross movements of the dominant (right) hand, and impaired complex motor coordination of the extremities.

Given the variety of neuropsychological studies that emphasize the importance of disturbance of left hemisphere function in various aspects of the schizophrenic syndrome, the investigation of Kolb and Whishaw (1983) comes as a surprise for they found bilaterally symmetrical frontotemporal dysfunction in 30 schizophrenics, tested within one week of admission to Lethbridge Municipal Hospital. They administered a very complete series of tests sensitive to right and left frontotemporal and parietal functions, previously validated at the Montreal Neurological Institute. In 16 of these patients, followed one year later on maintenance neuroleptic medication, all neuropsychological scores had normalized, with the exception of the Rey–Osterreith Complex Figure test. At the initiation of the study the schizophrenics had been on neuroleptics for "at least 24 hours" before testing. The diagnosis was Diagnostic Statistical Manual (third edition; DSM-III, 1980) based and of 58 consecutive psychotics (schizophrenic, schizoaffective, manic, and depressed), 30 (or more than half) statisfied the criteria. Here probably lies the explanation for the finding of symmetrical anterior cerebral dysfunction.

Kendell (1982) has shown that, by applying different diagnostic criteria for schizophrenia to 119 consecutive psychotic patients, 34% statisfied the Wing–Catego scheme, which hinges essentially on the presence of first-rank symptoms; 8% satisfied Feighner criteria and only 3% satisfied the criteria of Taylor and Abrams, the most restrictive corresponding closely to the dementia praecox of Kraepelin. The fact that in the Kolb and Whishaw study more than 50% of consecutive psychotics satisfied criteria indicates that the DSM-III classification, although inspired by Feighner's, is overinclusive and incorporates schizomanic, thought-disordered hypomanias, and even some thought-disordered schizodepressive states with blunted affect. Mania is characterized by bilateral frontal and nondominant hemispheric dysfunction (Flor-Henry and Yeudall, 1979; Taylor and Abrams, 1986) neuropsychologically and by a significant decrement of performance, relative to verbal IQ (Flor-Henry, 1983; Sackeim and Decina, 1983). The performance IQ of the schizophrenics in the Lethbridge study was 10 points lower than the verbal and *19* points lower than that of the normals. Curiously, the vocabulary and information subtests of the verbal scale, typically impaired in schizophrenia, were actually higher than in the controls. Further, the schizophrenics, on dichotic verbal stimulation, had "a much larger left ear suppression," indicative therefore of right temporal dysfunction. I would suggest, consequently, that the symmetrical dysfunction found is the result of the heterogeneity of the schizophrenias studied, consisting of dementia praecox types, with predominantly left-sided, and of bipolar psychoses with schizophrenic symptoms, with predominantly right-sided, dysfunction.

PSYCHOMETRIC PATTERNS AND SUBSCALE CLUSTERING

Gruzelier *et al.* (1987) examined 36 schizophrenic, 10 manic, and 14 depressed patients with tests considered sensitive to right and left frontal and hippocampal systems. These were Hebb's Recurring Digit test, the Corsi Block Tapping test, Petrides spatial and nonspatial conditional associate learning tests, and two oral word fluency tests (F, A and S and semantic categories: animals, fruit, flowers). Left hemispheric impairment was maximal in schizophrenics (25%), right hemispheric impairment was maximal in affective disorders (29%) but also was similarly present in healthy controls (24%), and in schizophrenia (25%). Bilateral impairment was present in 20% of the schizophrenics and 40% of the affectives. Completely normal scores were found in 65% of normals, 30% of schizophrenics, and 21% of affectives (Recurring Digits and Corsi test). On conditional associate learning tasks the affectives were significantly impaired compared to the normals. For oral word fluency, the manics were superior to both schizophrenics and depressives who did not differ from each other. Irrespective of diagnosis, patients with impaired left frontal functions were characterized by social withdrawal. Curiously, the 3 subjects with catatonic symptomatology had impaired left temporal but normal frontal functions.

A similar conclusion, demonstrating left hemispheric deficit in schizophrenia and right-sided impairment in depression, is reached by Dean *et al.* (1987) in their cognitive study of schizophrenia ($n = 20$), primary depression ($n = 20$), and healthy controls ($n = 20$). Psychometrically (WAIS) the schizophrenics were significantly more impaired in the verbal than in the performance scale (verbal IQ = 76; performance = 91) but were significantly inferior to normals for both scales. The depressed differed from normals only in nonverbal intelligence (verbal IQ = 103; performance IQ = 83). With respect to subtests, the schizophrenics relative to depressives, were selectively impaired on Similarities and Comprehension (verbal abstraction), while the depressives were deficient on Picture Completion and Object Assembly (long-term nonverbal memory and visuospatial processing). Importantly, the nonverbal deficit in depression was maintained when the performance subtests were rescored for correctness, eliminating the time bonuses, showing that the performance deficit in depression is not a by-product of psychomotor retardation.

Abrams *et al.* (1981) analyzed the WAIS profiles of 17 schizophrenics and 52 affective disorders (43 mania and 9 depression). In schizophrenia the verbal IQ = 86; performance IQ = 84; in mania verbal IQ = 101, performance IQ = 88; in depression, verbal IQ = 102, performance IQ = 95. The verbal IQ of the schizophrenics was significantly lower than that of manics or depressives. The schizophrenics were significantly impaired on the sub-

scales of Information, Comprehension, Similarities, Vocabulary, and Digit Symbol when compared to manics or depressives: 4 out of 5 of these subtests reflect dominant hemispheric state. Similar results were found by Gruzelier and Hammond (1976) whose 19 adult chronic schizophrenic patients showed a significant reduction on Similarities, Vocabulary, and Comprehension, relative to Block Design and Object Assembly. What is more, Gruzelier *et al.* (1979), in the analysis of 70 boys and 70 girls at risk for schizophrenia because of having one parent with the illness, showed that the children at risk had a significant decrement of verbal IQ than matched control children.

In our first series (Flor-Henry and Yeudall, 1979) of 50 schizophrenics and 54 affective psychotics, the schizophrenics were significantly impaired, relative to the affectives for Digit Span and Vocabulary, again two dominant hemisphere variables. In our second series (Flor-Henry *et al.*, 1983) the psychometric results (WAIS) were as follows: schizophrenia (n = 28) verbal IQ = 90, performance IQ = 86; mania (n = 25) verbal IQ = 104, performance IQ = 93; depression (n = 28) verbal IQ = 110, performance IQ = 104. Compared to normals the schizophrenics were impaired for both verbal and performance IQ, and the manics had a deficit in performance IQ. A factor analysis (principal component) performed on the 11 subtests across the four groups (including neurotic depressions, n = 24) revealed three factors that accounted for 73% of the variance. The first factor with high loadings on all the verbal tests, except Digit Span and Arithmetic corresponds to a left hemispheric verbal factor. The second, which loads on all the performance items, is a right hemispheric factor; while the third—grouping Arithmetic, Digit Span and Digit Symbol—can be variously described as short-term memory retrieval, freedom from distractibility, or a frontal attentional factor. A discriminant function performed on the factor scores for these three factors gives rise to two discriminant functions, the first corresponding to full-scale IQ and the second to performance IQ elevation relative to verbal IQ. Correlations of the patients' group vectors to this second function showed that manics were characterized by low performance, relative to verbal IQ on this function.

These various findings appear to contradict the conclusions reached by Aylward *et al.* (1984) who, in a very thorough review of intelligence in schizophrenia research, stated that "comparisons of schizophrenic patients with brain-damaged patients indicate that both groups are characterized by higher VIQ than PIQ, (pp. 450–451) citing Wechsler (1958), who also considered that schizophrenics generally had higher verbal than performance IQ on the Wechsler–Bellevue or WAIS. In fact on this particular matter, relatively few studies are cited, most were carried out in the period between 1940 and 1960 when in the United States virtually every second psychiatric pa-

tient was called schizophrenic, and it was widely believed the presence of auditory hallucinations was diagnostic of schizophrenia. Some studies included manic-depressives (i.e., Parker and Davidson, 1963) and in the one recent study that is cited (Holland and Watson, 1980) in which schizophrenics, organic brain syndromes, and neurotics are compared, process schizophrenia (rather curiously distinguished from reactive on the basic of having never been married) scored significantly below the mean for all patients on Comprehension and Arithmetic subtests! To say that schizophrenics, like brain-damaged subjects, have higher verbal and lower performance IQ is a meaningless statement: the psychometrics of brain-damaged individuals will depend on the nature and location of the brain damage.

It is quite certain that before Feighner *et al.* (1972) introduced their criteria, the concept of schizophrenia in the United States was so all encompassing, including all the schizodepressive and schizomanic forms (which do have a reduction of performance over verbal IQ), that little importance can be attached to these particular findings for schizophrenia research, strictly defined. Surely the one general statement that can be made is that, in schizophrenia, there is a systematic deficit of *both* verbal and performance IQ. The significance of this bilateral decrement, in the light of the increasing importance attached to developmental, perinatal, and postnatal events in the antecedents of subjects who later become schizophrenic, is that lateralized lesions to the left hemisphere in intrauterine life, or occurring postnatally before the age of 5, produce a fall in verbal IQ relative to performance IQ (Vargha-Khadem, 1982; Vargha-Khadem *et al.*, 1985): left hemisphere lesions before the age of 1 may produce a fall in both verbal and performance IQ, while right-brain lesions after the age of 1 are associated only with a decrement of performance IQ (Woods, 1980).

Further, Taylor (1976), in the detailed analysis of verbal and performance IQ before and after temporal lobectomies carried out in the treatment of unilateral epilepsy, has a sample consisting of very early onset cerebral disorganization—alien tissue tumors, which arise during embryogenesis; mesial temporal sclerosis, which is postnatal; and an acquired adult lesion—the temporal resection itself. He showed that through complex interactions, the age of the individual at lesion onset, the neuropathological nature and laterality of the lesion, as well as the sex and handedness of the patient all influenced the direction and size of consequent psychometric abilities. If the size of the difference between verbal IQ and performance IQ is not taken into account, and the entire population is analyzed, then in the preoperative material, left-temporal epilepsy was associated with reduced verbal and right with reduced performance IQ at a very significant level ($p < .001$). An analysis of variance, however, showed the verbal/performance difference was significant for the right- but not the left-lesion group. At the same time the

left-lesion group differed significantly from the right-lesion group in verbal (lower) but not on performance scores. Of importance to the question of psychopathological implications was Taylor's observation that higher intelligence was correlated with neurosis and right temporal lesions, while psychopathy was associated with lower IQ, the male sex, and left temporal lesions. Lansdell and Urback (1965) observed that the Wechsler scale lateralization after temporal lobectomy was found only in males.

In spite of the obvious complexity of the multiplicity of interacting factors, it seems reasonable to conclude that the direction and amount of discrepancy in the verbal/performance scores of the WAIS (and especially some critical subtests) are lateralizing neuropsychological indices. The neuropsychological evidence reviewed suggests, in the endogenous psychoses, patterns of cerebral disorganization in which the severity of neuropsychological dysfunction intersects with bilaterally asymmetrical dysfunction. These two intersecting dimensions are different in depression, mania, and schizophrenia. The pattern in depression appears to be fronto-temporal, bilateral, right > left. As the severity of dysfunction increases in mania, the dominant fronto-temporal regions become more disorganized (but at the same time showing signs of pathological efficiency, i.e., verbal acceleration). This process becomes maximal in schizophrenia where the directionality shifts to left > right disorganization.

Kronfol *et al.* (1978) found that endogenous depressive psychoses, before treatment with unilateral electroconvulsive therapy (ECT), had neuropsychological evidence of predominantly right hemispheric dysfunction, which selectively normalized after ECT and recovery, with the left hemispheric indicators unmodified. Fromm–Auch (1982) reviewed 22 studies published up to that time giving quantitative measures of memory functions before and after ECT in depression. Following unilateral nondominant ECT, after five induced seizures, a selective improvement in nonverbal functions occurred, with verbal functions remaining unchanged, or improving as well.

Fromm (Fromm-Auch) and Schopflocher (1984) studied the neuropsychological test performance of 60 depressed patients (psychotic and neurotic forms) before and after treatment with antidepressant drugs. The test battery was extensive, consisting of 37 tests and the WAIS. Because of a high attrition rate, only 33 patients were available for the posttreatment testing, on the average 7 weeks after the pretreatment evaluation. Most were on tricyclics, the remainder on monoamine oxidase inhibitors. When depressed the subjects had a similar type of dysfunction for both psychotic and neurotic forms, more severe in the psychotics, implicating selective impairment in the processing and retention of visuospatial material and in short-term memory, verbal and nonverbal. These functions normalized after treatment, and neither psychotic nor neurotic depressions could be statistically differentiated from normal controls.

Robertson and Taylor (1985a) investigated the cognitive correlates of affective disorders in 30 male criminals with mood disturbance compared to 41 male criminals without psychiatic illness. The same cognitive battery with 17 variables that were used by these authors in the study of schizophrenic criminals was utilized. The majority of the patients ($n = 16$) were bipolar affectives either asymptomatic or elated when tested; the others were unipolar depressives or reactive depressions. All three groups showed specific deficit in spatial–holistic tasks. The bipolar hypomanias had good verbal memory with poor spatial ability and the reactive depressions had the most generalized impairment in right hemisphere functions. Robertson and Taylor concluded that their results "lend further support to the view . . . the disorders of mood are associated with impairment of right hemisphere functioning" (p. 309), and note that a specific impairment in spatial–holistic functions was not found in any of the schizophrenic groups they had previously examined.

Abrams and Taylor (1987) tested 67 patients with major depression, melancholic subtype, on a variety of variables selected from various batteries. The depressed group was compared to 42 normal controls. After controlling for age, sex, handedness, and medication effects (most were drug free; only 2 were on antidepressants and 2 were on lithium) the depression group was found to be characterized by bilateral frontal and right frontoparietal dysfunction.

IN CONCLUSION

The evidence reviewed shows that neuropsychological tests, although developed in order to localize and quantify deficits caused by structural brain lesions, have also proved very sensitive as a measure of functional regional cerebral disorganization in psychopathology. Thus they can provide not only the "geography" of brain disorganization in particular syndromes of mental illness, but can also be used as external criteria to confirm or disprove a diagnostic impression based on mental symptoms alone. Further symptomatic improvement can often be objectified by the corresponding changes in neuropsychological patterns. Specific patterns of neuropsychological dysfunction, or to put it another way, characteristic neuropsychological configurations, underlie the various psychopathological syndromes, not only of the endogenous psychoses considered in this review but also in psychopathy, hysteria, the obsessional syndrome, and sexual deviations—as I have recently reviewed elsewhere (Flor-Henry, 1987a–c; 1989; in press, a, b). In a similar manner psychometrics, developed as a measure of intelligence in normal populations, can also be viewed as a mini-neuropsychological test battery, especially sensitive to posterior dominant and nondominant hemispheric organization of higher order cognitive complexity and to frontal attentional

mechanisms. The verbal/performance (dominant/nondominant relationships implied), and the particular patterns of subitems deficits and relative strengths, are not randomly distributed in psychopathology, but provide another tool for the elucidation of altered cerebral state in psychiatric disorders.

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