

NEUROPSYCHOLOGICAL DIFFERENTIATION OF CHRONIC SCHIZOPHRENIA

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Four groups of 20 each (chronic brain-damaged schizophrenics, chronic non-brain-damaged schizophrenics, chronic non-brain-damaged with "acute" exacerbation, and control subjects) were individually administered Form I of the Luria Nebraska Neuropsychological Battery (LNNB). Control subjects scored significantly lower than all clinical groups on all scales except for the chronic non-brain-damaged schizophrenics on the Reading Scale. "Acute" schizophrenics scored higher on Motor, Visual, Receptive Speech, Intellectual Processes, Pathognomonic, Right Hemisphere and Profile Elevations scales than the other clinical groups. Chronic brain-damaged schizophrenics scored significantly higher than chronic non-brain-damaged schizophrenics on the Profile Elevation scale. To examine the possibility that LNNB performance of the schizophrenic groups may have been related to neuroleptic medication, analyses were completed on the relationship between medication levels and LNNB scores. These results suggested that while the three clinical groups differed in their chlorpromazine equivalents (CPZE), LNNB scores were not related to CPZE dosage.

Keywords: Schizophrenia; neuropsychological tests.

NEUROPSYCHOLOGICAL DIFFERENTIATION OF SCHIZOPHRENIC SUBTYPES

Cognitive deficits associated with schizophrenia have been reported for over a century. Morel's term "dementia praecox" coined in 1860, and Kraepelin's more familiar Latin translation "dementia praecox", suggested that those suffering from this madly experienced a number of conditions including "mental deterioration" (Whitaker, 1992). It has been more than a century since Morel and Kraepelin made the first modern day attempts at classifying these patients. Since that time, a number of technological advances have made empirical investigation of cognitive disorders in schizophrenia more plausible (see Puente, 1982).

Perhaps the most important advancement was the development of standardized intellectual testing procedures in the 1930s. Over the past 60 years, numerous studies have been conducted in an attempt to discriminate schizophrenic from organic subjects (Todd, Coolidge, & Satz, 1977; DeWolf, Barrell, Beck, & Spanner, 1971; Chelune, Heaton, Lehman, & Robinson, 1979). A meta-analysis of studies investigating the relationship between schizophrenia and intelligence suggested not only the presence of intellectual deficits in schizophrenic subjects versus control subjects, but also that these deficits were believed to precede onset of symptomatology (Aylward, Walker, & Bettles, 1984).

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The development of neuropsychological instrumentation has also contributed to this literature (Seidman, 1983). Comprehensive instruments such as the Luria Nebraska Neuropsychological Battery (LNNB) and the Halstead-Reitan Neuropsychological Battery (HRNB) have been used to increase diagnostic accuracy (Walker, Lucas & Lewine, 1992). For example, in the original standardization of the LNNB, Purisch, Golden, and Hammeke (1978) reported an 88% accuracy rate in differentiating schizophrenics from neurologic patients. These results were partially replicated by Shelly and Goldstein (1983). In a review of the literature, Moses and Maruish (1988) concluded: "The findings to date support the validity of the LNNB clinical scales as predictive measures that are sensitively and accurately linked to psychiatric and radiologic criterion measures" (p. 51). Effective discriminations between schizophrenic and organic groups have also been reported with the HRNB (Chelune, Heaton, Lehman, & Robinson, 1979; Reitan & Wolfson, 1985).

Goldstein and Halperin (1977) addressed the issue of subtyping schizophrenic groups by comparing long-term versus short-term hospitalized schizophrenics and neurologically impaired individuals. They found that the chronicity and severity of schizophrenia was more closely associated with Wechsler Adult Intelligence Scale (WAIS) and HRNB test scores than with neurological disease. Puente, Heidelberg-Sanders, and Lund (1982) successfully differentiated chronic brain-damaged schizophrenics using the LNNB in effort to subtype different groups of schizophrenic. However, there has been some question as to whether their schizophrenic sample was accurately diagnosed based upon the DSM-III criteria (Moses & Maruish, 1988). Strauss and Silverstein (1986) found that 91% of their acute schizophrenic subjects who were classified as neurologically impaired by the LNNB were differentiated correctly, while 86% of acute patients who were identified as non-impaired were distinguished correctly.

The purpose for the current study was to extend these earlier efforts by examining whether neuropsychological discrimination could be accomplished when comparing chronic non-brain-damaged schizophrenics who have acute exacerbation, chronic non-brain-damaged schizophrenics, chronic brain-damaged schizophrenics, and control subjects using the LNNB.

NEUROPSYCHOLOGICAL DIFFERENTIATION

Method

Subjects

Four groups were formed using 60 schizophrenic inpatient volunteers and 20 control subjects. No volunteers nor control subject for this study were drawn from clinical files as all subjects were chosen to participate only for this study. Paranoid schizophrenics were excluded as subjects, because evidence suggests that paranoids differ from other schizophrenic groups on both psychological and physiological variables (Simpson, Bourne, Justesen, & Rhodes, 1979). Four groups of 20 were chronic undifferentiated brain-damaged schizophrenics (with more than one year of continuous hospitalization; \bar{x} = 5.5 years), chronic undifferentiated non-brain-damaged schizophrenics (with more than two years of continuous hospitalization; \bar{x} = 10 years), chronic undifferentiated non-brain-damaged schizophrenics with acute exacerbation (with less than 10 days of hospitalization; \bar{x} = 3.01 days), and controls. All patients with acute exacerbations exhibited positive schizophrenic symptoms, while the other two clinical groups exhibited negative symptoms. Controls were used to establish a

Table 1
Means and Standard Deviations for Demographic Variables for the Clinical and Control Group.

Group	Age*	Years of Education	Sex	Race
Brain-Damaged	51.7 (17.8)	9.8 (2.6)	M = 15 F = 5	W = 15 B = 5
Chronic	36.1 (11.1)	10.7 (2.4)	M = 15 F = 5	W = 8 B = 12
"Acute" Exacerbation	35.4 (14.2)	11.4 (3.1)	M = 11 F = 9	W = 10 B = 10
Control	19.5 (2.1)	12.6 (1.1)	M = 6 F = 14	W = 17 B = 3

"normal" baseline since, to date, such a baseline is not available. Controls were introductory level psychology students participating for class credit at a medium sized state university.

Schizophrenic subjects were each given a physical examination and a neurological screening by the attending board certified psychiatrist. A DSM-III (American Psychiatric Association, 1980) diagnosis was made by the psychiatrist using recorded clinical and historical chart data and a one hour unstructured interview. An abbreviated version of this procedure was completed independently by a licensed doctoral level psychologist. If the two diagnoses matched, the patient was included in the study. Evidence of brain-damage was ascertained from clinical laboratory test results (e.g., contrast CAT scans read by a radiologist) combined with the neurological screening. If evidence suggested the possibility of a neurological syndrome, but unequivocal evidence was not available, these volunteers were not used in the study. However, unequivocal neurological evidence had to be ascertained for the subject to be included in the brain-damaged group. Chronic subjects were recruited from the inpatient population of two 1,000 bed state hospitals, while "acute" subjects were obtained from a public receiving facility (a 500 bed general community hospital with psychiatric services).

The possibility exists that "acute" and chronic non-brain-damaged schizophrenics had organic syndromes due to such factors as chronic intake of large dosages of neuroleptic. However, these groups did not exhibit traditional neurological symptoms upon admission or during subsequent medical and neurologic evaluations.

Subjects were right-handed, and both males and females participated. Participants had adequate corrected and uncorrected vision and had at least a sixth grade education. Volunteers were able to read, understand, and sign a statement of informed consent. Demographic information is shown in Table 1. Significant age differences ($p < .05$) were noted between groups. Brain-damaged schizophrenics were found to differ from controls ($F(2,37) = 5.231$). Using Tukey's analyses ($p < .05$), the acute and chronic samples were also significantly different because the acute group was comprised of chronic, older, patients with recent exacerbations.

Procedure

All subjects were individually administered Form I of the Luria-Nebraska Neuropsychological Battery (Golden, Hammeke, & Purisch, 1980) in an isolated interview room (in hospital wards for clinical groups and at a university laboratory for students) by a trained technician. An attempt was made to test the acute patients on the first

day of hospitalization or before neuroleptic treatment was initiated. Since all acute patients were floridly psychotic upon admission, this testing proved to be impossible. Testing could not be completed until the third day of hospitalization ($\bar{x} = 3.01$ days). In comparison, none of the chronic schizophrenics exhibited positive symptoms, and testing was completed during initial contact.

The critical level of dysfunction developed by Golden, et al. (1980), which considers both age and education, was used to derive the dependent measures (SCALE T MINUS CRITICAL LEVEL, T SCORE = DEPENDENT MEASURE). This derivation was completed to take into account age, education and actual level of dysfunction more accurately than single T scores. Critical levels are set individually according to a constant combined with a numerical value attributed to age and educational attainment. T Scale scores exceeding the critical level are considered an indication of neuropsychological impairment (Golden, et al., 1980). Since the variable in question was not an absolute T score (which would not take into account age, education, or whether the scale score was in the impaired range), this derived scale is more sensitive to the criterion (i.e., neuropsychological impairment).

Results

A four level one-way analysis of variance (ANOVA) was performed across the 16 major LNNB scales using the change score as the dependent measure. The following scales were analyzed: Motor, Rhythm, Tactile, Visual, Receptive Speech, Expressive Speech, Writing, Reading, Arithmetic, Memory, Intellectual Processes, Pathognomonic, Left hemisphere, Right Hemisphere, Profile Evaluation, and Impairment Index (C1-C11, S1-S5). Significant group differences were noted $F(3, 17) = 5.7$ to 26.2 , $p < .01$ for all 16 scales of the LNNB. Table 2 provides the mean change scores and F values for each other 16 scales. Tukey's tests were completed using the .05 level for significance to determine specific group differences for each scale. It should be noted that higher T scores indicated greater neuropsychological impairment. Scores for the acute schizophrenic group were significantly higher than those for the chronic non-brain-damaged group on the Motor, Visual, Receptive Speech, Intellectual Processes, Pathognomonic, Right Hemisphere, and Profile Elevation scales. Scores for the acute group were also significantly higher than scores for the chronic brain-damaged group on the Pathognomonic scale. The chronic brain-damaged group scored significantly higher than the chronic non-brain-damaged group on the Profile Elevation Scale. No other significant differences were found between groups.

RELATIONSHIP TO NEUROLEPTIC DOSAGE

Killian, Holzman, Davis, and Gibbons (1984) reported that neuropsychological functioning can be affected by neuroleptic drugs. In order to determine whether this variable may have contributed to the neuropsychological differentiation between groups, T scores were correlated to neuroleptic levels. These levels were then compared across the three clinical groups.

Results

Subjects

Since controls were not diagnosed as schizophrenic and were not receiving psychotropic treatment, they were excluded in the analysis of this phase of the study. All

Table 2
Mean Change and T Scores for the 16 LNNB Scales for Clinical and Control Groups

Scale	Brain Damaged		Chronic		"Acute" Exacerbation		Control	
	Changed	T	Change	T	Change	T	Change	T
Motor	13.85	76.5	-1.2	57.1	21.4	92.5	-26.5	34.2
Rhythm	16.6	79.2	7.4	68.9	19.5	83.2	-25.4	37.0
Tactile	4.1	66.3	1.0	55.9	13.7	70.9	-13.4	38.2
Visual	4.2	67.3	.3	60.6	13.7	62.4	-12.9	35.7
Speech:								
-Receptive	7.9	75.5	-1.9	60.8	12.8	78.2	-22.5	36.8
-Expressive	4.9	72.3	4.8	58.5	16.6	71.9	-14.9	32.9
Writing	5.4	66.9	-4.7	58.6	8.4	82.9	-26.1	40.2
Reading	-6	64.4	-2.2	57.7	9.0	62.9	-9.5	39.2
Arithmetic	21.9	85.7	5.5	70.5	12.4	88.5	9.5	39.2
Memory	12.7	74.0	8.6	67.3	12.5	71.9	-18.4	35.1
Intellectual	11.5	73.5	6.05	70.2	18.0	78.2	-21.3	32.8
Pathognomonic	1.2	64.1	2.7	63.3	16.8	74.9	-16.4	30.1
Hemisphere								
-Left	5.8	70.3	.4	61.1	13.6	78.7	-21.4	37.2
-Right	9.2	74.6	-.4	58.0	14.0	75.6	-20.2	35.6
Profile-								
Elevation	16.5	79.3	-.5	70.9	14.1	86.5	-19.9	38.5
Impairment	11.3	74.5	7.75	67.4	14.5	78.5	-19.3	38.1
Mean Critical Level		65.2		61.8		59.6		57.5

Table 3
Mean and Standard Deviation CPZEs for Acute and Chronic Schizophrenic Non-Brain-Damaged and Brain-Damaged Schizophrenics

Brain-Damaged	"Acute"	Chronic
405.0 (316.6)	492.2 (671.76)	234.8 (2698.9)

schizophrenics, except two from the acute sample, were taking neuroleptic and were included in the analysis. Only those subjects with comprehensive medication data were included (to determine neuroleptic dosage level). A total of 20 acute, 10 chronic, and 10 brain-damaged schizophrenics were used in this analysis.

Procedure

Since participants were taking a wide variety of neuroleptic brands and dosages, dosage regimens were converted into chlorpromazine equivalents (CPZE) using the conversion formula developed by Davis (1976). Mean and standard deviation CPZE scores for each group are presented in Table 3.

Results

A one-way, three level ANOVA was computed on CPZEs across the three schizophrenics subgroups. However, no differences were noted between chronic non-brain-damaged and chronic brain-damaged schizophrenics. Pearson's r correlations between CPZE and the 16 LNNB scale change scores were not significant at the .01 level. Clinical subgroups yielded significant group differences $F(2, 37) = 6.55, p < .01$. Tukey's analyses were performed using the .01 level to determine significance. Results revealed that acute schizophrenic CPZE levels differed from chronic and brain-damaged schizophrenic subgroups. However, no differences were noted between chronic non-brain-damaged and chronic brain-damaged schizophrenics.

DISCUSSION

The results of the present study revealed that the LNNB differentiated between chronic schizophrenics with acute exacerbation and chronic non-brain-damaged schizophrenics on the Motor, Visual, Receptive Speech, Intellectual Processes, Pathognomonic, Right Hemisphere, and Profile Elevation scales. The acute group also differed from the chronic brain-damaged group Motor, Visual, Receptive Speech, Intellectual Processes, Pathognomonic, Right Hemisphere, and Profile Elevation scales. The acute group also differed from the chronic brain-damaged group on the Pathognomonic scale. All schizophrenic groups performed with the impaired range on the LNNB using critical level cut offs with the classification of brain-damaged averaging 60% for the chronic, 75% for the brain-damaged, and 90% for the "acute" schizophrenics. The "acute" group exhibited lower performance than the chronic brain-damaged and chronic non-brain-damaged groups. In addition, all groups differed significantly from controls on all scales except the Reading scale.

These findings do not support the results of Strauss and Silverstein (1986) who found that most non-brain-damaged schizophrenics perform similarly to normal con-

trols on the LNNB. However, while the acute group received higher doses of neuroleptic than the other groups, no relationship was found between CPZE and LNNB scale scores.

Several plausible explanations can account for these results. Goldstein et al. (1977) used both the WAIS and the HRNB, a comprehensive and lengthy combination of tests, while the present study used the one and one half to two hour LNNB. However, Golden, Kane, Sweet, Moses, Cardellina, Templeton, Vicente, & Carber (1981), and Goldstein (1986) have reported high correlations between the LNNB and the HRNB using schizophrenic subjects. Nevertheless, these results do support Goldstein et al.'s finding that chronicity may be more important than neurological status in differentiating between types of schizophrenia. In this study, acute schizophrenics were differentiated from chronic schizophrenics without brain-damage, but not from chronic schizophrenics with brain-damage. The heterogeneity of the schizophrenic symptomatology may have also played a role in these findings.

Nevertheless, all of the acute patients were floridly psychotic, though testable, while none of the chronic patients were exhibiting positive symptoms during testing. Thus, psychotic disorganization of a florid nature may have been the variable which affected outcome.

An alternative explanation for these findings is that the neuroleptics played a significant role in modulating these results. Despite the significant CPZE group differences that were noted, CPZE levels were not significantly correlated with LNNB scale scores for any of the three clinical groups. Regardless of criticisms such as those reported by Heaton and Crowley, (1981), somatic treatments are still being assessed with crude and non-standardized measures. In this study, neuroleptic regimens were converted to CPZE according to the frequently used formula of Davis (1976). Nevertheless, dosage does not appear to be as good a predictor as blood serum levels in predicting clinical states of schizophrenics (Mavroidis, Kanter, Hirschowitz, & Varver, 1983; Kurcharski, Alexander, & Tune, 1984). Another drug-related issue may be that neuroleptic drugs, despite their difference in doses, may have resulted in differential neuropsychological effects. The previously drug-free acute schizophrenics may have become sedated when initially administered large neuroleptic doses. Magliozzi, Gillespie, Lombrozo, and Hollister (1985), reported that "overwhelming sedative effects" of normal doses of haloperidol, the most frequently administered neuroleptic in this study, made "formal testing very difficult" with acute schizophrenics. Magliozzi et al. (1985) used medication-free subjects and short psychometric instruments (i.e., Profile of Mood States). Thus, it could be that our acute subjects were sedated (which the technicians, nurses and experimenters did observe), making testing not only difficult, but also making performance appear neuropsychologically impaired. Similarly, the chronic patients may have habituated to the large neuroleptic doses, as they had become a regular part of their hospitalization and physiological functioning.

Sub-typing chronic schizophrenia was partially accomplished with the LNNB. These findings need to be replicated and extended by analyzing blood serum levels, adding acute brain-damaged schizophrenic and brain-damaged non-schizophrenic groups, and focusing more closely on positive and negative symptoms in schizophrenia. Another issue would be serial or longitudinal testing of the acute schizophrenic patients.

REFERENCES

- American Psychiatric Association (1980). *Diagnostic and Statistical Manual of Mental Disorders* (3rd edition). Washington, D.C.: American Psychiatric Association.

- Aylward, E., Walker, E., & Bettes, B. (1984). Intelligence in schizophrenia: A review and meta-analysis of the literature. *Schizophrenia Bulletin*, 10, 430-459.
- Chelune, G. J., Heaton, R. K., Lehman, R. A., & Robinson, A. (1979). Level versus pattern of neuropsychological performance in schizophrenic and diffusely brain-damaged patients. *Journal of Consulting and Clinical Psychology* 47, 155-163.
- Davis, J. (1976). Comparative doses and costs of antipsychotic medication. *Archives of Psychiatry*, 33, 208-214.
- DeWolf, A. S., Barrell, R. P., Beck, & Spanner, F. E. (1971). Intellectual deficits in chronic schizophrenics and brain-damaged. *Journal of Consulting and Clinical Psychology* 36, 197-204.
- Golden, C. J., Hammeke, T. A., & Purisch, A. D. (1980). *The Luria-Nebraska Neuropsychological Battery*. Los Angeles: Western Psychological Services.
- Golden, C. J., Kane, R., Sweet, J. Moses, J. A., Carellina, J. A., Templeton, R., Vincente, P., & Garber, B. (1986). Relationship of the Halstead-Reitan Neuropsychological Battery and the Luria-Nebraska Neuropsychological Battery. *Journal of Consulting and Clinical Psychology* 49, 410-417.
- Goldstein, G. (1986). Neuropsychological assessment of psychiatric patients. In G. Goldstein (Ed.), *Advances in Clinical Neuropsychology* (pp. 55-88). New York: Plenum
- Goldstein, G., & Halperin, K. M. (1977). Neuropsychological differences among subtypes of schizophrenics. *Journal of Abnormal Psychology*, 86, 36-40.
- Heaton, R. R., & Crowley, T. J. (1981). Effects of psychiatric disorders and their somatic treatments on neuropsychological test results. In S. Fisklov, & T. Boll (Eds.), *Handbook of Clinical Neuropsychology* (pp. 481-525). New York: Wiley.
- Killian, G. A., Holzman, P. S., Davis, J. M., & Gibbons, R. (1984). Effects of psychotropic medication on selected cognitive and perceptual measures. *Journal of Abnormal Psychology*, 93, 58-70.
- Kucharski, L. T., Alexander, P., & Tune, L. C. (1984). Serum neuroleptic concentration and clinical response. A radioreceptor assay investigation of acutely psychotic patients. *Pharmacology*, 82, 194-198.
- Magliozzi, J. R., Gillespie, H., Lombrozo, L., & Hollister, L. D. (1983). Mood alteration following oral and intravenous haloperidol and relationship to drug concentration in normal subjects. *Journal of Clinical Pharmacology*, 25, 285-290.
- Mavroidis, M. C., Kanter, D. A., Hirschowitz, J., & Garner, D. (1983). Clinical response and plasma haloperidol levels in schizophrenia. *Psychopharmacology*, 81, 354-356.
- Moses, J. A., & Maruish, M. E. (1988). A critical review of the Lucia-Nebraska Neuropsychological Battery literature: Cognitive deficits in schizophrenia and related disorders. *International Journal of Clinical Neuropsychology*, 10, 51-62.
- Puente, A. E., Heidelberg-Sanders, C., & Lund, N. L. (1982). Discrimination of schizophrenics with and without nervous system damage using the Luria-Nebraska Neuropsychological Battery. *International Journal of Neuroscience*, 16, 59-62.
- Puente, A. E., (1982). Assessment of possible neural substrates. In L. C. Whitaker. *Schizophrenic Disorders*. New York: Plenum.
- Purisch, A. D., Goldell, C. J., & Hammeke, T. A. (1978). Discrimination of schizophrenics and brain-impaired patients by a standardized version of Luria's neuropsychological test. *Journal of Consulting and Clinical Psychology*, 46, 1266-1273.
- Reitan, R. M., & Wolfson, D. (1985). *The Halstead-Reitan Neuropsychological Test Battery*. Tucson: Neuropsychology Press.
- Seidman, L. J. (1983). Schizophrenia and brain dysfunction: An integration of recent neurodiagnostic function. *Psychological Bulletin*, 94, 195-235.
- Shelly, C., & Goldstein, G. (1983). Discrimination of chronic schizophrenia and brain-damaged with the Luria-Nebraska Battery. A partially successful replication. *Clinical Neuropsychology*, 5, 82-85.
- Simpson, C. B., Bourne, L. E., Justesen, D. R., & Rhodes, R. J. (1979). Schizophrenia and paranoid thinking in conceptual performance. *Bulletin of the Psychonomic Society*, 13, 97-100.
- Todd, J., Coolidge, F., & Staz, P. (1977). The Wechsler Adult Intelligence Scale Discrepancy Index: A neuropsychological evaluation. *Journal of Consulting and Clinical Psychology*, 65, 450-454.
- Walker, E. Lucas, M. & Lewine, R. (1992). Schizophrenic disorders. In A. E. Puente & R. J. McCaffrey (Eds.). *Handbook of Neuropsychological Assessment*, (pp. 309-334). New York: Plenum.
- Whitaker, L. (1992). *Schizophrenic Disorders*. New York: Plenum.