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Neurocognitive deficit in schizophrenia: A quantitative review of the evidence

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Abstract: The neurocognitive literature on test performance in schizophrenia is reviewed quantitatively. The authors report 22 mean effect sizes from 204 studies to index schizophrenia versus control differences in global and selective verbal memory, nonverbal memory, bilateral and unilateral motor performance, visual and auditory attention, general intelligence, spatial ability, executive function, language, and interhemispheric tactile-transfer test performance. Moderate to large raw effect sizes ($d > .60$) were obtained for all 22 neurocognitive test variables, and none of the associated confidence intervals included zero. The results indicate that schizophrenia is characterized by a broadly based cognitive impairment, with varying degrees of deficit in all ability domains measured by standard clinical tests.

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References:

1. Allen, H.A., Liddle, P.F., Frith, C.F., Negative features, retrieval processes, and verbal fluency in schizophrenia (1993) *British Journal of Psychiatry*, 163, pp. 769-775
2. Aloia, M.S., Gourovitch, M.L., Weinberger, D.R., Goldberg, T.E., An investigation of semantic space in patients with schizophrenia (1996) *Journal of the International Neuropsychological Society*, 2, pp. 267-273
3. (1987) *Diagnostic and Statistical Manual of Mental Disorders (3rd Ed.)*, Washington, DC: Author
4. Ammons, R.B., Ammons, C.H., *The Quick Test (QT): Provisional manual* (1962) *Psychological Reports (Monograph Supplement I-VII)*, pp. 111-161
5. Andreasen, N.C., Arndt, S., Swayze, V., Cizaldo, T., Flaum, M., O'Leary, D., Ehrhardt, J.C., Yuh, W.T.C., Thalamic abnormalities in schizophrenia visualized through magnetic resonance image averaging (1994) *Science*, 266, pp. 294-298
6. Andreasen, N.C., Ehrhardt, J.C., Ventricular enlargement in schizophrenia: Relationship to positive and negative symptoms (1982) *American Journal of Psychiatry*, 139, pp. 297-302
7. Archer, J., Hay, D.C., Young, A.W., Face processing in psychiatric conditions (1992) *British Journal of Clinical*

Psychology, 31, pp. 45-61

8. Axelrod, B.N., Goldman, R.S., Tompkins, L.M., Jiron, C.C., Poor differential performance on the Wisconsin Card Sorting Test in schizophrenia, mood disorders, and traumatic brain injury (1994) *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 7, pp. 20-24
9. Bakan, D., The test of significance in psychological research (1966) *Psychological Bulletin*, 66, pp. 1-29
10. Bartfai, A., Wirson, A., Levander, S., Schalling, D., Smooth pursuit eye tracking and neuropsychological performance in healthy volunteers (1989) *Acta Psychiatrica Scandinavica*, 80, pp. 479-486
11. Beatty, W.W., Jovic, Z., Monson, N., Katzung, V.M., Problem solving by schizophrenic and schizoaffective patients on the Wisconsin and California card sorting tests (1994) *Neuropsychology*, 8, pp. 49-54
12. Beatty, W.W., Jovic, Z., Monson, N., Staton, D., Memory and frontal lobe dysfunction in schizophrenia and schizoaffective disorder (1993) *The Journal of Nervous and Mental Disease*, 181, pp. 448-453
13. Bellini, L., Abbruzzese, M., Gambini, O., Rossi, A., Stratta, P., Scarone, S., Frontal and callosal neuropsychological performances in schizophrenia: Further evidence of possible attention and mnemonic dysfunctions (1991) *Schizophrenia Research*, 5, pp. 115-121
14. Benton, A.L., (1974) *Revised Visual Retention Test* (4th Ed.), , New York: Psychological Corporation
15. Benton, A.L., Hamsher, K., (1983) *Multilingual Aphasia Examination*, , Iowa City: AJA Associates
16. Benton, A.L., Sivan, A.B., Hamsher, K., Varney, N., Spreen, O., (1994) *Contributions to Neuropsychological Assessment* (2nd Ed.), , New York: Oxford University Press
17. Berman, K.F., Illowsky, B.P., Weinberger, D.R., Physiological dysfunction of dorsolateral prefrontal cortex in schizophrenia IV: Further evidence for regional and behavioral specificity (1988) *Archives of General Psychiatry*, 45, pp. 616-622
18. Bilder, R.M., Lipschutz-Broch, L., Reiter, G., Geisler, S.H., Mayeroff, D.I., Liberman, J.A., Intellectual deficits in first-episode schizophrenia: Evidence for progressive deterioration (1992) *Schizophrenia Bulletin*, 18, pp. 437-448
19. Blanchard, J.J., Neale, J.M., The neuropsychological signature of schizophrenia: Generalized or differential deficit? (1994) *American Journal of Psychiatry*, 151, pp. 40-48
20. Bornstein, R.A., Nasrallah, H.A., Olson, S.C., Coffman, J.A., Torello, M., Schwarzkopf, S.B., Neuropsychological deficit in schizophrenic subtypes: Paranoid, nonparanoid, and schizoaffective subgroups (1990) *Psychiatry Research*, 31, pp. 15-24
21. Borod, J.C., Martin, C.C., Alpert, M., Brozgold, A., Welkowitz, J., Perception of facial emotion in schizophrenic and right brain-damaged patients (1993) *The Journal of Nervous and Mental Disease*, 181, pp. 494-502
22. Braff, D.L., Information processing and attention dysfunctions in schizophrenia (1993) *Schizophrenia Bulletin*, 19, pp. 233-259
23. Braff, D.L., Glick, I.D., Johnson, M.H., Zisook, S., The clinical significance of thought disorder across time in psychiatric patients (1988) *The Journal of Nervous and Mental Disease*, 176, pp. 213-220
24. Braff, D.L., Heaton, R., Kuck, J., Cullum, M., Moranville, J., Grant, I., Zisook, S., The generalized pattern of neuropsychological deficits in outpatients with chronic schizophrenia with heterogeneous Wisconsin Card Sorting Test results (1991) *Archives of General Psychiatry*, 48, pp. 891-898
25. Brown, K.W., White, T., Palmer, D., Movement disorders and psychological tests of frontal lobe function in schizophrenic patients (1992) *Psychological Medicine*, 22, pp. 69-77
26. Buchanan, R.W., Strauss, M.E., Breier, A., Kirkpatrick, B., Carpenter, W.T., Attentional impairments in deficit and nondeficit forms of schizophrenia (1997) *American Journal of Psychiatry*, 154, pp. 363-370
27. Buschke, H., Fuld, P.A., Evaluating storage, retention, and retrieval in disordered memory and learning (1974) *Neurology*,

24, pp. 1019-1025

28. Butler, R.W., Jenkins, M.A., Sprock, J., Braff, D.L., Wisconsin Card Sorting Test deficits in chronic paranoid schizophrenia: Evidence for a relatively discrete subgroup? (1992) *Schizophrenia Research*, 7, pp. 169-176
29. Calev, A., Recall and recognition in mildly disturbed schizophrenics: The use of matched tasks (1984) *Psychological Medicine*, 14, pp. 425-429
30. Calev, A., Edelist, S., Kugelmass, S., Lerer, B., Performance of long-stay schizophrenics on matched verbal and visuospatial recall tasks (1991) *Psychological Medicine*, 21, pp. 655-660
31. Calev, A., Venables, P.H., Monk, A.F., Evidence for distinct verbal memory pathologies in severely and mildly disturbed schizophrenics (1983) *Schizophrenia Bulletin*, 9, pp. 247-264
32. Caplan, R., Guthrie, D., Blink rate in childhood schizophrenia spectrum disorder (1994) *Biological Psychiatry*, 35, pp. 228-234
33. Carpenter, W.T., Buchanan, R.W., Kirkpatrick, B., Tamminga, C., Strong inference, theory testing, and the neuroanatomy of schizophrenia (1993) *Archives of General Psychiatry*, 50, pp. 825-831
34. Carr, S.A., Interhemispheric transfer of stereognostic information in chronic schizophrenics (1980) *British Journal of Psychiatry*, 136, pp. 53-58
35. Carrigan, P.W., Green, M.F., Signal detection analysis of short-term recall in schizophrenia (1991) *The Journal of Nervous and Mental Disease*, 179, pp. 495-498
36. Carter, C.S., Robertson, L.C., Nordahl, T.E., Abnormal processing of irrelevant information in chronic schizophrenia: Selective enhancement of Stroop facilitation (1992) *Psychiatry Research*, 41, pp. 137-146
37. Chapman, L.J., Chapman, J.P., Problems in the measurement of cognitive deficit (1973) *Psychological Bulletin*, 79, pp. 380-385
38. Chapman, L.J., Chapman, J.P., When should schizophrenic and normal groups be compared? (1978) *Journal of Psychiatric Research*, 14, pp. 321-325
39. Chapman, L.J., Chapman, J.P., Strategies for resolving the heterogeneity of schizophrenics and their relatives using cognitive measures (1989) *Journal of Abnormal Psychology*, 98, pp. 357-366
40. Clare, L., McKenna, P.J., Mortimer, A.M., Baddeley, A.D., Memory in schizophrenia: What is impaired and what is preserved (1993) *Neuropsychologia*, 31, pp. 1225-1241
41. Cleghorn, J.M., Increased frontal and reduced parietal glucose metabolism in acute untreated schizophrenia (1989) *Psychiatry Research*, 28, pp. 119-133
42. Cleghorn, J.M., Garnett, E.S., Nahmias, C., Brown, G.M., Kaplan, R.D., Szechtman, H., Szechtman, B., Cook, P., Regional brain metabolism during auditory hallucinations in chronic schizophrenia (1990) *British Journal of Psychiatry*, 157, pp. 562-570
43. Cleghorn, J.M., Kaplan, R.D., Szechtman, B., Szechtman, H., Brown, G.M., Neuroleptic drug effects on cognitive function in schizophrenia (1990) *Schizophrenia Research*, 3, pp. 211-219
44. Clementz, B.A., Grove, W.W., Iacono, W.G., Sweeney, J.A., Smooth-pursuit eye movement dysfunction and liability for schizophrenia: Implications for genetic modeling (1992) *Journal of Abnormal Psychology*, 101, pp. 117-129
45. Cohen, J., (1988) *Statistical Power Analysis for the Behavioral Sciences* (2nd Ed.), , New York: Academic Press
46. Cohen, J., The earth is round (p
47. Condray, R., Steinhauer, S.R., Goldstein, G., Language comprehension in schizophrenics and their brothers (1992) *Biological Psychiatry*, 32, pp. 790-802
48. Condray, R., Steinhauer, S.R., Van Kammen, D.P., Kasperek, A., Working memory capacity predicts language

- comprehension in schizophrenic patients (1996) *Schizophrenia Research*, 20, pp. 1-13
49. Corcoran, R., Mercer, G., Frith, C.D., Schizophrenia, symptomatology and social inference: Investigating "theory of mind" in people with schizophrenia (1995) *Schizophrenia Research*, 17, pp. 5-13
 50. Cornblatt, B.A., Keilp, J.G., Impaired attention, genetics, and the pathophysiology of schizophrenia (1994) *Schizophrenia Bulletin*, 20, pp. 31-46
 51. Cornblatt, B.A., Lenzenweger, M.F., Kimling, L.E., The continuous performance test
 52. Identical pairs version II: Contrasting attentional profiles in schizophrenic and depressed patients (1989) *Psychiatry Research*, 29, pp. 65-85
 53. Craft, S., Willerman, L., Bigler, E.D., Callosal dysfunction in schizophrenia and schizo-affective disorder (1987) *Journal of Abnormal Psychology*, 96, pp. 205-213
 54. Crawford, J.R., Besson, J.A.O., Bremner, M., Ebmeier, K.P., Cochrane, R.H.B., Kirkwood, K., Estimation of premorbid intelligence in schizophrenia (1992) *British Journal of Psychiatry*, 161, pp. 69-74
 55. Crawford, J.R., Obonsawin, M.C., Bremner, M., Frontal lobe impairment in schizophrenia: Relationship to intellectual functioning (1993) *Psychological Medicine*, 23, pp. 787-790
 56. Cullum, C.M., Harris, J.G., Waldo, M.C., Smernoff, E., Madison, A., Nagamoto, H.T., Griffith, J., Freedman, R., Neurophysiological and neuropsychological evidence for attentional dysfunction in schizophrenia (1993) *Schizophrenia Research*, 10, pp. 131-141
 57. Culver, C.L., Kunen, S., Zinkgraf, S.A., Patterns of recall in schizophrenics and normal subjects (1986) *The Journal of Nervous and Mental Disease*, 174, pp. 620-623
 58. Cutmore, T.R.H., Beninger, R.J., Do neuroleptics impair learning in schizophrenic patients? (1990) *Schizophrenia Research*, 3, pp. 173-186
 59. Dabson, D.J.G., Neufeld, R.W.J., Span of apprehension among remitted schizophrenics using small visual angles (1987) *The Journal of Nervous and Mental Disease*, 175, pp. 362-370
 60. Dalby, J.T., Williams, R., Preserved reading and spelling ability in psychotic disorders (1986) *Psychological Medicine*, 16, pp. 171-175
 61. David, A.S., Callosal transfer in schizophrenia: Too much or too little (1993) *Journal of Abnormal Psychology*, 102, pp. 573-579
 62. David, A.S., Spatial and selective attention in the cerebral hemispheres in depression, mania, and schizophrenia (1993) *Brain & Cognition*, 23, pp. 166-180
 63. David, A.S., Cutting, J.C., Visual imagery and visual semantics in the cerebral hemispheres in schizophrenia (1992) *Schizophrenia Research*, 8, pp. 263-271
 64. David, D.G., Goldberg, T.E., Gibbon, R., Weinberger, D.R., Lack of a bimodal distribution of ventricular size in schizophrenia: A Gaussian mixture analysis of 1056 cases and controls (1991) *Biological Psychiatry*, 30, pp. 887-903
 65. Dean, R.S., Gray, J.W., Seretny, M.L., Cognitive aspects of schizophrenia and primary affective depression (1987) *International Journal of Clinical Psychology*, 9, pp. 33-36
 66. De Bonis, M., De Boeck, P., Lida-Pulik, H., Feline, A., Identity disturbances and self-other differentiation in schizophrenics, borderlines, and normal controls (1995) *Comprehensive Psychiatry*, 36, pp. 362-366
 67. Delis, D.C., Kramer, J.H., Kaplan, E., Ober, B.A., (1987) *California Verbal Learning Test*, San Antonio, TX: The Psychological Corporation
 68. DeMyer, M.K., Gilmore, R.L., Hendrie, H.C., DeMyer, W.E., Augustyn, G.T., Jackson, R.K., Magnetic resonance brain images in schizophrenic and normal subjects: Influence of diagnosis and education (1988) *Schizophrenia Bulletin*, 14, pp.

69. De Renzi, E., Vignolo, L., The Token Test: A sensitive test to detect receptive disturbances in aphasia (1962) *Brain*, 85, pp. 665-678
70. Dieci, M., Vita, A., Silenzi, C., Caputo, A., Comazzi, M., Ferrari, L., Ghiringhelli, L., Invernizzi, G., Non-selective impairment of Wisconsin Card Sorting Test performance in patients with schizophrenia (1997) *Schizophrenia Research*, 25, pp. 33-42
71. Ditchfield, H., Hemsley, D.R., Interhemispheric transfer of information and schizophrenia (1990) *European Archives of Psychiatry and Neurological Sciences*, 239, pp. 309-313
72. Dunn, L.M., Dunn, L.M., (1981) *Peabody Picture Vocabulary Test - Revised Manual*, , Circle Pines, MN: American Guidance Service
73. Earle-Boyer, E.A., Serper, M.R., Davidson, M., Harvey, P.D., Continuous performance tests in schizophrenic patients: Stimulus and medication effects on performance (1991) *Psychiatry Research*, 37, pp. 47-56
74. Eikmeier, G., Lodemann, E., Zerbin, D., Gastpar, M., P300, clinical symptoms, and neuropsychological parameters in acute and remitted schizophrenia: A preliminary report (1992) *Biological Psychiatry*, 31, pp. 1065-1069
75. Elwood, R.W., The California Verbal Learning Test: Psychometric characteristics and clinical application (1995) *Neuropsychology Review*, 5, pp. 173-201
76. Ennis, J.H., Whelton, C., The relationship between face recognition, facial affect recognition, and social skills in schizophrenia (1994) *Canadian Journal of Psychiatry*, 39, pp. 58-66
77. Ernst, J., Warner, M.H., Hochberg, M.T., Townes, B., Factor analysis of the Halstead-Reitan Neuropsychological Battery including the WAIS and replications using the WAIS-R (1988) *International Journal of Neuropsychology*, 10, pp. 103-105
78. Fautsman, W.O., Moses, J.A., Ringo, D.L., Newcomer, J.W., Left-handedness in male schizophrenic patients is associated with increased impairment on the Luria-Nebraska Neuropsychological Battery (1991) *Biological Psychiatry*, 30, pp. 326-334
79. Fossum, B., Holmberg, H., Reinvang, I., Spatial and symbolic factors in performance on the Trail Making Test (1992) *Neuropsychology*, 6, pp. 71-75
80. Frame, C.L., Oltmanns, T.F., Serial recall by schizophrenic and affective patients during and after psychotic episodes (1982) *Journal of Abnormal Psychology*, 91, pp. 311-318
81. Franke, P., Maier, W., Hain, C., Klinger, T., Wisconsin Card Sorting Test: An indicator of vulnerability to schizophrenia? (1992) *Schizophrenia Research*, 6, pp. 243-249
82. Franke, P., Maier, W., Hardt, J., Frieboes, R., Lichtermann, D., Hain, C., Assessment of frontal lobe functioning in schizophrenia and unipolar major depression (1993) *Psychopathology*, 26, pp. 76-84
83. Franke, P., Maier, W., Hardt, J., Hain, C., Cognitive functioning and anhedonia in subjects at risk for schizophrenia (1993) *Schizophrenia Research*, 10, pp. 77-84
84. Fraser, W.I., King, K.M., Thomas, P., Kendell, R.E., The diagnosis of schizophrenia by language analysis (1986) *British Journal of Psychiatry*, 148, pp. 275-278
85. Frith, C.D., Friston, K.J., Herold, S., Silberweig, D., Fletcher, P., Camila, C., Dolan, R.J., Liddle, P.F., Regional brain activity in chronic schizophrenic patients during the performance of a verbal fluency task (1995) *British Journal of Psychiatry*, 167, pp. 343-349
86. Galynker, I.I., Harvey, P.D., Neuropsychological screening in the psychiatric emergency room (1992) *Comprehensive Psychiatry*, 33, pp. 291-295
87. Garety, P.A., Phil, M., Hemsley, D.R., Wessely, S., Reasoning in deluded schizophrenic and paranoid patients (1991) *The*

Journal of Nervous and Mental Disease, 179, pp. 194-201

88. Gold, J.M., Herman, B.P., Randolph, C., Wyler, A.R., Goldberg, T.E., Weinberger, D.R., Schizophrenia and temporal lobe epilepsy: A neuropsychological analysis (1994) *Archives of General Psychiatry*, 51, pp. 265-272
89. Gold, J.M., Randolph, C., Carpenter, C.J., Goldberg, T.E., Weinberger, D.R., Forms of memory failure in schizophrenia (1992) *Journal of Abnormal Psychology*, 101, pp. 487-494
90. Goldberg, T.E., Gold, J.M., Neurocognitive deficits in schizophrenia (1995) *Schizophrenia*, pp. 146-162. , S. R. Hirsch & D. R. Weinberger (Eds.), Oxford, England: Blackwell Science
91. Goldberg, T.E., Gold, J.M., Greenberg, R., Griffin, S., Contrasts between patients with affective disorders and patients with schizophrenia on a neuropsychological test battery (1993) *American Journal of Psychiatry*, 150, pp. 1355-1362
92. Goldberg, T.E., Kelsoe, J.R., Weinberger, D.R., Pliskin, N.H., Kirwin, P.D., Herman, K.F., Performance of schizophrenia patients on putative neuropsychological tests of frontal lobe function (1988) *International Journal of Neuroscience*, 42, pp. 51-58
93. Goldberg, T.E., Ragland, D.R., Gold, J.M., Bigelow, L.B., Torrey, E.F., Weinberger, D.R., Neuropsychological assessment of monozygotic twins discordant for schizophrenia (1990) *Archives of General Psychiatry*, 47, pp. 1066-1072
94. Goldberg, T.E., Saint-Cyr, J.A., Weinberger, D.R., Assessment of procedural learning and problem solving in schizophrenic patients by tower of Hanoi type tasks (1990) *Journal of Neuropsychiatry and Clinical Neurosciences*, 2, pp. 165-173
95. Goldberg, T.E., Weinberger, D.R., Pliskin, N.H., Berman, K.F., Plodd, M.H., Recall memory deficit in schizophrenia: A possible manifestation of prefrontal dysfunction (1989) *Schizophrenia Research*, 2, pp. 251-257
96. Golden, C.J., (1978) *Stroop Color and Word Test*, , Chicago: Stoelting
97. Golden, C.J., Purisch, A.D., Hammeke, T.A., (1985) *Luria-Nebraska Neuropsychological Battery: Forms I and II*, , Los Angeles: Western Psychological Services
98. Goldstein, G., Comprehensive neuropsychological assessment batteries (1984) *Handbook of Psychological Assessment*, pp. 181-210. , G. Goldstein & M. Hersen (Eds.), New York: Pergamon Press
99. Goldstein, G., Shelly, C., Statistical and normative studies of the Halstead Neuropsychological Test Battery relevant to a neuropsychiatric hospital setting (1972) *Perceptual and Motor Skills*, 34, pp. 603-620
100. Goldstein, G., Zubin, J., Neuropsychological differences between young and old schizophrenics with and without associated neurological dysfunction (1990) *Schizophrenia Research*, 3, pp. 117-126
101. Goldstein, P.C., Rosenbaum, G., Taylor, M.A., Assessment of differential attention mechanisms in seizure disorders and schizophrenia (1997) *Neuropsychology*, 11, pp. 309-317
102. Gourovitch, M.L., Goldberg, T.E., Weinberger, D.R., Verbal fluency deficits in patients with schizophrenia: Semantic fluency is differentially impaired as compared with phonologic fluency (1996) *Neuropsychology*, 10, pp. 573-577
103. Green, B.F., Hall, J.A., Quantitative methods for literature reviews (1984) *Annual Review of Psychology*, 35, pp. 37-53
104. Green, M., Walker, E., Neuropsychological performance and positive and negative symptoms in schizophrenia (1985) *Journal of Abnormal Psychology*, 94, pp. 460-469
105. Green, M., Walker, E., Attentional performance in positive and negative symptom schizophrenia (1986) *The Journal of Nervous and Mental Disease*, 174, pp. 208-213
106. Greiffenstein, M., Milberg, W., Lewis, R., Rosenbaum, G., Temporal lobe epilepsy and schizophrenia. Comparison of reaction time deficits (1981) *Journal of Abnormal Psychology*, 90, pp. 105-112
107. Gruzelier, J., Liddiard, D., Davis, L., Wilson, L., Topographical EEG differences between schizophrenic patients and controls during neuropsychological functional activation (1990) *International Journal of Psychophysiology*, 8, pp. 275-282

108. Gruzelier, J., Seymour, K., Wilson, L., Jolley, A., Hirsch, S., Impairments on neuropsychological tests of temporohippocampal and frontohippocampal functions and word fluency in remitting schizophrenia and affective disorders (1988) *Archives of General Psychiatry*, 45, pp. 623-629
109. Guich, S.M., Buchsbaum, M.S., Burgwald, L., Wu, J., Haier, R., Asarnow, R., Nuechterlein, K., Patkin, S., Effect of attention on frontal distribution of delta activity and cerebral metabolic rate in schizophrenia (1989) *Schizophrenia Research*, 2, pp. 439-448
110. Hagger, C., Buckley, P., Kenny, J.T., Friedman, L., Ubogy, D., Meltzer, H.Y., Improvement in cognitive functions and psychiatric symptoms in treating refractory schizophrenic patients receiving clozapine (1993) *Biological Psychiatry*, 34, pp. 702-712
111. Hain, C., Maier, W., Klinger, T., Frankle, P., Positive/ negative symptomatology and experimental measures of attention in schizophrenic patients (1993) *Psychopathology*, 26, pp. 62-69
112. Hanes, K.R., Andrewes, D.G., Pantelis, C., Cognitive flexibility and complex integration in Parkinson's disease, Huntington's disease, and schizophrenia (1995) *Journal of the International Neuropsychological Society*, 1, pp. 545-553
113. Harris, J.G., Adler, L.E., Young, D.A., Cullum, C.M., Rilling, L.M., Cicerello, A., Intermann, P.M., Freedman, R., Neuropsychological dysfunction in parents of schizophrenics (1996) *Schizophrenia Research*, 20, pp. 253-260
114. Harvey, P.D., Speech competence in manic and schizophrenic psychoses: The association between clinically rated thought disorder and cohesion and reference performance (1983) *Journal of Abnormal Psychology*, 92, pp. 368-377
115. Harvey, P.D., Earle-Boyer, E.A., Wielgus, M.S., Levinson, J.C., Encoding, memory, and thought disorder in schizophrenia and mania (1986) *Schizophrenia Bulletin*, 12, pp. 252-261
116. Harvey, P.D., Keefe, R.S.E., Moskowitz, J., Putram, K.M., Mohs, R.C., Davis, K.L., Attentional markers of vulnerability to schizophrenia: Performance of medicated and unmedicated patients and normals (1990) *Psychiatry Research*, 33, pp. 179-188
117. Harvey, S.A., Nelson, E., Haller, J.W., Early, T.S., Lateralized attentional abnormality in schizophrenia is correlated with severity of symptoms (1993) *Biological Psychiatry*, 33, pp. 93-99
118. Heaton, R.K., Chelune, G.J., Talley, J., Kay, G.G., Curtiss, G., (1993) *Wisconsin Card Sorting Test Manual - Revised and Expanded*, , Odessa, FL: Psychological Assessment Resources
119. Heaton, R.K., Crowley, T.J., Effects of psychiatric disorders and their somatic treatments on neuropsychological test results (1981) *Handbook of Clinical Neuropsychology*, pp. 481-525. , S. B. Filskov & T. J. Boll (Eds.), New York: Wiley
120. Heaton, R.K., Paulsen, J.S., McAdams, L.A., Kuck, J., Zisook, S., Braff, D., Harris, J., Jeste, D.V., Neuropsychological deficits in schizophrenics: Relationship to age, chronicity, and dementia (1994) *Archives of General Psychiatry*, 51, pp. 469-476
121. Hedges, L.V., Fixed effect models (1994) *The Handbook of Research Synthesis*, pp. 285-299. , H. Cooper & L. V. Hedges (Eds.), New York: Russell Sage Foundation
122. Hedges, L.V., Olkin, I., (1985) *Statistical Methods for Meta-analysis*, , New York: Academic Press
123. Heinrichs, R.W., Variables associated with Wisconsin Card Sorting Test performance in neuropsychiatric patients referred for assessment (1990) *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 3, pp. 107-112
124. Heinrichs, R.W., Schizophrenia and the brain: Conditions for a neuropsychology of madness (1993) *American Psychologist*, 48, pp. 221-233
125. Heinrichs, R.W., Awad, A.G., Neurocognitive subtypes of chronic schizophrenia (1993) *Schizophrenia Research*, 9, pp. 49-58
126. Heinrichs, R.W., Ruttan, L.A., Zakzanis, K.K., Case, D., Parsing schizophrenia with neurocognitive tests: Evidence of

- stability and validity (1997) *Brain and Cognition*, 35, pp. 207-224
127. Highgate-Maynard, S., Neufeld, R.W.J., Schizophrenic memory-search performance involving nonverbal stimulus properties (1986) *Journal of Abnormal Psychology*, 95, pp. 67-73
 128. Holzman, P.S., Shenton, M.E., Solovay, M.R., Quality of thought disorder in differential diagnosis (1986) *Schizophrenia Bulletin*, 12, pp. 360-372
 129. Iacono, W.G., Moreau, M., Beiser, M., Heming, J.A.E., Liu, T.Y., Smooth-pursuit eye tracking in first-episode psychotic patients and their relatives (1992) *Journal of Abnormal Psychology*, 101, pp. 104-116
 130. Javitt, D.C., Doneshka, P., Zylberman, I., Ritter, W., Vaughan Jr., H.G., Impairment of early cortical processing in schizophrenia: An event-related potential confirmation study (1993) *Biological Psychiatry*, 33, pp. 513-519
 131. Johnson, B.T., (1989) *DSTAT: Software for the Meta-analytic Review of Research Literatures*, Hillsdale, NJ: Erlbaum
 132. Johnson, O., Crockett, D., Changes in perceptual asymmetries with clinical improvement of depression and schizophrenia (1982) *Journal of Abnormal Psychology*, 91, pp. 45-54
 133. Jones, S.H., Gray, J.A., Hemsley, D.R., Loss of the kamin blocking effect in acute but not chronic schizophrenics (1992) *Biological Psychiatry*, 32, pp. 739-755
 134. Jones, S.H., Hemsley, D.R., Gray, J.A., Contextual effects on choice reaction time and accuracy in acute and chronic schizophrenics: Impairment in selective attention or in the inference of prior learning? (1991) *British Journal of Psychiatry*, 159, pp. 415-421
 135. Joyce, E.M., Collinson, S.L., Crichton, P., Verbal fluency in schizophrenia: Relationship with executive function, semantic memory and clinical alogia (1996) *Psychological Medicine*, 26, pp. 39-49
 136. Kahn, E.M., Weiner, R.D., Coppola, R., Kudler, H.S., Schultz, K., Spectral and topographic analysis of EEG in schizophrenic patients (1993) *Biological Psychiatry*, 33, pp. 284-290
 137. Kareken, D.A., Gur, R.C., Mozley, P.D., Mozley, L.H., Saykin, A.J., Stasel, D.L., Gur, R.E., Cognitive functioning and neuroanatomic volume measures in schizophrenia (1995) *Neuropsychology*, 9, pp. 211-219
 138. Kareken, D.A., Moberg, P.J., Gur, R.C., Proactive inhibition and semantic organization: Relationship with verbal memory in patients with schizophrenia (1996) *Journal of the International Neuropsychological Society*, 2, pp. 486-493
 139. Katsanis, J., Iacono, W.G., Beiser, M., Anhedonia and perceptual aberration in first-episode psychotic patients and their relatives (1990) *Journal of Abnormal Psychology*, 99, pp. 202-206
 140. Kawasaki, Y., Maeda, Y., Suzuki, M., Urato, K., Higashima, M., Kiba, K., Yamaguchi, N., Hisada, K., SPECT analysis of regional cerebral blood flow changes in patients with schizophrenia during the Wisconsin Card Sorting Test (1993) *Schizophrenia Research*, 10, pp. 109-116
 141. Keefe, J.A., Magaro, P.A., Creativity and schizophrenia: An equivalence of cognitive processing (1980) *Journal of Abnormal Psychology*, 89, pp. 390-398
 142. Keefe, R.S.E., Lees Roitman, S.E., Harvey, P.D., Blum, C.S., DuPre, R.L., Prieto, P.M., Davidson, M., Davis, K.L., A pen-and-paper human analogue of a monkey prefrontal cortex activation task: Spatial working memory in patients with schizophrenia (1995) *Schizophrenia Research*, 17, pp. 25-33
 143. Kerr, S.L., Neale, J.M., Emotion perception in schizophrenia: Specific deficit or further evidence of generalized poor performance (1993) *Journal of Abnormal Psychology*, 102, pp. 312-318
 144. Killian, G.A., Holzman, P.S., Davis, J.M., Gibbons, R., Effects of psychotropic medication on selected cognitive and perceptual measures (1984) *Journal of Abnormal Psychology*, 93, pp. 58-70
 145. Klove, H., Clinical neuropsychology (1963) *The Medical Clinics of North America*, pp. 1647-1658. , F. M. Forster (Ed.), New York: Saunders

146. Knight, R.A., Elliot, D.S., Freedman, E.G., Short-term visual memory in schizophrenics (1985) *Journal of Abnormal Psychology*, 94, pp. 427-442
147. Knight, R.A., Youard, P.J., Wooles, I.M., Visual information-processing deficits in chronic schizophrenic subjects using tasks matched for discriminating power (1985) *Journal of Abnormal Psychology*, 94, pp. 454-459
148. Kolb, B., Whishaw, I.Q., Performance of schizophrenic patients on tests sensitive to left or right frontal, temporal, or parietal function in neurological patients (1983) *The Journal of Nervous and Mental Disease*, 171, pp. 435-443
149. Krakowski, M.I., Convit, A., Jaeger, J., Lin, S., Volavka, J., Neurological impairment in violent schizophrenic inpatients (1989) *American Journal of Psychiatry*, 146, pp. 849-853
150. Kraemer, H.C., Andrews, G., A nonparametric technique for meta-analysis effect size calculation (1982) *Psychological Bulletin*, 91, pp. 404-412
151. Kremen, W.S., Seidman, L.S., Faraone, S.V., Pepple, J.R., Lyons, M.J., Tsuang, M.T., The "3Rs" and neuropsychological function in schizophrenia: An empirical test of the matching fallacy (1996) *Neuropsychology*, 10, pp. 22-31
152. Kwapil, T.R., Chapman, L.J., Chapman, J.P., Monaural and binaural story recall by schizophrenic subjects (1992) *Journal of Abnormal Psychology*, 101, pp. 709-716
153. Kwapil, T.R., Hegley, D.C., Chapman, L.J., Chapman, J.P., Facilitation of word recognition by semantic priming in schizophrenia (1990) *Journal of Abnormal Psychology*, 99, pp. 115-221
154. Landro, N.I., Orbeck, A.L., Rund, B.R., Memory functioning in chronic and non-chronic schizophrenics, affectively disturbed patients and normal controls (1993) *Schizophrenia Research*, 10, pp. 85-92
155. Laplante, L., Everett, J., Thomas, J., Inhibition through negative priming with Stroop stimuli in schizophrenia (1992) *British Journal of Clinical Psychology*, 31, pp. 307-326
156. Lawrie, S.M., Abukmeil, S.S., Chiswick, A., Egan, V., Santosh, C.G., Best, J.J.K., Qualitative cerebral morphology in schizophrenia: A magnetic resonance imaging study and systematic literature review (1997) *Schizophrenia Research*, 25, pp. 155-166
157. Levander, S.E., Bartfai, A., Schalling, D., Regional cortical dysfunction in schizophrenic patients studied by computerized neuropsychological methods (1985) *Perceptual and Motor Skills*, 61, pp. 479-495
158. Levin, S., Hall, J.A., Knight, R.A., Alpert, M., Verbal and nonverbal expression of affect in speech of schizophrenic and depressed patients (1985) *Journal of Abnormal Psychology*, 94, pp. 487-497
159. Levin, S., Yurgelun-Todd, D., Craft, S., Contributions of clinical neuropsychology to the study of schizophrenia (1989) *Journal of Abnormal Psychology*, 98, pp. 341-356
160. Lewis, S.W., Ford, R.A., Syed, G.M., Reveley, A.M., Toone, B.K., A controlled study of 99mTc-HMPAO single-photon emission imaging in chronic schizophrenia (1992) *Psychological Medicine*, 22, pp. 27-35
161. Lezak, M.D., (1995) *Neuropsychological Assessment* (3rd Ed.), , New York: Oxford University Press
162. Liddle, P.F., Barnes, T.R.E., Syndromes of chronic schizophrenia (1990) *British Journal of Psychiatry*, 157, pp. 558-561
163. Lim, K.O., Sullivan, E.V., Zipursky, R.B., Pfefferbaum, A., Cortical gray matter volume deficits in schizophrenia: A replication (1996) *Schizophrenia Research*, 20, pp. 157-164
164. Maler, W., Franke, P., Hain, C., Kopp, B., Rist, F., Neuropsychological indicators of the vulnerability to schizophrenia (1992) *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 16, pp. 703-715
165. Mandal, M.K., Rai, A., Responses to facial emotion and psychopathology (1987) *Psychiatry Research*, 20, pp. 317-323
166. Marsh, L., Suddath, R.L., Higgins, N., Weinberger, D.R., Medial temporal lobe structures in schizophrenia: Relationship of size to duration of illness (1994) *Schizophrenia Research*, 11, pp. 225-238
167. Mather, J.A., Neufeld, R.W.J., Merskey, H., Russel, N.C., Disruption of saccade production during oculomotor tracking in

- schizophrenia and the use of its changes across target velocity as a discriminator of the disorder (1992) *Psychiatry Research*, 43, pp. 93-109
168. Mattes, R., Cohen, R., Berg, P., Canavan, A.G.M., Hopmann, G., Slow-cortical potentials (SCPS) in schizophrenic patients during performance of the Wisconsin Card Sorting Test (WCST) (1991) *Neuropsychologia*, 29, pp. 195-205
 169. McCarley, R.W., Faux, S.R., Shenton, M., LeMay, M., Cane, M., Ballinger, R., Duffy, F.H., CT abnormalities in schizophrenia: A preliminary study of their correlations with P300/P200 electrophysiological features and positive/negative symptoms (1989) *Archives of General Psychiatry*, 46, pp. 698-708
 170. McGuire, P.K., Silbersweig, D.A., Wright, I., Murray, R.M., Frackowiak, R.S.J., Frith, C.D., The neural correlates of inner speech and auditory verbal imagery in schizophrenia: Relationship to auditory verbal hallucinations (1996) *British Journal of Psychiatry*, 169, pp. 148-159
 171. McKay, S.E., Golden, C.J., The assessment of specific neuropsychological skills using scales derived from factor analysis of the Luna-Nebraska Neuropsychological Battery (1981) *International Journal of Neuroscience*, 14, pp. 189-204
 172. McKay, S.E., McKenna, P.J., Bentham, P., Mortimer, A.M., Holbery, A., Hodges, J.R., Semantic memory is impaired in schizophrenia (1996) *Biological Psychiatry*, 39, pp. 929-937
 173. Meehl, P.E., Nuisance variables and the ex post facto design (1970) *Minnesota Studies in the Philosophy of Science*, pp. 373-402. , M. Radner & S. Winokur (Eds.), Minneapolis, MN: University of Minnesota Press
 174. Michie, P.T., Fox, A.M., Warp, P.B., Catts, S.V., McConaghy, N., Event-related potential indices of selective attention and cortical lateralization in schizophrenia (1990) *Psychophysiology*, 8, pp. 234-244
 175. Milner, B., Some effects of frontal lobectomy in man (1964) *The Frontal Granular Cortex and Behavior*, pp. 313-334. , J.