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Brief Report

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The Halstead Category Test of brain dysfunction is one of the most sensitive neuropsychological measures currently available. While the instrument has received widespread use, nevertheless, the exact nature of what it measures has been poorly delineated. The present brief report presents the results of separate factor analyses of the Category Test along with other neuropsychological measures from the Halstead-Reitan battery. Despite considerable differences in samples, as well as in the particular neuropsychological measures included in the separate analyses, the Category Test consistently lined-up with general intellectual and memory components, in each instance.

The Halstead Category Test is a sensitive neuropsychological indicator of brain dysfunction (Adams & Trenton, 1981; Boyle, 1975, 1986; Wood & Strider, 1980). According to Lezak (1983, p. 481), "Along with measuring abstract concept formation (Pendleton & Heaton, 1982) and ability to maintain attention to a lengthy task, this test has a visuospatial component, correlating most highly with Block Design and Picture Arrangement sub-tests of the WAIS (Lansdell & Donnelly, 1977)." Boll (1981) notes that the test also "requires learning skills for effective performance." Other investigators (e.g., Goldstein & Shelly, 1984; Kupke & Lewis, 1985; Lin & Rennick, 1974; Seidenberg, Giordani, Berent, & Boll, 1983; Telzrow & Harr, 1987) have reported correlations in the 0.5 to 0.6 range suggesting that the Category Test shares about 25% common variance with the WAIS/WISC-R. Both the Category Test and the WAIS measures are sensitive to brain disorders and their effects on adaptive abilities. Such tests would be expected to be correlated, but it does not follow that they measure the same thing,
or that they are equivalent. Nevertheless, it is important to ascertain precisely the nature of what the Category Test measures in relation to the WAIS.

The present paper explores the relationship between psychometric intelligence and performance on the Category Test using a factor analytic approach. Given the studies cited above, it is hypothesized that the Category Test will exhibit significant loadings predominantly on non-verbal/performance measures, rather than on verbal measures of ability. Chelune (1983, p. 933) has pointed out that analyses of data across diagnostic groups rather than simply within a "brain-damaged population" has the advantage of increasing the variability in the data so that relationships are more readily discernible. Carroll (1985, p. 31) has recommended that "Samples should be selected so as to represent at least substantial variation in all the hypothesized abilities being investigated."

Accordingly, the present study utilizes both a mixed sample of brain-damaged and non-brain-damaged patients, as well as a sample of neuropsychiatric patients in order to increase the measurement variance on the various neuropsychiological indicators, in accord with sound factor analytic guidelines (cf. Gorsuch, 1983).

**Method**

**Subjects**

Sample A comprised 51 subjects (16 brain-damaged patients, eight paraplegic non-brain-damaged patients, 27 normal individuals). Mean IQ was 103.97 (SD = 16.71). Mean age was 32.43 years (ranging from 16 to 68 years). Mean education was 9.74 years (range of 5 to 18 years). Diagnostic categories for the brain-damaged patients included severe epilepsy, cerebral gunshot injuries, encephalitis with residual cerebral impairment, degenerative diseases,

Sample B consisted of 50 neuropsychiatric male patients originally studied by Halstead (1947). Demographic details of this sample were provided in Halstead's book. Reanalysis of Halstead's own data was undertaken in an attempt to partially cross-validate the factor analytic findings derived from Sample A. Accordingly, the two samples together provided a diversity of neuropsychological abilities, as recommended both by Chelune (1983) and Carroll (1985).

**Design and Procedure**

Although the two samples were tested on somewhat different neuropsychological measures, it was considered appropriate to compare the factor structure of the Category Test across analyses in order to ascertain the robustness of its factor alignments in each instance. Only by comparing the relationship of the factor structures for the Category Test and a diversity of other neuropsychological measures, was it possible to ascertain comprehensively the relationship of the Category Test to these other indicators of brain dysfunction.

In the analysis on Sample A, a shortened version of the Category Test (Boyle, 1975, 1986) was used as part of the Halstead-Reitan battery, whereas Halstead (1947) employed the full Category Test. The comparability of the shortened and full Category Test has been well documented (e.g., Calsyn,
O'Leary, & Chaney, 1980; Golden, Kuperman, Macinnes, & Moses, 1981; Gregory, Paul, & Morrison, 1979; Sherrill, 1985). While Sample A took the WAIS, Halstead employed the Carl Hollow Square Test and the Henmon-Nelson Test as measures of non-verbal and verbal intelligence respectively. In both of the present analyses, the intercorrelation matrix for the Category Test, the respective intelligence measures, and the various neuropsychological indicators was subjected to an iterative principal factoring procedure along the lines advocated by Cattell (1978), and Gorsuch (1983), factor- extraction number was determined by the Scree test (Hakstian, Rogers, & Cattell, 1982) and rotation was to oblique (direct Oblimin) simple structure.

Results

Analysis A

Thirty-four iterations of the factor matrix were required in order to reach convergence of the communality estimates (SMC's) at the third decimal place. The resultant four-factor solution is presented in Table I. As is evident, Factor 1 represents general intelligence given the significant loadings for the Category Test, WAIS scores, and Wechsler Memory Scale score. Factor 2 was loaded by Tactual Performance Test scores suggesting a sensorimotor-coordination interpretation. Factor 3 exhibited significant loadings for the Finger-Tapping Test, suggestive of a motor speed interpretation. Factor 4 represents incidental memory, being loaded significantly by both memory and localization components of the Tactual Performance Test. The highly significant (inverse) loading for age on this factor suggests that memory and localization capacities decline directly with advancing age in adult- hood. However, age did not load significantly on the first
three factors. Evidently, performance on the Category Test is positively enhanced either by high intelligence and/or educational level.

Table 1
Oblique Factor-Pattern Matrix for Sample A

<table>
<thead>
<tr>
<th>Measures</th>
<th>Factor</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Category Test (Errors)</td>
<td>-.42</td>
<td>.00</td>
<td>.21</td>
<td>.35</td>
<td>.51</td>
</tr>
<tr>
<td>WAIS Verbal IQ</td>
<td>.98</td>
<td>.02</td>
<td>.02</td>
<td>.14</td>
<td>.89</td>
</tr>
<tr>
<td>WAIS Performance IQ</td>
<td>.66</td>
<td>-.23</td>
<td>-.10</td>
<td>-.21</td>
<td>.77</td>
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<tr>
<td>WAIS Total IQ</td>
<td>.97</td>
<td>-.05</td>
<td>-.02</td>
<td>-.02</td>
<td>.99</td>
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<tr>
<td>Wechsler Memory Scale</td>
<td>.80</td>
<td>-.10</td>
<td>.00</td>
<td>.20</td>
<td>.63</td>
</tr>
<tr>
<td>Tactual Performance Test (Right Hand)</td>
<td>.02</td>
<td>.99</td>
<td>-.10</td>
<td>-.12</td>
<td>.95</td>
</tr>
<tr>
<td>Tactual Performance Test (Left Hand)</td>
<td>.02</td>
<td>.89</td>
<td>.02</td>
<td>.07</td>
<td>.82</td>
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<tr>
<td>Tactual Performance Test (Both Hands)</td>
<td>-.09</td>
<td>.80</td>
<td>.11</td>
<td>.12</td>
<td>.80</td>
</tr>
<tr>
<td>Tactual Performance Test (Memory)</td>
<td>.36</td>
<td>-.03</td>
<td>-.23</td>
<td>-.50</td>
<td>.66</td>
</tr>
<tr>
<td>Tactual Performance Test (Localization)</td>
<td>.36</td>
<td>-.05</td>
<td>-.16</td>
<td>-.54</td>
<td>.65</td>
</tr>
<tr>
<td>Finger Tapping Test (Right Hand)</td>
<td>-.01</td>
<td>-.01</td>
<td>-.95</td>
<td>.17</td>
<td>.61</td>
</tr>
<tr>
<td>Finger Tapping Test (Left Hand)</td>
<td>-.07</td>
<td>.01</td>
<td>-.80</td>
<td>-.06</td>
<td>.87</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>.19</td>
<td>.16</td>
<td>-.17</td>
<td>.75</td>
<td>.63</td>
</tr>
<tr>
<td>Education (Years)</td>
<td>.76</td>
<td>.11</td>
<td>.05</td>
<td>-.16</td>
<td>.62</td>
</tr>
<tr>
<td>Percentage Variance:</td>
<td>43.2</td>
<td>19.0</td>
<td>10.0</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue:</td>
<td>6.05</td>
<td>2.66</td>
<td>1.40</td>
<td>1.26</td>
<td></td>
</tr>
</tbody>
</table>

Notes. Factor loadings are reported to two decimal places only. As initial communality estimates were maximum off-diagonal elements of the inter-correlation matrix, only factor loadings of .40 or higher are shown as significant. Factor I correlates -.20 with Factor 2, -.44 with Factor 3, and -.26 with Factor 4. Factor 2 correlates .02 with Factor 3, and .32 with Factor 4, while Factor 3 correlates .16 with Factor 4. The intercorrelation matrix was reported in Boyle (1986, p. 619).

Analysis B (Halstead's Data)

The factor solutions provided by Halstead (1945, pp. 58-59; 1947, pp. 40-41) were not reproduced using the procedures in SPSS. As Carroll (1985) pointed out, the bi-factor method has not gained acceptance because of its lack of clarity as compared with the multiple factor analysis approach. Hence, of the two different solutions provided by Halstead (1945, 1947), only the multiple factor
solution served as the comparative base for the present analyses. Halstead reported four oblique factors of "biological intelligence" which he labelled C (Central Integrative Field), A (Abstraction), P (Power), and D (Directional).

The correlation matrix from Halstead (1947, p. 40) was subjected to an iterative principal factoring procedure. Forty-four iterations of the initial communality estimates (SMC's) were required (at which point one particular communality estimate reached unity). Four factors were extracted and rotated to oblique simple structure (see Table 2). Factor 1 evidently represents perceptual discriminatory power (akin to the automatic level in the ITPA model). Factor 2 is clearly a general cognitive-intellectual dimension, with the Category Test having loadings on both measures of verbal and performance IQ. This finding strongly supports those from Table 1, even though there are considerable differences in the specific intelligence and neuropsychological measures included in each analysis. The third factor suggests a sensorimotor-coordination interpretation, while Factor 4 involves incidental memory. There is a marked degree of similarity between the two sets of neuropsychological factors, given the somewhat different measures included in each separate analysis. Under these circumstances, there can be no doubt that the Category Test is a measure of general intellectual ability (Spearman's "g")-(cf. Jensen, 1980).
Discussion

For Sample A, only those measures for which complete data was available on all 51 subjects were included in the analysis given the limited sample size. While the two samples were small, nevertheless, the Category Test loaded mainly on the general intelligence factor in both instances. Chelune (1982, p. 580) commented that "the components of 'intelligence' above and beyond those tapped by the V/AIS are most salient to clinical neuropsychologists." However, the present cross-validated results indicate that the Category Test has high loadings on intelligence measures such as the WAIS, on a common factor. Nevertheless, the Category Test remains a more sensitive indicator of neuropsychological dysfunction than does the WAIS which is more suited to normal individuals (Goldstein & Shelly, 1984, p. 384). The Category Test is much more related to age than to education in neurologically normal individuals (even more so than are the WAIS Performance sub-tests), whereas the opposite is true for the WAIS Verbal subtests. Reitan (Note 1) has indicated that "The Category Test differs from IQ (as measured by the WAIS) in many ways such as sensitivity to cerebral functioning, lateralization effects, etc. Results on normals do not relate the instrument to aspects of brain functioning. Instances in which the Category Test and the WAIS deviate from expectancy represent the area of interest-not the expected correlation between the two measures."

The WAIS and Category Test play a complimentary role in clinical neuropsychological assessment. The Category Test is much more sensitive than the Wechsler scales as a general measure, while the WAIS is useful for lateralization and localization purposes. Kane et al. (1985, p. 220) pointed out that "patients with more focal lesions may show isolated areas of impairment in the
context of preserved general abilities.... Such individuals might be misdiagnosed using only WAIS measures." However, on the basis of the present findings, the Category Test is a measure of general intellectual ability (and not just of performance ability as generally intimated (e.g., Lezak, 1983, p. 481). Indeed, in both samples, the Category Test exhibited higher factor loadings on verbal ability than on non-verbal ability. This occurred irrespective of whether the full Category Test or the shortened version was employed (which attests further to the robustness of the shortened version and its validity as compared with the full test). In addition, there is some evidence that memory components contribute to a lesser extent to performance on the Category Test. The goal of clarifying what is measured by complex neuropsychological tests is an important one. The present paper goes some way toward answering this question for the Halstead Category Test.

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