The Performance of Learning-Disabled and Normal Young Men on the Test of Visual-Perceptual Skills

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The present study explored the discriminative validity of the motor-free Test of Visual-Perceptual Skills (TVPS) as an assessment for adults. The subjects were 26 learning-disabled and 26 normal young men. Overall, the subjects with learning disabilities made significantly more errors and took significantly more time on the total TVPS than did the normal subjects. The group with learning disabilities demonstrated significantly lower accuracy scores on four of the seven subtests and longer time scores on five subtests. Discriminant analysis revealed that the time score for Visual Sequential Memory and the accuracy score for Visual Closure were the two subtest scores that best discriminated between groups and, together, were able to correctly classify 84.6% of the subjects. The TVPS total accuracy score for the subjects with learning disabilities significantly correlated with their overall performance IQ but not with their verbal IQ. Their TVPS total accuracy scores also correlated with scores on Block Design, but not with scores on the Object Assembly or Picture Completion subtests of the WAIS-R. The results seem to indicate that the TVPS is valid as an assessment of visual-perceptual functions for young adult subjects. Recommendations for further study were made.

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Occupational therapists frequently assess visual-perceptual problems in their patients. A valid assessment requires that the selected visual-perceptual test be age-appropriate and a sensitive measure of specific visual-perceptual deficits (Gaddes, 1981; Lezak, 1983). Siev and Freishtat (1976) performed a survey of the use of clinical perceptual assessments by occupational therapists and found that perceptual tests intended for assessing children's developmental competency have been commonly applied to adult patients. Children's tests are used with adults because the availability of standardized tests of visual perception for adults is limited. Standard score norms of children's tests, however, cannot be applied to an adult population because of the performance differences that exist between adults and children (Gaddes; Lezak). Peterson and Wikoff (1983) suggested that a children's test should first be validated with adult subjects before it is used with adult patients.

Furthermore, a controversy exists regarding whether or not persons with learning disabilities exhibit visual-perceptual deficits. Recent findings have suggested that only a portion of clients with learning disabilities have associated visual-perceptual problems (Gross & Rothenberg, 1979; Harris, 1982; Mattis, French, & Rapin, 1975; Rourke, 1978; Strang & Rourke, 1985; Weintraub & Mesulam, 1983). An additional, related controversy centers on whether or not persons with learning disabilities who also have visual-perceptual problems in childhood resolve their visual-perceptual deficits during the normal course of development. However, Rourke and Gates (Rourke, 1978; Rourke & Gates, 1981) have suggested that there may be problems of measurement reliability in the studies that have concluded that visual-perceptual deficits of persons with learning disabilities resolve during later childhood.

Therefore, this investigation was implemented for the following reasons: (a) Therapists need a valid visual-perceptual test for assessing adults with known or suspected central nervous system dysfunction or damage, (b) little information has been reported regarding the visual-perceptual status of adults with learning disabilities, and (c) the neuropsychological performance of adults with learning disabilities is assumed to occupy a position between the performance of normal and brain-damaged adults (O'Donnell, Kurtz, & Ramanaiah, 1983). If the visual-perceptual problems demonstrated by adults with learning disabilities are more subtle than those found in brain-damaged adults, and if those problems are more subtle in young adulthood than during childhood, then young adults with learning disabilities are the optimal population for determining whether a visual-perceptual test designed for children has validity when used
with adults. Any test sensitive enough to identify the more subtle deficits in young adults with learning disabilities can be assumed to also be valid when applied to brain-injured adults.

The Test of Visual-Perceptual Skills

Gardner (1982) designed the motor-free Test of Visual-Perceptual Skills (Non-Motor) (TVPS) to assess visual perception in 4- to 12-year-old children. The TVPS involves the use of predrawn configurations and designs, thereby excluding any motor component in the administration. The TVPS has the potential to be an excellent choice for assessing visual perception in brain-injured or stroke patients. Gardner evaluated the content validity of the TVPS and reported other reliability (internal consistency) and validity (criterion-related, item, and predictive validity) data. He also reported the results of a discriminative (diagnostic) validity study involving 45 children with learning disabilities and 45 matched normal children. The norms of the TVPS were established according to the performance of a normal school population (N = 962).

In the Ninth Mental Measurements Yearbook, two test reviewers, Busch-Rossnagel (1985) and Denison (1985), had certain concerns regarding the TVPS. They each identified many weaknesses in the rationale and validity evidence provided for the TVPS. Busch-Rossnagel suggested that the decline of reliability data in the older normative subjects (age 10 to 12 years) might be evidence of the fact that the validity of the TVPS is inadequate when it is used with older children. Denison questioned whether the seven subtests of the TVPS represented distinctive aspects of visual perception because no studies had been conducted. Busch-Rossnagel and Denison both suggested that future studies of the TVPS should attempt to establish diagnostic and predictive validity, assess test-retest reliability, and use factor analysis to identify the specific aspects of visual perception that are tested by the TVPS. This investigation was implemented in response to the need for validity studies of the TVPS.

Visual-Perceptual Deficits and Learning Disabilities

The term learning disabilities has been applied to a group of conditions observed in the school and the clinic. However, not all such conditions have been associated with visual-perceptual deficits. Several studies have found that developmental dyslexia is associated with good right-hemisphere skills (Geschwind & Galaburda, 1985; Witelson, 1977) and/or normal to superior visuospatial scores on intellectual profiles (Bannatyne, 1968; Rugel, 1974). In contrast, Mattis et al. (1975) found that about 15% of their dyslexic subjects were primarily characterized by visual-perceptual disorders. However, although opinions on the existence of visual-perceptual deficits in learning-disabled persons with either dyslexia or left-hemisphere dysfunction have been contradictory, past research has suggested the possibility of visual-perceptual deficits in many persons with learning disabilities (Gross & Rothenberg, 1979; Harris, 1982; Rourke, 1982).

Several studies have revealed that visual-perceptual deficits or low visual-perceptual abilities are most frequent in learning-disabled children who have significantly higher verbal than performance scores on the Wechsler intellectual profile (Rourke & Telegdy, 1971; Rourke, Young, & Flewelling, 1971), or who have more difficulties with arithmetic than on reading and spelling (Rourke & Finlayson, 1978; Strang & Rourke, 1985). Similarly, O’Donnell (1985) found that learning-disabled adults with associated deficits in both language and visual-perceptual abilities had more severe overall neuropsychological dysfunction than those who had language disorders only. Finally, research has indicated that visual-perceptual or visuospatial deficits are commonly associated with persons who are not dyslexic or who have right-hemisphere dysfunction (Brumback & Staton, 1982; Rourke, 1982; Rudel, 1980; Strang & Rourke, 1985; Weintraub & Mesulam, 1983).

Although many researchers have concluded that visual-perceptual deficits are the signs of a general maturational lag and appear only in younger children with learning disabilities (Satz, Taylor, Friel, & Fletcher, 1978; Rutter, 1978), Rourke and Gates (1981) suggested that cortical-level visual-perceptual deficits persist into adulthood and that failure to find visual-perceptual problems in older children with learning disabilities has been due to the use of developmentally simple assessments with inadequate ceilings for older ages. Such developmentally low-level tests lack the sensitivity to detect subtle deficits in older children or adults.

Some studies did find that visual-perceptual deficits persist into adulthood. Silver and Hagin (1964) found persistent visual-perceptual and visuomotor problems in adult reading-disabled subjects who had demonstrated similar problems in childhood. Weintraub and Mesulam (1983) reported a developmental nondyslexic syndrome that was characterized by visuospatial, emotional, interpersonal, and paralinguistic difficulties persisting from childhood into adulthood. Finally, Blalock (1982) stated that visual-perceptual problems might affect the choice of job, job performance, and the quality of the daily life of adults with learning disabilities.
The purpose of the present investigation was to obtain exploratory information regarding the validity of the TVPS as an assessment of visual-perceptual problems in adult subjects. This information was obtained by examining the differences in performance between learning-disabled and normal young men. More specifically, the following hypotheses were tested:

1. Young men with learning disabilities have significantly lower mean accuracy scores and longer mean time scores on the TVPS than normal young men.
2. TVPS accuracy and time total and/or subtest scores discriminate between learning-disabled and normal young men.
3. The total TVPS accuracy scores of young men with learning disabilities correlate with their scores on the Block Design, Object Assembly, and Picture Completion subtests of the WAIS-R.
4. The total TVPS accuracy scores of young men with learning disabilities correlate with their performance IQ but not with their verbal IQ scores.

Method

Subjects. The subjects were 26 learning-disabled and 26 normal Caucasian young men. The subjects with learning disabilities had been diagnosed prior to admission to a small, Boston area liberal arts college that has a special program for learning-disabled students. The normal subjects were recruited from a Boston area university. The normal subjects reported no significant neurological, orthopedic, visual, or auditory problems, and they had no history of learning disabilities and academic delays or need for remedial assistance. All subjects participated voluntarily. Results from t-tests indicated that there were no significant differences between groups in age ($t[46] = 1.25; p = 0.22$) or years in college ($t[48] = 0.14; p = 0.89$). The mean age of the normal group was 20.3 years ($SD = 1.8$), and the mean age of the group with learning disabilities was 19.9 years ($SD = 1.4$). The average number of years of college for both groups was 2.0 years (range = 1 to 4 years).

The WAIS-R scores for the subjects with learning disabilities were obtained from their college admission records. From the obtained WAIS-R scores ($n = 25$), the mean IQ of the group with learning disabilities fell within the average range (full-scale IQ = 104.6, $SD = 7.62$; performance IQ = 101.4, $SD = 10.44$; verbal IQ = 106.0, $SD = 7.93$). The majority of learning-disabled subjects had lower overall performance than verbal IQ scores, but only 2 subjects had a discrepancy of 15 or more points between their performance and verbal IQ scores. The mean scores for the learning-disabled group on the three WAIS-R spatial subtests were as follows: Block Design, $M = 10.5$, $SD = 2.12$; Object Assembly, $M = 9.4$, $SD = 2.06$; and Picture Completion, $M = 10.9$, $SD = 2.08$. These WAIS-R scores suggest average overall visual-perceptual abilities among the subjects with learning disabilities.

Measuring instrument. The TVPS includes a book of test plates, arranged in order by subtest, and a subject record sheet. The seven subtests in the TVPS, each containing 16 items, are Visual Discrimination, Visual Memory, Visual-Spatial Relationships, Visual Form Constancy, Visual Sequential Memory, Visual Figure–Ground, and Visual Closure. Response time on each item was measured with a stopwatch.

Procedure. After an orientation to the testing procedure, each subject was tested individually in a quiet room. The TVPS was administered with two modifications to the standardized procedures given in the test manual (Gardner, 1982). First, all items of the TVPS were administered regardless of the number of consecutive errors; and second, the time taken for the completion of each item was recorded. For each subtest of the TVPS, accuracy (the number of correct answers) and time scores were recorded. The subject was told there was no time limit; however, if the time on any single item exceeded 25 seconds, the subject was encouraged to guess. The reason for continuing the administration beyond four or five consecutive errors and for recording the response time for each item was to maximize the probability that the TVPS scores would discriminate between the normal and the learning-disabled groups.

Results

Because the TVPS was not standardized on young adults and because of the modifications made to the standardized test procedures, only raw scores were used in the analysis of the results. All subjects completed all subtests, and no subject had more than four consecutive errors. Tables 1 and 2 show the means and standard deviations for accuracy and time scores for the total TVPS and TVPS subtest scores for each group.

Two Bartlett’s tests of sphericity were performed to determine if there was a significant lack of homogeneity of variance among the subtest accuracy scores or among the subtest time scores. Results were nonsignificant ($F[6, 50] = 1.48, p = .418$) in relation to the accuracy scores, but were significant ($F[6, 50] = 4.04, p < .0005$) in relation to the time scores (Hull & Nie, 1981). These findings suggested that the hypothesis of homogeneity of variance should be accepted for the accuracy scores and rejected for the time scores. Therefore, univariate analysis of variance (ANOVA)
procedures were used to analyze the accuracy scores; the time score data were analyzed using multivariate analysis of variance (MANOVA) procedures, which are considered more powerful when variance is not homogeneous.

Results from the accuracy score two-way (Group × Subtest) ANOVA for repeated measures on subtest revealed a significant group effect, \( F(1, 50) = 12.63 \), a significant subtest effect \( F(6, 50) = 26.42 \), but no significant interaction effect \( F(6, 50) = 1.03 \). Post hoc Newman-Keuls tests were subsequently performed to locate significant \( p \leq 0.05 \) group mean differences in subtest accuracy scores. Significant differences between group accuracy scores were found for Visual Form Constancy, Visual Sequential Memory, Visual Figure-Ground, and Visual Closure (see Table 1).

Results from the two-way MANOVA for repeated measures on the time scores suggested significant \( p \leq 0.005 \) group differences in time scores (Wilks’s lambda = 0.97; approximate multivariate, \( F(1, 50) = 69.73 \). As the MANOVA did not generate values for mean square within or between variables, seven \( t \) tests were performed to determine if there were significant differences between groups for each subtest time score. Since so many \( t \) tests were performed, two-tailed probability was used and the level of significance was set at 0.05. The results indicated that the group with learning disabilities took significantly more time than the normal group on all of the subtests except Visual Form Constancy and Visual Figure-Ground; Visual Form Constancy approached significance (see Table 2).

Two additional \( t \) tests were used to test for significant differences between group total TVPS accuracy and total TVPS time scores. Both tests were significant (see Tables 1 and 2). Considered together, these results suggest that the hypothesis that young adults with learning disabilities demonstrate significantly more errors and take more time on the TVPS should be accepted for the TVPS total and for the majority of the TVPS subtest accuracy and time scores.

To determine which set of TVPS scores best discriminated between the two groups, four stepwise discriminant analyses were performed, in each analysis, a different set of independent variables was used as follows: (a) the seven subtest accuracy scores, (b) the seven subtest time scores, (c) the total TVPS accuracy score and the total TVPS time score, and (d) all 14 of the subtest accuracy and time scores. The classification results for each of the four discriminant analyses are shown in Table 3.

The stepwise discriminant analysis of the seven subtest accuracy scores (Analysis 1) revealed that the accuracy score of Visual Closure was the most powerful discriminator between the two groups \( F(1, 50) = \)
The discriminant function of the accuracy score for Visual Closure correctly classified 69.2% of the cases; 50% would have been correctly classified by chance.

The stepwise discriminant analysis of the seven subtest time scores (Analysis 2) revealed that time scores for Visual Sequential Memory, Visual Closure, and Visual Figure-Ground (in order of greatest contribution) discriminated significantly between groups \( F[3, 48] = 13.49, p < .0005 \) and correctly classified 78.9% of the cases.

The stepwise discriminant analysis of the total TVPS accuracy score and the total TVPS time score (Analysis 3) revealed that both the total time score and the total accuracy score of TVPS (in order of greatest contribution) were able to discriminate significantly between groups \( F[2, 49] = 13.08, p < .00005 \) and correctly classify 76.9% of the cases.

The final stepwise discriminant analysis, which used all of the accuracy and time subtest scores (Analysis 4), revealed that, in order of greatest contribution, the time score of the Visual Sequential Memory and the accuracy score of Visual Closure discriminated significantly between learning-disabled and normal subjects \( F[2, 49] = 18.62, p < .00005 \). This discriminant function correctly classified 84.6% of the cases. The results of the four discriminant analyses suggest that the hypothesis that TVPS scores discriminate between learning-disabled and normal young men is correct.

To test the third and fourth hypotheses that (a) total TVPS accuracy scores correlate with WAIS-R spatial subtest scores and (b) the performance IQ, but not the verbal IQ, correlates with total TVPS accuracy scores, Pearson correlation coefficients were computed. The results revealed that total TVPS accuracy scores correlated significantly with Block Design \( r = .62, p = .001 \), but not with Object Assembly \( r = .32, p = .063 \) or Picture Completion \( r = .10, p = .316 \). Finally, total TVPS accuracy scores correlated significantly with the performance IQ \( r = .38, p = .050 \) but not with the verbal IQ \( r = .19, p = .184 \).

To better understand the TVPS as a potential test for adult subjects, the floor and ceiling effects within and between the two groups were examined. The subtest accuracy scores for all subjects were first re-categorized into the following three categories: (a) score was below 9, subject passed 50% or fewer of the subtest items; (b) score was between 9 and 15, subject passed more than 50% of the items but did not reach the upper limit of the subtest; and (c) score was 16, subject reached the upper limit of the subtest. Cross-tabulation procedures were then implemented and revealed the following:

1. All subjects in this study, except one case in the group with learning disabilities, were able to pass more than half of the items in every subtest.
2. The normal group had a greater proportion of subjects with ceiling scores on all but one subtest. Three subtests had more than 40% of the normal subjects with ceiling scores of 16. No more than 27% of the subjects with learning disabilities reached scores of 16 on any subtest.
3. Several subjects in both groups had ceiling scores in Visual Discrimination, Visual-Spatial Relationships, and Visual Figure-Ground.
4. Yates corrected \( X^2 (1, N = 52) = 8.29 \) revealed a significant difference, \( p = .004 \), in the proportion of subjects between the three re-categorized groups only for Visual Closure.

### Discussion

The findings of this study appear to support results from past research that the visual-perceptual deficits of children with learning disabilities persist into young adulthood (Rourke, 1978; Rourke & Gates, 1981; Silver & Hagin, 1964; Weintraub & Mesulam, 1983). As hypothesized, the young men with learning disabilities demonstrated more errors and took longer time than did the normal young men on the TVPS.

The group with learning disabilities demonstrated lower total TVPS accuracy scores and had significantly lower accuracy subtest scores on Visual Form Constancy, Visual Sequential Memory, Visual Figure-Ground, and Visual Closure. However, the average group difference for six of the seven subtests was only 1 raw score point (see Table 1). Such a small difference, even when statistically significant, may...
suggest that the subtest accuracy scores are not clinically meaningful. Furthermore, the finding that four of the subtest accuracy scores were significantly different, but that only Visual Closure entered the discriminant function (see Table 3), suggests that the four accuracy scores may measure overlapping aspects of visual-perceptual abilities.

Comparison of TVPS time to the accuracy subtest scores revealed more significant group differences for time than accuracy scores (see Tables 1 and 2). The discriminant analysis revealed that time scores were more sensitive predictors of actual group membership than were accuracy scores (see Table 3). However, the results also indicated that time scores and accuracy scores measured (discriminated) different aspects of visual-perceptual group differences because both type of scores entered into the discriminant functions of those analyses which included both types of scores. Therefore, in the future clinical application of the TVPS the use of time scores as well as of accuracy scores should be considered.

Three of the time subtest scores entered the discriminant function (see Table 3), which indicated that these three time subtest scores measure nonoverlapping functions. This may be related to the ability of the TVPS time scores to measure both perceptual processing and attention. More specifically, significant differences in time scores can be assumed to reflect some aspect of processing visual-perceptual information, but the results did not indicate the exact nature of the deficit. The deficit may have been poor visual perception, but it is also possible that the deficit was related to attention deficit disorders and/or some other type of unidentified dysfunction which could have influenced processing time. Further research should include a factor analysis of TVPS time and accuracy subtest scores to clarify the component skills (factors) tested by the TVPS.

The discriminant analysis classification results also suggested a tendency for the performance between groups to overlap such that some of the better scores of learning-disabled subjects were as good as those of the normal subjects and a few of the normal subjects' scores were within the range of the learning-disabled group. This is not surprising because the learning-disabled subjects studied in this investigation did not represent a preselected homogeneous group of learning-disabled persons with identified visual-perceptual deficits; the subjects in the group with learning disabilities had average performances on the three spatial subtests and on the performance IQ of the WAIS-R. However, the results of the ANOVA, which revealed significant mean accuracy score differences between groups, and the results of the discriminant analyses, when considered together, appeared to suggest that many of the learning-disabled subjects, when compared with the normal control group, did demonstrate impaired visual-perceptual performance. These results confirmed studies that have found significantly lower visual-perceptual abilities in some, but not all, persons with learning disabilities (Gross & Rothenberg, 1979; Harris, 1982; Mattis et al., 1975; Rourke, 1978, 1982; Strang & Rourke, 1985). These findings also suggest that the TVPS is a more sensitive measure of impaired visual-perceptual performance than are WAIS-R scores; however, this conclusion should be considered with caution since WAIS-R scores for the normal group were not available to determine if the two groups were matched for IQ.

The result that the total TVPS accuracy score correlated with Block Design, but not with Object Assembly or Picture Completion, may suggest that the total TVPS accuracy score possesses a visuospatial organization component; Block Design has been demonstrated to possess the highest visuospatial organization component of all of the WAIS-R subtests (Lezak, 1983). Interestingly, the subjects with learning disabilities demonstrated average Block Design scores yet significantly lower mean total TVPS accuracy scores.

As hypothesized, the total TVPS accuracy score correlated with the performance IQ but not with the verbal IQ. However, this correlation may not be clinically meaningful because it explained less than 16% of the shared variance. Further, this relatively low correlation, while higher than the correlation with the verbal IQ, suggests that only a small component of the performance IQ is related to the nonmotor aspect of visual-perception measured by the TVPS.

Both groups took longer time on Visual Form Constancy and Visual Figure–Ground and shorter time on Visual Memory and Visual Sequential Memory. Longer time may have been required on the former two subtests because they measure more complex skills (both subtests include embedded and distractive features); shorter time may have been required on the latter two subtests because they involve only the recall of simple designs from immediate or short-term memory.

Concerns that the TVPS may be unreliable for older children (Busch-Rossnagel, 1985) or that there was a maturation effect in the older normative population of the TVPS (Gardner, 1982) were not supported by the results of this study. Virtually all the subjects successfully completed half of the items in each subtest, but a ceiling effect was only seen among the normal subjects on three of the seven subtests. Furthermore, none of the subjects obtained a perfect total TVPS accuracy score. Therefore, it might be appropriate to use an alternative short form for testing adult subjects that does not include the easiest items within...
each subtest. Such a revised version would have the advantage of being a shorter test while retaining all of the time and accuracy scores that were found to differ significantly between groups and/or contributed to the various discriminant functions. However, before a shortened version is used, an item analysis should be conducted to exclude redundant items.

The TVPS might be valid when applied to patients with more severe neurological dysfunction since it is sensitive enough to identify the subtle visual-perceptual differences between learning-disabled and normal young men. This assumption should be tested by assessing the performance of adult brain-damaged patients on the TVPS.

Conclusions

The TVPS appears to be a valid assessment of visual-perceptual deficits for young adult subjects and can be used for identifying visual-perceptual deficits in young adults with learning disabilities. The administration of the TVPS should incorporate the measuring of subtest time scores since the young adults with learning disabilities demonstrated significant differences in accuracy as well as time of visual-perceptual processing. The diagnostic validity of the TVPS for adult subjects has been confirmed by this study. Future studies of the TVPS should include factor analysis of subtest accuracy and time scores to better identify specific constructs measured by the TVPS. (b) use item analysis to eliminate redundant items prior to the development of a shorter version for use with adults, and (c) use the TVPS to assess the visual-perceptual performance of brain-damaged adults.

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