ARE WE LABELING OUR DEAF CHILDREN WITH THE USE OF INAPPROPRIATE TESTS OF INTELLIGENCE?

By

Vivienne Ratner,

and

Steven Schwager

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ABSTRACT

Performance scores on tests of intelligence for deaf children with visual perceptual learning disabilities can be misleading. On all performance subtests in currently used standardized intelligence tests, the tasks require considerable spatial and other visual perceptual skills. Visual perceptual learning disabilities are likely to reduce the child's scores on performance scales and <u>also</u> to contribute to poor academic achievement. There will then appear to be a very small discrepancy between the child's apparent potential and his/her academic performance. Therefore, the child's learning problems might erroneously be attributed to deafness alone, or worse, to mental retardation, resulting in inappropriate class placement or allocation of special services.

The need for dynamic stimuli, missing in currently used tests of visual perception, is detailed. The new Test of Visual Perceptual Abilities contains dynamic as well as static stimuli, and reveals several different visual perceptual deficits not considered previously. These deficits are confounding factors in the analysis of intelligence scores of deaf children, whose I.Q. scores are based entirely upon performance scales.

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Vivienne Ratner, Ph.D. and Steven J. Schwager, Ph.D.

Vivienne Ratner, Ph.D.
74 Lower Salem Road
South Salem, New York 10590

Steven J. Schwager, Ph.D.
Biometrics Unit
337 Warren Hall
Cornell University
Ithaca, New York 14853

Dr. Ratner has her doctorate in deafness and learning disabilities. She is a counselor in deafness rehabilitation and also a specialist in educational assessment. She is the author of the Test of Visual Perceptual Abilities (TVPA). She is the Director of the Education Center, College of New Rochelle, New York and is on the teaching faculty of the Graduate School, Department of Special Education.

Dr. Schwager is an Applied Theoretical Statistician. He is an Associate Professor of Biological Statistics in the Biometrics Unit at Cornell University. His Ph.D. is from the Statistics Department at Yale University.

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There has been increasing concern about appropriate servicing of hearing-impaired children with specific learning disabilities, particularly when every year more of these youngsters are being mainstreamed into the public school system. School psychologists with little previous exposure to deaf children are often responsible for testing them to determine the discrepancy between the child's level of intellectual functioning and academic achievement.

Intelligence classifications for hearing-impaired children are based entirely upon performance scales of intelligence tests, such as the Wechsler Intelligence Scale for Children, Revised (WISC-R) (Wechsler, 1974). Verbal scales are not appropriate for deaf children because of their severe language deficits. The objective of this article is to describe research by the authors which indicates specific circumstances in which it is inappropropriate to use performance scales of intelligence tests to determine class placement or discrepancy between intelligence and achievement.

A high incidence of visual perceptual learning disabilities has been identified by the authors among 700 deaf children. The designation of "deaf" is used for these subjects because their average unaided speech threshold level is 85 dB and higher in the better ear and their speech is unintelligible. Their main mode of communication is sign language or total communication.

Research has just been completed using two new tests designed specifically for hearing-impaired students, the Test of Visual Perceptual Abilities (TVPA) and the Test of Spatial Perception in Sign Language (TSPSL) (Ratner, 1988). The TVPA differs from existing tests of visual perception in that it uses dynamic as well as static stimuli. The TVPA and TSPSL identified a widespread primary handicapping condition entirely distinct from deafness, visual perceptual learning disabilities. This disorder seriously affects the young deaf child's ability to accurately perceive spatial relationships of static and dynamic objects, form and shape, directionality, line drawings, figure-ground relationships, body boundaries, and part/whole relationships. Even more devastating, the disorder affects the deaf child's ability to communicate and comprehend the communication of others. The results of the research revealed that 16% of the 700 deaf students, ages 8-18 years, had deficits in two or more subskills of visual perception.

The tasks on all of the performance subtests in currently used standardized tests of intelligence require considerable spatial and other visual perceptual skills. If a child has a visual perceptual deficit, this condition is likely to reduce his score on the performance portion of the I.Q. test, resulting in his being classified as having less than average intelligence. In addition, the disorder will contribute to poor academic performance (Ratner, 1988). There is likely to be a small discrepancy, if any, between the child's apparent level of intellectual functioning and academic achievement. Therefore, some of his learning problems might not be attributed to specific learning disabilities, but to deafness alone, or worse, to mental retardation. Inaccurate conclusions may be drawn from the tests, precluding appropriate professional services for each handicapping condition, and resulting in inappropriate class placement or labeling that can ultimately destroy the child.

Description of the Test Materials Used in the Research

The Test of Visual Perceptual Abilities (TVPA) was designed for hearing-impaired children to assist in the identification of specific perceptual/spatial learning disabilities. The TVPA contains dynamic as well as static stimuli, a component missing in currently used tests. The instrument separates visual perception into twelve separate subskills: Discrimination of Shape, Discrimination of Static Size, Spatial Relationships of Static Objects, Visual Closure, Visual Figure-Ground, Perception of Space Between Objects, Size Constancy, Perception of Changing Spatial Location of a Moving Object, Perception of Spatial Relationships of Moving Objects, Temporal-Spatial Integration, Perception of Body Boundaries, and Shape Constancy.

The Test of Spatial Perception in Sign Language (TSPSL) is not a test of sign vocabulary, but a measure to assess the deaf child's ability to discriminate a variety of visual perceptual/ spatial components of sign language.

The Need for Dynamic Stimuli

Many of the children with visual perceptual deficits revealed their difficulties when presented with the dynamic stimuli on the TVPA. They had passed the currently used tests of visual perception which present only static stimuli. Current neurological research indicates that the specific channels of the human cortex that process static three-dimensional drawings and simple line drawings are different from the channels that process stimuli moving in depth and in specific directions and orientations (Regan, Beverly, Cynader, 1979; Hubel & Wiesel, 1962; Hubel, Wiesel & Stryker, 1978; Livingston & Hubel, 1983).

Children who do poorly on the performance scales of the intelligence tests may not have been identified as having visual perceptual deficits because they passed visual perception tests that contained only static stimuli. They were shown drawings in test booklets or stimulus cards that laid flat on a horizontal desk or table. The drawings remained stationary, enabling the students to examine and re-examine the stimulus that neither moved across the visual field, offered even a momentary glimpse of its alternate side, nor changed dimensions. Either their compensatory strategies were adequate to perform satisfactorily, given enough time, or their problems involved the perception of the dynamic, rather than the static, visual world. Their basic concepts, however, were affected by their deficits.

Our ability to revisualize, manipulate objects in our mind's eye, plan ahead, and analyze possible positions and combinations depends crucially on accurate perceptions of shape, size, distance, length, width, orientation, accurate body image, direction of movement, speed of movement, time and space, etc. These are the components of images that contribute to clarity. Deficits in any of the above skills will affect the ability of a child to organize activities within the time limits of the Wechsler Intelligence Scale for Children, Revised (WISC-R) (Wechsler, 1974), Leiter International Performance Scale (Leiter, 1979), and Raven's Progressive Matrices (Raven, 1956). In addition, the research by the authors has revealed that a visual perceptual learning disability has an impact on the deaf child's ability to comprehend sign language. This particular problem will be discussed in relation to the deaf child's performance on tests of intelligence.

Language Deficits

The research by the authors revealed that when visual perceptual deficits interfered with any of the perceptual skills essential to sign language comprehension, the deaf child's language and concept development was affected. Semantics and syntax are literally built into the specific positions of the hands on or near the body, at different levels of the head and torso, and in the signing space in front of the body. The direction of their movements and the spatial relationships of their fingers determine what is said and even what is implied. The children who revealed visual perceptual deficits on the TVPA also revealed difficulties with communication and comprehension. When administering the WISC-R to a deaf child, the examiner cannot be certain that the deaf child with this deficit understands the directions for the performance tasks on the intelligence test.

In addition, hearing students are expected to understand the language the examiner is using, unless a child has recently come from a foreign country and speaks a foreign language. No professional who works with deaf children can expect all of them to understand to the same degree the concepts, the intent of the communication, or the signs conveying that intent. In a group of ten deaf children, there are ten levels of language ability. This ability is dependent upon the age at which deafness occurred, the degree of hearing loss, the hearing ability of the child's parents, the age at which hearing aids were prescribed, years in a signing environment, and myriad other socioeconomic and cultural factors.

If the deaf child indicates by puzzled expression, frustration, and other behaviors that he does not understand what he is expected to do, the test results cannot be considered a valid indicator of intelligence. The lack of understanding could be due to poor language development and poor communication ability, which in turn can be caused by the visual perceptual deficit of the deaf child. Analysis of the research data revealed the following: (1) There were significant associations between a student's visual perceptual abilities, measured by performance on the TVPA, and the school's assessment (by the School Psychologist, Classroom Teacher, and Speech Pathologist) of the student's ability to comprehend sign language (Table 1). (2) There were significant associations between a student's visual perceptual abilities and the ability to communicate either verbally or in sign (Table 2). (3) 45% of the deficits in comprehending spatial components of sign language were explained by a linear relationship with the deficits in subskills of visual perception (Table 3). (4) There was a pattern of highly significant positive correlation between performance on the dynamic subtests of the TVPA and the spatial subtests of the WISC-R (Picture Completion, Block Design, and Object Assembly) (Table 4). The correlation of the total TVPA score with each of the three spatial subtests of the WISC-R was greater than .3O, showing a statistically significant linear relationship; higher

TVPA scores tended to occur with higher WISC-R subtest scores (and vice versa). (5) There was a significant association between a student's visual perceptual abilities and assessed intelligence level based on I.Q. score (Table 5). These findings are discussed in more detail in the Statistical Analysis section.

Time Restraints of Intelligence Tests

The time restraints of intelligence tests can be a confounding factor when testing deaf children. This observation was confirmed by the research in which the perceptual tests were administered personally by the author. Time required for completion of several of the performance tasks on intelligence tests is incorporated into the scoring procedure when determining the intelligence quotient. When testing normally hearing children, time can indeed be an important factor. However, there are problems, unique with deaf children, that can skew the outcome and contribute to erroneous conclusions.

It can often be concluded that hearing children who take longer than their peers to complete a task on a test have problems performing that task, although there may be other reasons for such behavior. Such a conclusion is especially warranted when other indicators are noted, such as tension, lots of erasing, twisting of the body, and facial grimaces.

When deaf children take longer to complete a task, it is not necessarily due to deficits. Even their grimaces, body tension, erasing, and twisting of the body may be indicators of other problems. Deaf children, especially in the early grades, are rarely tested formally. They are not used to taking tests. They appear to be slow, but in many instances they are being unduly careful. Deaf children are also very easily distracted. If there is the slightest movement at the other end of the room or in the hallway, they turn to look for the cause. They cannot hear, so they must depend upon their vision to "check out" what is happening in their world. There is also a certain amount of power in the ability to stop listening by simply turning their eyes away, even closing them, or turning off their hearing aids. The examiner must be the focus of the child's attention. Once the attention is lost, it takes time to draw the deaf child back to the task at hand. Therefore, the lower scores with time restraints will not necessarily indicate the deaf individuals' intellectual ability, but might very well indicate distrust of their own abilities to perform a task and difficulty understanding what is expected.

Statistical Analysis

Statistical analysis used in this study were of three kinds. First, one-way analysis of variance (ANOVA) demonstrated a clear relationship between TVPA scores and three classification variables: sign language comprehension ability, communication skills, and assessed intelligence level (Tables 1, 2, and 5). Each of these can be treated as a category variable, dividing the students into several groups. For example, the assessed intelligence variable divides the students into five groups, ranging from Below Average (I.Q. 79 & Below) to Superior (I.Q. 120-129), shown in Table 5. For each of these three variables, the average TVPA scores differ significantly among its groups, with higher average scores generally being attained by groups rated as better on the grouping criterion.

The data show another interesting feature, unequal variances within the groups formed by each of these grouping variables. This is seen in Tables 1, 2, and 5, and confirmed by performing Bartlett's test of homogeneity of variances among groups (see Snedecor & Cochran, 1980, Sec. 13.10), in which the null hypothesis of equal variances is rejected. Smaller variances occur in the groups rated as better on the grouping criterion. This violates the standard ANOVA assumption of equal variances and can adversely affect the validity of ANOVAs performed by standard methods, so the Brown-Forsythe method was employed (Brown & Forsythe, 1974). This method provides a valid ANOVA in the presence of unequal variances within different groups.

The TVPA scores observed in the groups may be interpreted as follows. Lower-rated groups, such as the Below Average group on the assessed intelligence criterion (Table 5), have lower average scores and higher score variability (wider range of scores). Conversely, TVPA scores in the highest-rated groups, such as the Superior group on assessed intelligence (Table 5), are uniformly very high, since such groups have very high average scores and low within-group variation in TVPA score. In other words, students assessed by their schools as being Superior have uniformly high TVPA scores; consequently, any student having a very high actual I.Q. but also a visual perceptual deficit is very <u>un</u>likely to be assessed as being in the Superior group, even though this student belongs in this group. Thus, students assessed as being in a lower-rated group may well be in this group (rather than a higher one) precisely <u>because</u> of a visual perceptual deficit <u>rather than</u> a low I.Q. This dramatizes the need for the TVPA by demonstrating empirically that a student with a high I.Q. and a visual perceptual deficit is likely to be misjudged and classified as having a lower I.Q., unless the TVPA is used to help in classifying the student.

The second statistical technique used was correlation analysis. This established a consistent pattern of positive association between the TVPA subtest and total scores of students and their spatial subtest scores on the WISC-R (see Table 4). Although consistent, these correlations are weak. All of the correlations between TVPA scores and WISC-R subtest scores lie between .1 and .4. The correlation between the TVPA total score and each of the WISC-R subtest scores is about .3; the square of the correlation, about .1 or 10%, is the fraction of the student-to-student variation in TVPA total score explained by any of the WISC-R subtest scores, or vice versa. Thus, the information contained in TVPA scores differs substantially from that in the WISC-R spatial subtest scores.

The third statistical technique used was multiple regression, which determined what fraction of the overall variability in students' TSPSL scores could be explained by their TVPA subtest scores. The higher this fraction is, the more predictable the TSPSL score is from a student's TVPA subtest scores. The multiple regression analysis used the TSPSL score as the dependent variable and the TVPA subtest scores as predictors. The resulting squared multiple correlation coefficient was .45; thus 45% of the total variability in TSPSL scores was attributable to their linear relationship with the TVPA subtest scores. For a detailed treatment of multiple regression, see Draper & Smith (1981).

Table 1

One-Way Analysis of Variance:
TVPA Subtest Scores by
School's Assessment of Student's Sign Language
Comprehension Ability

	TVPA 7	TVPA 8-9	TRPA 10	TVPA 11	TVPA DTOT[1]
VERY POOR	(17)	(16)	(16)	(16)	(16)
MEAN	7.76	15.69	8.19	8.56	45.13
S.D.	2.91	5.57	2.07	2.12	12.10
POOR	(337)	(337)	(336)	(337)	(335)
MEAN	8.77	17.91	8.27	9.45	49.32
S.D.	2.13	3.63	2.26	1.34	7.57
GOOD	(249)	(249)	(221)	(248)	(220)
MEAN	9.45	18.92	8.75	9.80	51.71
S.D.	1.36	2.41	1.83	.68	5.07
EXCELLENT	(19)	(19)	(19)	(19)	(19)
MEAN	9.68	19.58	9.58	9.95	53.79
S.D.	.58	.77	1.61	.23	2.59
D.F.[2]	3;32	3;26	3;78	3;23	3;26
F RATIO[2]	8.69	7.12	5.03	6.68	7.46
F SIGNIF.[2]	.000	.001	.004	.003	.001

[1]Total dynamic stimuli score TVPA DTOT includes Subtests 7-12.

[2]F degrees of freedom, ratio, and corresponding significance level are calculated by the Brown-Forsythe analysis of variance method, which is used because of unequal group variances (see text).

Table 2

One-Way Analysis of Variance:
TVPA Subtest Scores by School's Assessment
of Student's Communication Skills

	TVPA 7	TVPA 8-9	TRPA 10	TVPA 11	TVPA DTOT[1]
COMMUN. BY MIME & GESTURE	(30)	(30)	(30)	(30)	(30)
MEAN	7.13	15.33	7.67	8.30	43.27
S.D.	2.93	5.71	2.14	2.37	11.20
COMMUN.BY SIGN LANGUAGE	(532)	(531)	(502)	(530)	(500)
MEAN	9.11	18.30	8.51	9.63	50.34
S.D.	1.83	3.20	2.14	1.09	6.87
COMMUN. ORALLY	(3)	(3)	(3)	(3)	(3)
MEAN	10.00	19.33	10.00	9.67	54.00
S.D.	.00	.58	.00	.58	.00
COMMUN. BY TOTAL COMMUNICATION	(113)	(113)	(113)	(113)	(113)
MEAN	9.26	18.53	8.67	9.62	51.02
S.D.	1.55	3.28	1.85	.99	6.23
D.F.[2]	3;50	3;53	3;92	3;43	3;52
F RATIO[2]	11.00	6.29	3.73	7.47	9.66
F SIGNIF.[2]	.000	.001	.015	.000	.000

[1]Total dynamic stimuli score TVPA DTOT includes Subtests 7-12.

[2]F degrees of freedom, ratio, and corresponding significance level are calculated by the Brown-Forsythe analysis of variance method, which is used because of unequal group variances (see text).

Table 3

Multiple Regression Analysis of TSPSL Subtest and Total Scores on the TVPA Dynamic Subtest Scores

	TVPA 7	TVPA 8-9	TVPA 10	TVPA 11
TSPSL 18	(N=503)			
Beta	.0861	.2383	.0549	.1121
T	1.741	4.319	1.146	2.231
Signif T	.0822	.0000	.2523	.0262
Multiple R = .394				
R squared = .155				
D.F. = 4;498				
F Ratio = 22.84				
Signif F < .0001				
TSPSL 29 (N=503)				
Beta	.1805	.3989	.1881	.1316
T	4.681	9.058	5.037	3.357
Signif T	.0000	.0000	.0000	.0008
Multiple R = .697				
R squared = .486				
D.F. = 4;498				
F Ratio = 117.65				
Signif F < .0001				
TSPSL Total (N=503)				
Beta	.1668	.3872	.1558	.1471
T	4.198	8.734	4.049	3.642
Signif T	.0000	.0000	.0001	.0003
Multiple R = .67				
R squared = .45				
D.F. = 4;498				
F Ratio = 103.67				
Signif F < .0001				

Table 4

Pearson Correlations Between TVPA Subtests and WISC-R Subtests: Picture Completion, Block Design, and Object Assembly

	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY
TVPA 7	(272) .1726 P = .004	(273) .1799 P = .003	(270) .1972 P = .001
TVPA 8-9	(271) .3927 P = .000	(272) .3171 P = .000	(269) .3239 P = .000
TVPA 10	(271) .1017 P = .095	(272) .1713 P = .005	(269) .2240 P = .000
TVPA 11	(271) .2686 P = .000	(272) .2253 P = .000	(269) .2268 P = .000
TVPA DTOT*	(271) .3196 P = .000	(272) .3031 P = .000	(269) .3326 P = .000

*Total dynamic stimuli score TVPA DTOT includes Subtests 7-12.

Number of cases for which both variables are present is shown in parentheses, followed by correlation and p-value.

Table 5

One-Way Analysis of Variance:
TVPA Subtest Scores by Assessed Intelligence Level[1]

	TVPA 7	TVPA 8-9	TVPA 10	TVPA 11	TVPA DTOT[2]
BELOW AVERAGE (79 & Below)	(29)	(29)	(29)	(29)	(29)
MEAN	7.72	14.93	7.75	8.58	43.86
S.D.	2.90	4.22	1.90	2.28	8.40
LOW AVERAGE (80-89)	(115)	(115)	(112)	(114)	(111)
MEAN	8.70	17.71	8.21	9.60	49.16
S.D.	1.95	3.59	2.30	.94	7.18
AVERAGE (90-109)	(330)	(329)	(319)	(329)	(318)
MEAN	9.20	18.60	8.56	9.61	50.87
S.D.	1.72	2.92	2.04	1.06	6.20
HIGH AVERAGE (110-119)	(73)	(73)	(65)	(73)	(65)
MEAN	9.70	19.49	9.20	9.95	53.23
S.D.	.81	1.08	1.49	.28	2.38
SUPERIOR (120-129)	(34)	(34)	(26)	(34)	(26)
MEAN	9.88	19.85	9.54	9.97	54.12
S.D.	.33	.44	.76	.17	1.11
D.F.[3]	4;71	4;92	4;214	4;44	4;96
F RATIO[3]	9.49	17.89	7.09	6.99	17.98
F SIGNIF[3]	.000	.000	.000	.000	.000

[1]Assessed intelligence level grouping (Below Average to Superior) is based on student's I.Q. score.

[2]Total dynamic stimuli score TVPA DTOT includes Subtests 7-12.

[3]F degrees of freedom, ratio, and corresponding significance level are calculated by the Brown-Forsythe analysis of variance method, which is used because of unequal group variances (see text).

Conclusion

A classification and label of intelligence level for the deaf child whose sole I.Q. assessment is based upon nonverbal, spatial tasks should be viewed with healthy skepticism under the best of circumstances. The spatial subtests of the WISC-R and other intelligence tests are not accurate estimates of intellectual function for learning-disabled children with diagnosed visual perceptual problems (Kaufman, 1979, p. 153). Unfortunately, we do not have appropriate intelligence tests at the present time for deaf children with visual perceptual learning disabilities.

The authors recommend that if a deaf child does poorly on the spatial subtests of the WISC-R or other performance scales, a test of visual perceptual abilities should be administered. The results of their research also demonstrate the need to diagnose visual perceptual problems with an instrument that includes dynamic as well as static stimuli. If the child's performance indicates that he/she has a visual perceptual learning disability, then the scores on the intelligence tests should not be used for intellectual labeling or for purposes of determining class placement.

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