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Abstract

This study was conducted to determine if certain types of neurological screening techniques demonstrate more sensitivity to the neurological differences existent among groups of deaf individuals with differing etiologies of hearing loss. The subjects consisted of 40 deaf volunteers, ranging in age from 16 to 20 years, selected on the basis of their etiology of deafness. The assignment of subjects yielded three *in situ* conditions: rubella, meningitis, and genetic. Subjects were administered the Bender Gestalt Test and the Trail Making Test to determine if significant differences exist among these groups in their performance on these neurological screening techniques. Results indicate that a significant difference exists between etiological conditions based on Part A of the Trail Making Test. A significant difference was found between the meningitis and genetic groups; however, there was no significant difference between the rubella and meningitis groups, or the rubella and genetic groups. There exist no significant differences among etiological conditions on Part B of the Trail Making Test or the Bender Gestalt Test. There was no significant relationship between degree of hearing loss and performance on both Parts A and B of the Trail Making Test or the Bender Gestalt Test. A discussion of results and implications with respect to rehabilitation is included.

Brain damage in deafened individuals is significantly related to both education and to vocational rehabilitation. Brain damage may manifest its presence in the form of learning disabilities, behavioral disorders and many other serious problems. Thus, the fact that the leading causes of brain damage are also major etiologies of deafness has implications of major significance (Vernon, Griffin, & Yoken, 1981).

Brain damage is known to be more prevalent among the deaf population than the general population (Getz & Vernon, 1986; Shaver & Vernon, 1978; Vernon, Griffin, & Yoken, 1981; Vernon & Hess, 1983; Vernon & Hicks, 1980). Therefore, if one could determine certain aspects of deafness (e.g., etiology), which correlate with specific types of brain damage, it would be possible to more accurately predict the relative success or failure of a deafened individual in certain structured school and rehabilitation programs and/or prescribe procedures to improve success rates. For example, if one could predict from etiology to perceptual motor performance, special rehabilitation programs could be developed to improve this aspect of functioning. It has been demonstrated, for example, that academic success is more likely in genetically deafened individuals because they have been shown to have higher I.Q.'s than deaf individuals with exogenous causes (Kusche, Greenberg, & Garfield, 1983). Yet, studies to date have not demonstrated significantly more brain damage in exogenously deafened groups than in the genetically deafened group (Getz & Vernon, 1986; Keogh, Vernon, & Smith, 1970).

There is one main consideration when assessing the intelligence of deafened individuals. A measure of intelligence, to be valid for prelingually deafened individuals, must be a non-verbal performance instrument (Vernon & Andrews, 1990). When assessing the magnitude of brain injury in deaf individuals, the Bender Gestalt Test (BGT) is probably the most widely used screening instrument even though scoring norms are somewhat inadequate and interpretations quite subjective (Lacks, 1979; Vernon, 1961). Over the last two decades, more reliable and valid assessment techniques, such as the Halstead-Reitan Neuropsychological Test Battery, have been developed (Jarvis & Barth, 1984). We hypothesized that Part A and Part B of the Trail Making Test (TMT) of the Halstead-Reitan Neuropsychological Battery, which assesses motor performance as an index of brian functioning, could be a useful technique when assessing certain forms of brian injury in deafened individuals (Reitan, 1958).

There have been two studies which attempted to determine the relationship between etiology of deafness and brain functioning. Keogh, et al. (1970) attempted to demonstrate a relationship among etiological groups and BGT performance. Since deaf subjects with brain damaging pathologies have been shown to have a higher incidence of cognitive dysfunction, they hypothesized that genetically deafened persons would perform better on the BGT than the those with exogenous etiologies. However, Keogh et al. (1970) found no significant differences among etiological groups.

In another effort to analyze the relationship between etiology of deafness and brain dysfunction, Getz and Vernon (1986) tested for differences among etiological groups by using an alternative BGT scoring system for analyzing BGT protocols. Although a significant difference among I.Q. groups was demonstrated based on BGT performance, there were no significant differences among etiological groups. However, the BGT lacks sensitivity with respect to certain major forms of neurological impairment; noteably, it does not depict a complete analysis of the brain impairment (Bigler & Ehrforth, 1980).

In an effort to gain a clearer understanding, the present research controlled for decibel loss, which had not been controlled in earlier research, and employed not only the BGT, but also the TMT (Reitan & Wolfson, 1985). Nadler and Ryan (1984) utilized these two instruments and reported that the TMT proved more helpful in differentiating organic from nonorganic schizophrenics than the BGT. Our survey of the literature revealed no published research on the TMT as a diagnostic technique for assessing the deaf population.

It was hypothesized that by making the above described methodological changes, significant differences among the exogenously deafened groups and the genetically deafened group might be detected. If so, these findings would suggest that deafness, per se, does not produce perceptual motor dysfunction, but that the brain damage resulting from conditions such as rubella and meningitis may be the primary cause of perceptual motor dysfunction that may be present.

Sample and Methods

The subjects were drawn from deaf students attending the Maryland School for the Deaf and the

Model Secondary School for the Deaf. The groups under investigation consisted of 40 deaf volunteers, between the ages of 16 and 20 years, selected on the basis of their etiology of deafness. The assignment of subjects yielded three *in site* conditions: rubella, meningitis, and genetic. The respective number of subjects in each condition were 15, 10, and 15. Each subject was administered the BGT (Bender, 1938) and the TMT (Reitain, 1958). Each BGT protocol was scored using the instructions put forth by Pascal and Suttell (1951). Background information including age, gender, etiology, and decibel loss in the better ear was obtained from the subjects' school records.

Sequence of test presentation was rotated after each subject was tested to control for possible order of testing presentation effects.

Results

The hypothesis that there would be a significant difference among the etiological groups was supported for Part A of the TMT (Table 1). To determine exactly where the difference among the groups was located further analysis was completed (Table 2). It demonstrated the significant difference to be between the meningitis and genetic groups only.

TABLE 1

SUMMARY OF THE KRUSKAL-WALLIS ONE WAY ANOVA FOR DIFFERENTIAL EFFECTS DEMONSTRATED BY ETIOLOGICAL CONDITION ON PERFORMANCE OF THE BENDER GESTALT TEST AND TRAIL MAKING TEST

Test	Condition	n	M	SD	Mean Rank	H	p
Part A							
	Rubella	15	44.03	31.22	21.97	6.75	.0342
	Meningitis	10	43.47	11.20	26.85		
	Genetic	15	30.33	13.77	14.80		
Part B							
	Rubella	15	98.74	78.47	22.07	4.04	.1327
	Meningitis	10	87.89	31.85	25.00		
	Genetic	15	65.39	37.95	15.93		
Bender							
	Rubella	15	94.67	35.19	22.63	1.07	.5867
	Meningitis	10	80.00	13.39	20.70		
	Genetic	15	81.93	28.63	18.23		

It was further hypothesized that there would be significant differences among the etiological groups demonstrated by the TMT, Part B. This hypothesis was not supported (Table 1).

In order to compare present results with those of prior research, tests of significance of difference were used to determine if the etiological groups were different in terms of mean scores obtained on the BGT. The results yielded no significant differences (Table 1), a finding which was consistent with the prior research (Getz & Vernon, 1986; Keogh et al., 1970).

Further analysis revealed no significant relationship between hearing loss and performance on the TMT Parts A and B or the BGT (Table 3).

Order of testing presentation significantly altered the time needed to complete both Parts A and B of the TMT, but it did not significantly effect scores obtained on the BGT (Table 4).

Discussion and Conclusions

This investigation indicates that there exists a significant difference between etiological groups of deaf subjects based on performance on Part A of the TMT. This finding is important from both a diagnostic and rehabilitative perspective. Diagnostically, it indicates that Part A of the TMT is more sensitive than both Part B of the TMT and the BGT in discriminating brain damage among those individuals with exogenous causes of hearing loss and individuals with genetic deafness. Both exogenous etiological groups had higher (more pathological) mean scores on this visual motor test than the genetic group even though only one comparison proved significantly different.

The fact that a significant difference was demonstrated with Part A of the TMT while degree of hearing loss was held constant indicates that

TABLE 2

SUMMARY OF THE MULTIPLE COMPARISONS BETWEEN ETIOLOGY GROUPS FOR TRAIL MAKING TEST, PART A [a]

Comparison	$\lvert R_u - R_v \rvert$	$\underline{z}$
Rubella - Meningitis	4.88	11.42
Rubella - Genetic	7.17	10.22
Genetic - Meningitis	12.05	11.42*

Note: *Mean Ranks differed significantly at $\underline{p} < .05$, two-tailed.

[a]Multiple Comparisons Between Treatments Procedure described by Siegel and Castellan, Jr. (1988).

auditory deprivation, per se, does not result in brain damage or altered brain function. It would appear that the sequelae meningitis not only cause deafness but also cause brain injury in a significant number of cases. From a rehabilitation perspective, one could more accurately predict success or failure of deafened individuals in structured rehabilitation programs and/or better prescribe corrective techniques with the use of this etiological data.

This research indicates that the TMT Part A is the choice instrument for the quick detection of brain damage due to the respective etiologies of rubella and meningitis in deaf students.

TABLE 3

SUMMARY OF SPEARMAN COEFFICIENT CORRELATIONS FOR HEARING LOSS IN BETTER EAR AS RELATED TO PERCEPTUAL MOTOR TEST

Test	r_s	p
Trail Making Test Part A	-.1973	.111
Trail Making Test Part B	-.0245	.440
Bender Gestalt Test	.1127	.244

Note: p = one-tailed probability.

TABLE 4

SUMMARY OF MANN-WHITNEY U RESULTS FOR PRESENTATION EFFECT MAKING TEST

Test	Presentation[a]	Mean Rank	z	p
Part A				
	Bender First	24.25	-2.49	.0129
	Trail Making Test First	14.88		
Part B				
	Bender First	24.77	-2.83	.0047
	Trail Making Test First	14.09		
Bender				
	Bender First	20.15	-.2349	.8143
	Trail Making Test First	21.03		

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