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ABSTRACT

The Snijders-Oomen Nonverbal Intelligence Test (SON) was administered to 251 deaf children (6-15 years old) and 101 hearing children (10-12 years old) in Israel. The SON was judged appropriate for measuring cognitive functioning in the deaf because it requires no verbal instructions or responses and includes a measure of abstract thinking ability. Factor analysis for older and younger Ss revealed four main findings: (1) the factor structure for the total deaf group differed from the hearing group; (2) differences in cognitive structure was evident by age level for the deaf; (3) differences existed between cognitive structures of hearing and deaf Ss of the same age; and (4) a similar abstract thinking component existed for hearing and older deaf Ss. Data supported the view that deaf individuals use different coping mechanisms to perform cognitive tasks and that the abstract thinking component of their intellectual structure appears later than that of their hearing peers. (CL)

A FACTOR ANALYSIS STUDY OF INTELLECTUAL DEVELOPMENT IN DEAF AND HEARING CHILDREN

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ABSTRACT

Explanations of cognitive functioning in the deaf have been marred by the use of inappropriate measurement instruments, comparisons based on the average performance of deaf and hearing subjects, and failure to consider developmental changes across age levels. In the present study the Snijders-Oomen Nonverbal Intelligence Test (SON) was administered to 251 deaf children and 101 hearing children in Israel. The SON is appropriate for measuring cognitive functioning in the deaf because it requires no verbal instructions or responses by the subject and it includes a measure of abstract thinking ability. Factor analysis was done separately for older and younger subjects to determine the developmental nature of the underlying structure of intelligence in the deaf and hearing. The four main findings were: (1) the factor structure for the total deaf group differs from the hearing group, (2) differences in cognitive structure are evident by age level for the deaf, (3) differences exist between the cognitive structures of hearing and deaf subjects of the same age, and (4) a similar abstract thinking component is found for hearing and older deaf subjects. Thus, empirical support was provided for a shift from previous theories that the deaf are limited to concrete thinking to a position that the deaf use different coping mechanisms in performing cognitive tasks and that the abstract thinking component of their intellectual structure appears later than that of their hearing peers. The findings of this study are discussed in terms of both their theoretical and methodological implications for reaching a better understanding of the cognitive development of deaf children.

A Comparison of Intellectual Structure in Deaf and Hearing Children

Cognitive functioning in the deaf has been explained from numerous perspectives, two of which are Myklebust's (1964) organismic shift hypothesis and Furth's (1971) view that no difference exists between deaf and hearing subjects in conceptual performance, at least up to the level of concrete operative thinking. Myklebust hypothesized that the deaf are quantitatively equal to the hearing, but qualitatively inferior, in that the deaf develop a more "concrete," and therefore, less abstract intelligence. Myklebust and Brutton (1953) stated that deafness "restricts the child functionally to a world of concrete objects and things" (p. 93).

Furth (1971) concluded that the thinking processes of deaf children are similar to those of hearing children, at least through the stage of concrete operations. In addition, Furth (1964) labeled the deaf "linguistically deficient" because they do not use "the living language as heard and spoken in our society" (p. 47). This "linguistic deficiency" restricts the cognitive development of deaf individuals to concrete operational thinking. Furth emphasized that the use of verbal tests to assess deaf children's intelligence was not fair.

More recently, Moores (1982) concluded that deaf and hearing children are similar across a wide range of areas traditionally related to the study of cognitive and intellectual abilities. Findings of a "plateau" in the development of deaf intelligence seem to have been the result of using tests and instructions that were inappropriate for the deaf population.

Previous explanations of the differences in intellectual abilities have been based largely on the comparison of the average performance of deaf and hearing subjects. In order to better understand the similarities and differences in their cognitive structure, it is necessary to use a technique such as factor analysis that finds the significant dimensions among a number of variables (Cattell, 1978). Factor analysis is a method for determining the number and nature of the underlying variables among larger numbers of measures. Thus, using the factor analytic technique permits comparison of the underlying cognitive structures for the deaf and hearing.

Bolton (1978) compared the factor structures for deaf and hearing children, aged 3 to 10, based on the HisKey-Nebraska Test of Learning Ability (H-NTLA). He concluded that the results of his work, and other factor analytic studies (Farrant, 1964; Holmberg, 1966; Juurmaa, 1963), generally agreed with Myklebust's (1964) organismic shift hypothesis and did not support Furth's (1971) position. He interpreted the difference in the organization of subtest abilities for deaf and hearing children as an indication that sensory deprivation alters the equilibrium and integration of perceptual and conceptual abilities.

The major problem with the previous factor analytic work is that it has aggregated data across age groups and thus obscured differences in developmental progression. Many studies report that deaf children lag behind hearing children at early ages, but that the lags are often not observed in older children (Canabal, 1970; Hoemann & Briga, 1980).

The present research used factor analytic techniques to examine the nature of cognitive development in deaf children. The factor analyses were done separately for younger and older groups in order to determine developmental differences. The Snijders-Oomen Nonverbal Intelligence Test (SON) was used as the measure of intelligence. This test is appropriate for assessing the intelligence of deaf children because (1) the ability of the experimenter to communicate the instructions will not impede the child's performance, (2) heavily verbal tasks common to many intelligence tests are avoided, and (3) the test covers the whole intellectual span including the assessment of abstract thinking (Harris, 1982; Kearney, 1969; Kyle, 1980). The SON's test items are restricted to the type that can be visually demonstrated and imitated, thus no verbal instructions are given and no verbal responses are required.

METHODOLOGY

Subjects. The subjects included 251 deaf children ages 6 to 15 (approximately 25 children from each age level) who were randomly selected (stratified by age and sex) from the population of all Israeli deaf children in special education settings in 1975 and 1976. The deaf children were divided evenly by sex, 125 boys and 126 girls, with the same proportion (50%) at each age level. This sample represents 62% of the known population. Twelve percent of the sample were deaf children of deaf parents, most of whom also have deaf siblings. Thirty percent of the deaf children of hearing parents also had at least one deaf sibling. The demographic data indicate a slightly greater representation of the lower socioeconomic level as compared to the overall Israeli population. Most of the children (more than 85%) were profoundly deaf from birth. All the children attended oral-oriented educational settings (the only system in Israel). Sixty percent of the deaf subjects were in segregated schools and 40% were in mainstreamed settings. Most of them wore hearing aids and had a moderate level of oral communication which enabled them to communicate with their parents and others. Manual communication was reported only among deaf children with deaf parents.

The hearing sample consisted of 101 'ildren, aged 10 to 12, who were chosen from three schools representing r. : ioeconomic levels. They were matched to the deaf group on all of the demographic variables.

Procedure. The SON was administered individually to all the children by a trained psychologist following the test manual directions (Snijders & Oomen, 1953) using pantomime and general clues. The administration was the same for both deaf and hearing subjects.

Instrumentation. Israeli norms were created for the SON (Zwiebel & Rand, 1975), and reliabilities were found to range from .76 on the memory subscales to .88 on the arrangement subscale with an overall Kronbach α of .84. The SON was found to correlate .61 with the Draw-a-Person Test and .55 with the teacher's rating of intelligence.

The SON includes four subtests and 11 subscales. Because four of the subscales are designed only for small children, no variance was associated with them in the present sample. Consequently, these four subscales were eliminated from the data analysis. The following subscales were used:

(1) Mosaic B - The child uses flat squares to build a pattern shown on a card (Motor-perceptual skills).

(2) Block Design - The child constructs a pattern with cubes (Motor-Perceptual-thinking skills).

(3) Picture Memory - A small card with one or more pictures is shown for a few seconds, after which the subject must pick them out on a large card (Memory skill).

(4 & 5) Picture-Series - There are two picture series subscales that are based on difficulty level. The child has to arrange pictures in a logical order which will make a story (Information and general comprehension).

(6) Picture Analogies - The child is shown an example of an analogy in a concrete pictorial relation (e.g., broken-unbroken; empty-full). The child then has to apply the abstract principle to other materials (Concrete thinking).

(7) Figure Analogies - This is the same test as the picture analogies except that abstract figures are used instead of concrete pictures (Abstract thinking).

Data Analysis. The factor analytic procedures were as follows: Principal factoring with iteration was used to determine a solution with communalities in the diagonals of the correlation matrix (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1970). VARIMAX rotation was then used to maximize the squared loadings in each column.

RESULTS

The factor analysis for the total group of deaf subjects revealed a single factor structure that has fairly uniform weights on each subscale (Table 1). This seems to reflect an overall factor of general intelligence that is heavily perception-oriented. When the data for the total group of deaf subjects were analyzed by mode of communication used in the home, the single factor structure was again found. However, when the data for the deaf subjects were analyzed by age level, different factor structures emerged.

For the youngest group of deaf subjects (age 6 to 9), three factors were identified. The Block Design and Picture Series B subscales loaded heavily on the first factor, thus suggesting that this factor is measuring general comprehension and perceptual thinking. It is not simply a perceptual skill because of the low loading on the Mosaic subtest. The Mosaic and Picture Analogy subtests loaded heavily on the second factor, thus this is more a measure of perceptual and concrete thinking. The third factor is characterized by a heavy loading only on the Picture Memory subscale.

Analysis of the data for the middle age group of deaf children (age 10 to 12) revealed two factors: (1) general intelligence, and (2) perceptual skills. The Figure Analogy subscale does not load heavily on either factor for this group, thus suggesting a weak or absent abstract thinking component. However, for the hearing group of the same age, the heavy loading of the figure analogy test does indicate an abstract thinking component.

For deaf subjects who are older (age 13 to 15), the abstract thinking component is found for the second factor. The major differences between the hearing group and the oldest deaf group appear to be on the Mosaic and Block Design for the first factor and the Picture Memory for the second factor. Thus, a comparison of the oldest deaf group and the hearing group reveals: (1) a greater emphasis on perception in the general intelligence factor for the deaf group, and (2) the emergence of an abstract thinking component that is similar for the two groups, except that the deaf group tends to rely more heavily on memory skills.

DISCUSSION

The results indicate that a factor analytic approach using the SON and disaggregating that data by age group provides a more accurate picture of the cognitive structure in the deaf than was evidenced by previous research. While simple comparison of the average intelligence score on matched groups of hearing and deaf children can provide information on differences in task performance, it cannot adequately depict the intellectual structure of either group.

Four main points emerge from the results of the data analysis: (1) the factor structure for the total deaf group differs from the hearing group, (2) differences in cognitive structure are evident by age level for the deaf, (3) differences exist in the cognitive structure between hearing and deaf subjects of the same age, and (4) a similar abstract thinking component is found for hearing and older deaf subjects.

For the total deaf group, only one factor emerged, while two factors emerged for the hearing group. The deaf group's single factor reflects general intelligence. The hearing group's first factor reflects general intelligence; its second, abstract thinking. These results support the need to analyze the data for the deaf group by age level.

The trend in the development of cognitive structure for the deaf subjects appears to be from a less organized to a more organized state of general intelligence and from a perceptual and visual orientation to a perceptual and abstract thinking orientation. As the deaf children get older, the perceptual component seems to merge into the factor of general intelligence as the abstract thinking factor emerges. Memory is a consistently important component in the manifestation of intellectual structure in the deaf. When coping with the abstract thinking problems of the nonverbal SON test, older deaf children seem to use abstract thinking skills rather than rely solely on perceptual skills.

The most important difference between the deaf and hearing subjects of the same age is the weak presence of an abstract thinking component in the deaf group accompanied by a strong perceptual factor. The deaf subjects appear to rely on visual, perceptual skills, while their hearing peers rely on abstract thinking skills.

However, when hearing subjects are compared to a group of older deaf subjects, similar structures emerged with a general intelligence factor and an abstract thinking factor. Nevertheless, the general intelligence factor for the deaf contains a heavier loading on the perceptual component and their abstract thinking factor contains a heavier loading on the memory component.

One interpretation of the results is that the SON's visual stimuli may be processed more "verbally" by the hearing and more "visually" by the deaf. So, coping with such visual stimuli, the deaf tend to use a more "visual" thinking technique (as is seen in the single factor in the deaf population as a whole). Overall, the hearing subjects tend to use a "verbal" technique in coping with the same stimuli. The older deaf children, ages 13 to 15, appear to adopt a technique similar to that of the hearing. Further research is necessary in order to determine whether the oral training experiences of the older deaf students contributes to their adoption of the verbal style of processing the information, and to their demonstration of abstract thinking a fe years later than their hearing peers.

Another interpretation of the results is that deaf children manifest a lag in their intellectual development that results from experiential deficits. This lag could be caused by parents of deaf children restricting the child's social and physical experiences. If so, this lag could not be attributed to deafness itself, but to inappropriate responses to deafness (Moores, 1982). Further research is necessary to determine the effects of enriched environmental experiences on intellectual development for deaf children.

The theoretical implications of the results suggest that neither Myklebust's nor Furth's positions accurately explain the intellectual development of the deaf. The present study supports previous findings that no difference exists in the pattern of cognitive development in deaf and hearing children (Moores, 1982). However, differences do seem to exist in the rate of development and in the intellectual processes of the two groups. It is possible that these differences are influenced by environmental conditions such as communication mode.

The use of the factor analytic approach and the SON allowed additional insights into the cognitive structure of deaf and hearing children. The method of analysis used in the present study provides the beginning of an explanation of the development of cognitive structure that was not evident in previous factor analytic work. For example, Bolton (1978) only presented the results of his factor analysis and did not attempt to explain the underlying structures. Furthermore, based on Bolton's use of the Hiskey-Nebraska Test of Learning Ability, an abstract thinking factor was not identified. When the more appropriate SON is used, an abstract thinking factor did emerge. Thus, greater insight has been gained into the cognitive structure of deaf and hearing children than was previously possible.

Due to the heuristic nature of the present investigation, certain limitations must be recognized. The design of this study inherently limits the kinds of conclusions that can be drawn. With factor analytic techniques, no cause and effect relationships can be assumed. However, the results do reveal interesting patterns of relationships and suggest hypotheses for future explorations of the development of intelligence in the deaf.

Continued research is necessary that uses appropriate measurement techniques and that analyzes the data in such a way that developmental progression can be determined. In addition, a deaf group that uses manual communication may contribute to the explanation of this research problem. Perhaps these results pave the way for a better understanding of the cognitive development of deaf children and the techniques these children use to process information.

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Table 1

Factor Analytic Results of the SON for Deaf and Hearing Children by Age Level

Subscales	All Deaf Factor	Deaf (Age 6-9) Factor			Deaf (Age 10-12) Factor		Deaf (Age 13-15) Factor		Hearing (Age 10-12) Factor	
	1	1	2	3	1	2	1	2	1	2
Mosaic B	.56	.03	.90	.02	.04	.82	.65	.22	-.18	-.13
Block Design	.61	.56	.29	.05	.35	.40	.15	.66	.64	.40
Picture Memory	.57	.20	.06	.71	.61	.17	.39	.40	.69	-.09
Picture Series A	.58	.33	.38	.05	.57	.17	.57	.12	.04	.13
Picture Series B	.73	.95	.03	.06	.51	.32	.53	.56	.60	.27
Picture Analogy	.62	.33	.47	-.28	.56	.25	.67	.35	.00	.17
Figure Analogy	.44	.18	.08	-.21	.33	-.13	.25	.68	.37	.80