10 The hearing-impaired child: intellectual and educational development

Introduction and aim

The aim of this part of the research was to study the intellectual, language and educational development of those hearing-impaired children who were not suffering from severe multiple handicaps. Of the 59 subjects who were identified as hearing-impaired, five had severe multiple handicaps and were accordingly excluded from psychological assessment. The mean age of the hearing-impaired group was eight years four months at first assessment and nine years four months at the second assessment. We compared this group with a normal control group of 101 children, whose salient characteristics have already been described. In addition, in certain analyses we have included a comparison group of 84 speech retarded children who had had no serious organic problems or intellectual handicap and who were of the same age as the control group. As the psychological literature is so central to an understanding of our findings we have reviewed it more comprehensively than is usual in the previous chapter.

Method

Selection of cases

Our initial intention was to match the hearing-impaired with the speech retarded and the normal controls with regard to the variables of sex, age and, broadly, social class. This proved to be impossible as the prevalence of clinical deafness is under two per 1000 (Reed, 1970). We therefore sought a statistically viable sample by accepting for inclusion all available known hearing-impaired children from a slightly wider age range and from a wider area than the immediate Newcastle city boundaries. In fact, we sought out children living in the geographical area of Tyneside. The mean age at first assessment was seven years five months for the controls, seven years six months for the speech retarded and, as already stated, eight years four months for the hearing-impaired. The age differences do not affect the comparisons as only age-corrected tests were used. The sex ratios of the groups were, however, similar. Furthermore, there were no significant occupational social class differences between the control and hearing-impaired groups.

Tests used

As Reed (1970) points out verbal tests of intelligence are not valid with deaf children. We therefore confined ourselves *mainly* to the use of those tests which were non-verbal:

(i) *Conceptual maturity* The test used was the Goodenough-Harris Draw-a-Man Test (1963).
(ii) *Psycholinguistic performance* The tests used were the non-verbal items of the Illinois Test of Psycholinguistic Abilities (1968).
(iii) *Visuomotor perception* The test used was the Frostig (1966).
(iv) *Non-verbal intelligence* The performance items of the Wechsler Intelligence Scale for Children (1949) were used.
(v) *Reading* The Schonell Graded Word Reading Test (1960) was used.

Definition of deafness

In a physiological sense deafness implies a significantly reduced sensitivity to sound; psychologically it refers to an inability to adequately hear and perceive speech and other meaningful sounds (Watson, 1967; Schein, 1968). There are, of course, varying degrees of deafness. Children with such hearing impairment are usually classified as profoundly deaf or partially hearing in terms of a number of important criteria in addition to the most obviously important, namely, response to audiometric measurement.

Audiometric assessment of our hearing impaired group

It is important to distinguish between those children who are profoundly deaf and those who are partially hearing. We were able to

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Findings

Differences

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subdivide our hearing impaired sample according to whether the children were attending schools for the profoundly deaf or units for the partially hearing. The factors determining attendance at one or other type of school were not simply those of severity of hearing loss (see Chapter 1), though degree of hearing was an important consideration. In marginal cases, child behaviour and parental circumstances were often the deciding factors and therefore there was a certain degree of overlap. Using these crude criteria 33 of the 54 children were classified as profoundly deaf and the other 21 as partially hearing. From Fig. 1 it will be seen that the average hearing loss for our profoundly deaf group is just beyond 80 decibels and that our partially hearing group is about 68 decibels. Hearing loss of around 80 decibels or more is considered by many (Reed, 1970; Moores, 1972; Vernon, 1976; Conrad, 1977) to distinguish those with profound deafness from those with less severe degrees of deafness. Hence we believe that the criteria we have used for defining profound deafness are satisfactory. However, this may not be so in the case of our partially hearing group. An examination of our audiometric profile reveals that the greater proportion of our partially hearing group falls towards the more severe end of the hearing loss continuum. It is therefore possible that some of those whom we have included in the partially hearing group might be considered as seriously deaf by other research workers. Furthermore, it needs to be noted that we have used the terms profound deafness and partially hearing as if there was a clear-cut distinction between them whereas it is evident that hearing loss lies along a continuum. We appreciate that the dichotomy we have used is a relatively simple one, but its purpose was to allow a study of the effects of different degrees of deafness.

Findings

Differences between the means of the groups on cognitive tests

From Table I it will be seen that on all measures used the performance of the total hearing-impaired group is significantly inferior to that of the control group. The least differences occurred on the WISC performance scale and the widest differences on the Draw-a-Man, Frostig visuo-perceptual, and on the non-verbal ITPA tests. Furthermore, though the differences between the WISC performance quotients of the deaf and controls was only 4 points, the difference between these two groups on the Schonell is 14 points. It is therefore evident that the hearing impaired are seriously retarded in reading.

Of considerable theoretical importance is the fact that the mean scores of the total deaf group are closer to those of the Residual Speech

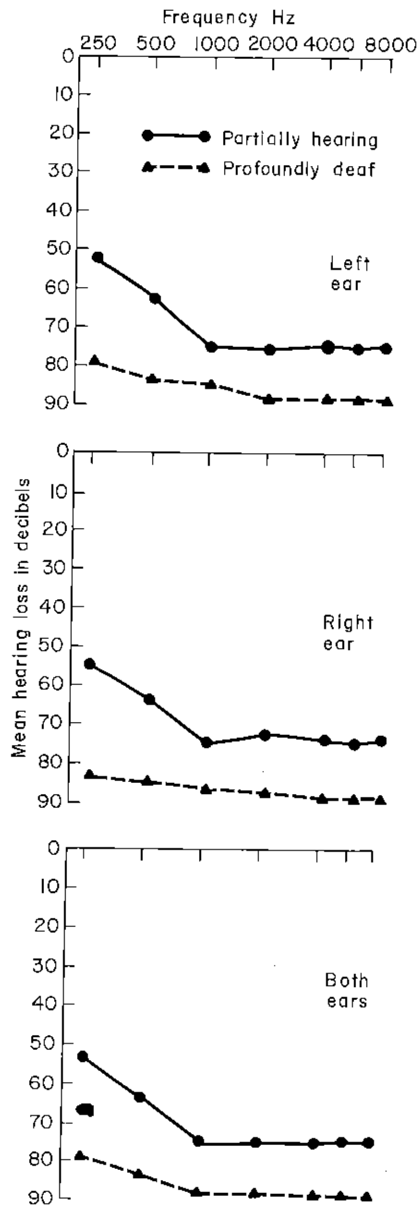


Fig. 1 Mean hearing loss in decibels at each frequency for partially hearing and profoundly deaf groups

Table I *Comparisons of total hearing-impaired and control groups on cognitive and educational data*

Tests		*Groups*			*Significance*	
		A = Controls	B = Residual speech retarded	C = Total hearing impaired	A *vs* C	B *vs* C
Draw-a-Man	m	96·4	92·4	89·3	1%	5%
	s.d.	9·9	9·1	8·9		
ITPA (visuomotor tests)	m	31·4	28·7	28·4	1%	NS
	s.d.	3·4	4·0	3·2		
Frostig	m	95·9	86·8	82·5	1%	5%
	s.d.	11·9	14·1	9·6		
WISC performance	m	101·2	94·9	96·8	5%	NS
	s.d.	11·0	13·3	13·1		
Schonell	m	93·9	80·4	79·5	1%	NS
	s.d.	19·2	15·7	12·4		

Draw-a-Man: Conceptual maturity standard score; ITPA: Mean scaled score for five non-verbal tests; Frostig: Visuo-perceptual Quotient; WISC: Non-verbal Intelligence Quotient; Schonell: Graded Word Reading Quotient.

Table II *Degrees of deafness and intellectual and educational development*

Test		A = Controls (*n* = 101)	B = Residual speech retarded (*n* = 84)	C = Partially hearing (*n* = 21)	D = Profoundly deaf (*n* = 33)	*Significance*				
						A *vs* C	A *vs* D	C *vs* D	B *vs* C	B *vs* D
Draw-a-Man	m	96·4	92·4	91·4	88·0					
	s.d.	9·9	9·1	10·1	7·9	1%	1%	NS	NS	1%
ITPA (visuomotor tests)	m	31·4	28·7	29·8	27·4					
	s.d.	3·4	4·0	2·9	3·1	NS	1%	1%	NS	NS
Frostig	m	95·9	86·8	83·4	81·9					
	s.d.	11·9	14·1	8·9	10·0	1%	1%	NS	NS	NS
WISC performance	m	101·2	94·9	101·9	93·6					
	s.d.	11·0	13·3	11·8	13·0	NS	1%	5%	5%	NS
Schonell Graded Word Reading	m	93·9	80·4	87·6	74·4					
	s.d.	19·2	15·7	13·7	8·3	NS	1%	1%	NS	1%

NS = not significant

Retarded than to those of the controls. Furthermore, in two instances, namely, the Draw-a-Man and Frostig visuo-perceptual tests, the mean scores of the total hearing-impaired group are significantly lower than those obtained by the Residual Speech Retarded Group.

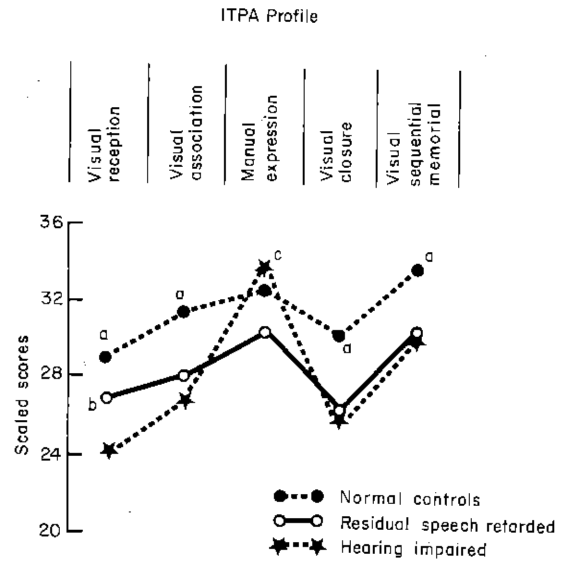
When data is re-analysed according to the degree of deafness (Table II) the partially hearing group prove to be superior to the profoundly deaf group on all the tests and significantly so on three of the tests. The profoundly deaf group are significantly inferior to the controls on all the tests used but the partially hearing are significantly inferior to the controls on only two of the five tests (i.e. in terms of conceptual maturity and visual perception). Furthermore, the partially hearing group are significantly superior to the Residual Speech Retarded Group on the performance IQ.

Subtest profiles

So far the hearing-impaired group as a whole has proved inferior to the control group on the WISC performance scale and the summated scaled score of the five ITPA non-verbal subtests. The next question is whether such inferior performance is general or whether it is specific to certain subtests (and conversely whether the deaf perform better on any of the subtests). The data is more simply presented in profiles.

On the ITPA Profile (Fig. 2) it is evident that the scores of the hearing-impaired are significantly depressed on four of the subtests compared to the controls, but on manual expression they score significantly better than the Residual Speech Retarded Group. This subtest was devised to measure the ability of the child to express ideas by means of manual gesture and pantomime. Therefore the circumscribed better ability on the test is likely to represent greater exposure, experience and training in the use of a manual form of communication. Another interpretation of these findings is that this better ability of the hearing-impaired represents a better inner language potential than is revealed by the other subtests. It is therefore evident that, with one exception, the abilities of the hearing-impaired as a whole group as found on the ITPA are poorer than those of the controls, even in those tests which are considered non-verbal.

The ITPA Profile in Fig. 3 includes separate profiles for the partially hearing and profoundly deaf groups. It clearly shows that the profoundly deaf have the superior score on manual expression but their other ITPA abilities are below those even of the Residual Speech Retarded Group and significantly so in the case of visual reception and visual closure. The shape of the profile of the partially hearing group is similar to that of the controls but is slightly depressed. This suggests



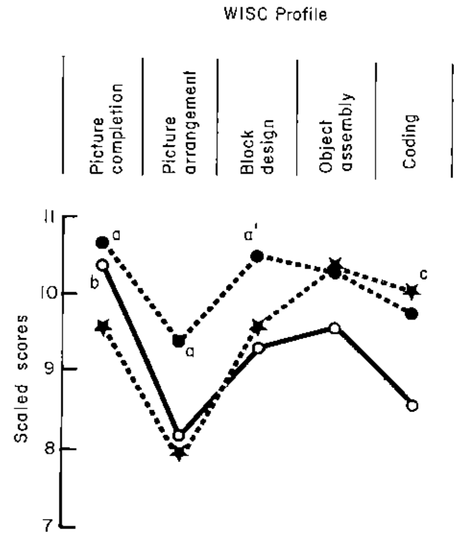
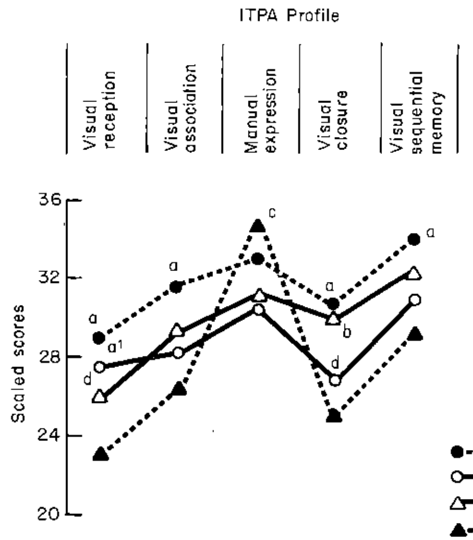
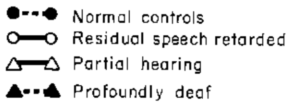


Fig. 2 (left) ITPA non-verbal mean scaled scores of hearing impaired, residual speech retarded and control groups. a = controls significantly better than hearing impaired at 0·001 level; b = residual speech retarded significantly better than hearing impaired at 0·01 level; c = hearing impaired significantly better than residual speech retarded at 0·001 level.
Fig. 4 (right) WISC non-verbal mean scaled scores of hearing impaired, residual speech retarded and control groups. a = controls significantly better than hearing impaired at 0·01 level; a^1 = controls significantly better than hearing impaired at 0·05 level; b = residual speech retarded significantly better than hearing impaired at 0·05 level; c = hearing impaired significantly better than residual speech retarded at 0·001 level.





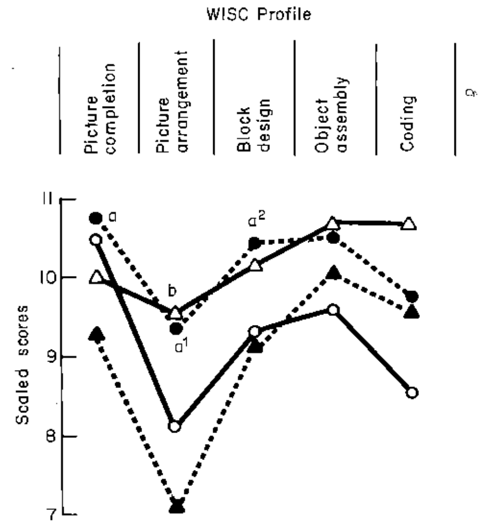


Fig. 3 (left) ITPA non-verbal mean scaled scores of partially hearing, profoundly deaf, residual speech retarded and control groups. a = controls significantly better than profoundly deaf at 0·01 level. a[1] = controls significantly better than partially hearing at 0·05 level; b = partially hearing significantly better than profoundly deaf at 0·05 level; c = profoundly deaf significantly better than controls at 0·05 level, profoundly deaf significantly better than residual speech retarded at 0·01 level, profoundly deaf significantly better than partially hearing at 0·01 level; d = residual speech retarded significantly better than profoundly deaf.

Fig. 5 (right) WISC non-verbal mean scaled scores of partially hearing, profoundly deaf, residual speech retarded and control groups. a = controls significantly better than profoundly deaf at 0·01 level a[1] = controls significantly better than profoundly deaf at 0·001 level; a[2] = controls significantly better than profoundly deaf at 0·05 level; b = partially hearing significantly better than profoundly deaf at 0·01 level, partially hearing significantly better than residual speech retarded at 0·05 level.

that the non-verbal skills of the partially hearing are generally similar to those of hearing children. Of equal importance is the similarity of their profile to the Residual Speech Retarded Group. This is not surprising as varying degrees of language impairment are common to both of these groups. In the case of the Residual Speech Retarded Group, evidence suggestive of language delay is provided in an earlier part of this book, and in the case of the deaf the evidence derives from the literature.

The findings on the manual expression task of the ITPA are important. The task consists not only of manual gesture but also how to manipulate specified objects (Paraskevopoulos and Kirk, 1969). It therefore tends to tap more concrete aspects of expressive communication. The better ability of the deaf on manual expression is to be expected in view of the greater experience in this form of communication. Such experience is less likely to be obtained with less severe degrees of hearing loss where verbal communication is more likely to predominate.

On the WISC performance subtests the profile of the hearing-impaired group (Fig. 4) is significantly depressed on picture completion, picture arrangement and block design, compared to the controls. This is not the case for object assembly and coding. Reed (1970) considers that the subtests of picture arrangement and picture completion are more verbally loaded and thus the inferior scores of the hearing-impaired group on these two tests is according to expectation. Similar explanations cannot be offered for block design.

When the hearing-impaired group is divided into the profoundly deaf and partially hearing it is immediately evident that the WISC performance subtest (Fig. 5) profiles of the partially hearing and the controls are broadly similar. The profile of the Residual Speech Retarded Group is similar but depressed in comparison to the controls. The profoundly deaf are particularly poor in relation to the controls on the two subtests which are thought to be verbally loaded (picture completion and picture arrangement) and only on coding does their mean score approach that of the controls.

Subtest scatter

The standard deviation of the subtests of the WISC and the ITPA were used to derive measures of scatter. The means and standard deviation of the subtest scores of each child were calculated and the standard deviations thus obtained were used as a measure of scatter. These standard deviations were themselves summed, group by group, and the mean standard deviation scores for each group were then compared.

Subtest scatter was not calculated for the profoundly deaf group as they were not given all the tests. The partially hearing group obtained a significantly greater ($p < 0{\cdot}001$) subtest scatter than did the controls for both the WISC and ITPA.

Deafness and specific intellectual functions

To what extent subtests of tests such as the WISC and ITPA reliably measure specific cognitive functions is debatable, as each subtest usually requires more than one intellectual function for it to be completed successfully (Cohen, 1959; Rappaport *et al.*, 1968; Hine, 1971; Hare *et al.*, 1973). Nevertheless, it is customary to attempt to identify the main cognitive function measured by that subtest. Such definition allows a cautious interpretation of deficits or strengths displayed by groups of children with a particular disorder. While Cohen (1959) generally advises against interpretation of individual subtest scores, Sattler (1974) is of the view that cautiously made interpretations may prove to be useful. This is a view which appears to be shared by Kirk and Kirk (1971) in relation to the ITPA and by Glasser and Zimmerman (1967) in relation to the WISC.

In the light of the above the following attempt at interpreting individual subtest scores must be seen both as tentative and speculative, but nevertheless aimed at generating hypotheses which might be tested in other research.

Visual perception

On tasks where visual perception plays an important part, e.g. on the ITPA subtests of visual reception and visual closure, the profoundly deaf group had significantly poorer results than their hearing counterparts. Similarly, on the WISC subtests of picture completion and block design, the profoundly deaf group again proved to be significantly inferior to the hearing group. In contrast, the partially hearing group fared significantly worse than their hearing counterparts on only one of the above subtests, namely, visual reception of the ITPA; on the other hand, the partially hearing were superior to their profoundly deaf counterparts on visual association.

The studies already quoted in the review section of the previous chapter provide contradictory evidence on the subject of the visual perceptual ability of the deaf. In our study the profoundly deaf group show wide impairment in visual perceptual ability compared with the controls both in terms of global and subtest scores. In the case of the partially hearing group, it is less widespread, being evident only on the visual reception subtest of the ITPA and on the global score on the Frostig Test of Visual Perception. The differences in visual perceptual ability between the profoundly deaf and partially hearing groups in comparison with their normal hearing counterparts leads us to the view that it is determined by the degree of deafness of the different subgroups. It has been claimed that different sensory modalities can take over in the face of a serious impairment in one of the other modalities. However, our findings do not provide evidence in support of the view that there is widespread compensation in visual perceptual ability of deaf children.

Conceptual thinking

We have already noted that the evidence in the literature tends to support the view that the cognitive abilities of the deaf are more likely to be adversely affected on tasks dependent on abstract and symbolic thinking. We have examined the subtests, and two of them in particular appear to require greater degrees of non-verbal reasoning ability of an abstract nature. On the WISC the non-verbal subtest which has been found in research to relate significantly to an analytic conceptual ability is picture arrangement (Kagan *et al.*, 1964; Sattler, 1974). On the ITPA by definition the visual association subtest demands an ability to comprehend the relationship between visually presented symbols and hence emphasizes the child's ability to cope with analogies (Paraskevopoulos and Kirk, 1969). It is evident that both these tests have additional perceptual components but this is the kind of overlap to which we have already referred. It is to be noted that on both of these subtests the profoundly deaf group have significantly poorer results. These findings are consistent with evidence in the literature as reported above. On the other hand, the partially hearing did not significantly differ from the controls on these two subtests. We therefore conclude that degree of hearing loss is related to extent of deficit on abstract and symbolic abilities.

A third non-verbal test which, in our view, falls into the conceptual thinking category is the manual expression subtest of the ITPA. Not only does it measure the child's ability to express ideas by means of manual gesture and pantomime, but it also demands a degree of symbolic thinking for its execution. On this test the profoundly deaf group scored significantly better than the control, Residual Speech Retarded and partially hearing groups.

Memory

Only one task was administered to our hearing-impaired subjects in which memory could be said to be the predominating function. That was the visual sequential memory subtest of the ITPA.

On this subtest the profoundly deaf group proved to be significantly poorer than the controls, whereas the partially hearing group did not significantly differ from the controls. It would be unwise to advance a general conclusion about the deaf child's memory function on the basis of this subtest alone. On the other hand, our findings of the poorer performance on visual sequential memory is consistent with Withrow's (1968) findings. He found that his deaf group did worse on tests of visual memory for successively presented stimulus material and where non-meaningful visual forms, which are also characteristic of the ITPA visual sequential memory subtest, featured. It may well be, as we have already argued, that degree of hearing loss is an important factor which contributes to the cognitive differences we have found between the partially hearing and profoundly deaf, compared to the normal controls.

Discussion

There is general agreement that hearing loss and its associated effect on language tend to limit the hearing-impaired child's modes of thought (Lewis, 1968; Rodda, 1970; Myklebust, 1964; Meadow, 1975). Our findings provide evidence in support of this view, and also give rise to a number of other conclusions which are of considerable importance. Perhaps the most notable of these is that cognitive impairment appears to be related to the severity of hearing loss. Second, the partially hearing group showed minimal cognitive impairment on non-verbal tests and indeed on only one of these was there a significant difference from the controls. This may well be a chance finding as most of the other major studies do not report any such impairment. Third, a widespread pattern of cognitive impairment was found in the case of the profoundly deaf; however, this group of children did particularly well on the manual expression subtest of the ITPA, which is a measure of gestural language. This better performance may merely reflect a greater degree of experience in gestural language which is a commonly used form of communication among the deaf (Levine, 1960).

Correlation of handicaps and achievements

One simple way of re-analysing our data is to develop an index of handicap in four main areas in relation to all the groups which we have so far studied in this research. For the purposes of this analysis we have included the two subgroups of speech retarded children defined and

Table III *Evidence of handicap*

Handicap	Control group	Specific speech delay group	General delay group	Partially hearing group	Profoundly deaf group
Hearing[a]	1	1	1	3	4
Language[b]	1[d]	2[d]	2[d]	3[d]	4[d]
Speech dealy[c]	1	3	3	3	4
Motor delay[c]	1	1	3	1	2
Total handicap score	4	7	9	10	14
Rank of groups	1	2	3	4	5

[a] Based on global audiometric assessment
[b] Based on clinical assessment by speech therapist
[c] Based on early history
[d] Weighting system: clear evidence = 4; moderate evidence = 3; minimal evidence = 2; no evidence = 1.

described in an earlier section of this monograph. The two groups are the specific speech delayed group (i.e. those with speech delay but whose walking milestones were achieved early) and the general delayed group (i.e. those whose speech and walking milestones were both delayed). We have arbitrarily given weightings of 1 to 4 to each of the groups on the basis of historical or clinical evidence (see Table III). The handicaps which we have identified as important are hearing as assessed audiometrically, language as assessed by the speech therapist, and speech and motor delays as based on historical evidence. In Table III we have arranged the groups so that they range from that with the lowest total handicaps score, which is the normal control group, to that with greatest handicaps score, which is the group of profoundly deaf children.

We then advance the hypothesis that the group with highest loadings of handicaps will have the lowest cognitive achievements and vice versa. We can now test this hypothesis by comparing handicapped scores with cognitive achievements. In Table 21, Appendix 1, we provide the mean scores of the ITPA subtests for the five groups which we have studied. We also provide rankings of the scores of these subtests, which immediately allows us to compare these rankings with the sum of ranks on the index of handicap. When we compare the bottom two rows of this table it is evident that our hypothesis is only broadly substantiated, with the partially hearing group doing far better and the general delayed group doing much worse than would have been forecast by our hypothesis. This unexpectedly good performance from the partially hearing may be a reflection of the handicaps incorporated into the weighting system (three hearing and speech and only one motor).

With regard to the subtests, the pattern described above is usually repeated. The only variations of note are that the control group is worse on manual expression and visual closure than predicted by our hypothesis; and the profoundly deaf are far better at manual expression than expected.

When this analysis is repeated using subtests of the WISC (Table 22, Appendix 1) we perceive the same pattern—the general delayed group doing far worse and the partially hearing far better than we would have expected. Indeed, on this occasion the partially hearing (in terms of their sum of ranks) do even better than the controls. Returning to the subtests, the specific speech delayed group do better than expected on only one subtest and worse than expected on all the others. The profoundly deaf do better than expected on object assembly and coding. These general patterns and trends are repeated on the other tests used, namely the Frostig Test of Visual Perception, Draw-a-Man Test of Conceptual Maturity, WISC performance IQ and the Schonell Graded Word Reading Quotient (Table 22, Appendix 1).

Such analysis can only indicate trends as it relies on rankings and not statistically significant differences. Nevertheless such trends become important if they persistently emerge on a variety of cognitive tests. Our findings lead us to conclude that children with milder degrees of deafness compensate for their handicaps on non-verbal tests by doing as well as the specific speech delayed group on the non-verbal tests of the ITPA and as well as the controls on the performance subtests of the WISC.

The next most obvious pattern is the poor performance of the general delayed group, as on no subtest do they perform better than expected. We again conclude that the poor performance of this group is determined by general intellectual backwardness. The profoundly deaf do badly on most subtests, but despite their heavy weighting of handicap they perform especially well on manual expression of the ITPA. It is worthwhile noting that the profoundly deaf also do better than expected on object assembly and coding, while the specific speech delayed group do worse than expected on these two tests (in terms of rank order). This demonstrates that in certain areas the profoundly deaf, either through compensatory adjustment to their hearing loss or through experience and training in related skills, are able to function almost as well as their hearing counterparts.

Finally, it is interesting to note that a far better prediction of outcome on the basis of handicap could have been obtained by using a smaller selection of indices of handicap. For instance, the use of speech and motor milestones alone would have predicted performance on cognitive tests better than the index which we have actually used (see Table III).

Rank order and gaps between non-verbal subtests (WISC and ITPA)

WISC

In a previous chapter we described an alternative way of studying the data by comparing the rankings of the mean scores on the subtests of the groups studied. The rankings are shown in Table IV. It will be seen that on the non-verbal scale of the WISC the rankings of the partially hearing and profoundly deaf groups are similar to each other but appear very different from those of the controls. After ranking the mean subtest scores and using the Newman-Keuls Test for correlated data and testing for a significant gap we found that there were no significant gaps between any of the subtests in the case of the partially hearing group; on the other hand, in the case of the profoundly deaf there was a significant gap between object assembly on the one hand and picture arrangement on the other ($p < 0{\cdot}01$). This is repeated in relation to coding, picture completion and block design and on all occasions this consisted of a significant gap with picture arrangement ($p < 0{\cdot}01$).

In summary, in terms of rankings of the non-verbal subtests the partially hearing and profoundly deaf have similar patterns, but only the profoundly deaf have a number of significant gaps on the WISC.

ITPA

The exercise described above was repeated for the ITPA subtests. The differences in patterns of rankings are not as evident as in the WISC. It will be seen that, with some minor variations, the patterns of rankings of both the partially hearing and the profoundly deaf are similar to each other and indeed also similar to those of the controls (see Table IV).

When comparing subtest scores with each other within groups it will be seen that, in the case of the partially hearing group, the only significant gap was between visual reception and visual sequential memory ($p < 0{\cdot}05$). However, in the profoundly deaf group the gaps between manual expression and the remaining subtests are all significant ($p < 0{\cdot}01$). In addition, there are significant gaps between visual sequential memory and visual reception ($p < 0{\cdot}01$), visual closure ($p < 0{\cdot}01$) and visual association ($p < 0{\cdot}05$).

In summary, in the ITPA tests the pattern of rankings of the non-verbal subtests for the three groups are broadly similar. However, when testing for a significant gap using the Newman–Keuls Test a wide scatter is found in the results of the profoundly deaf group. This is almost entirely determined by the better performance on the manual expression subtest, compared with the other subtests. However, the

Table IV *Rank order of mean scores on non-verbal subtests of ITPA and WISC*

	Controls	Partially hearing	Profoundly deaf
WISC			
Picture completion	1	4	3
Block design	2	3	4
Object assembly	3	1·5	1
Coding	4	1·5	2
Picture arrangement	5	5	5
ITPA			
Visual sequential memory	1	1	2
Manual expression	2	2	1
Visual association	3	4	3
Visual closure	4	3	4
Visual reception	5	5	5

High rankings e.g. 1, 2 = high achievements
Low rankings e.g. 4, 5 = low achievements

profoundly deaf also do well on the visual sequential memory test compared with the results on the remaining subtests. We discuss elsewhere the patchy performance of the partially hearing group as measured by scatter. As scatter was determined by verbal as well as non-verbal tests we were unable to apply this technique to the profoundly deaf group. However, the present test for significant gaps between subtests in a sense also reflects scatter, and it is evident that this is greatest in the profoundly deaf (as measured by non-verbal subtests). This patchy performance of the profoundly deaf is unlikely to be determined only by deafness or its causes. It is more likely to be affected by an interaction of aetiological factors, severity of deafness and environmental influence. This appears to be less true of the partially hearing who, in many ways, function more like the control group than like a deaf group.

Verbal abilities of partially hearing children

Introduction, aim and method

In the previous section we gave an account of the intellectual and educational progress of partially hearing and profoundly deaf children. There we confined our analyses to those tests which were non-verbal (with the exception of the reading test) as it is usually not possible to obtain valid results on verbal tests with a significant percentage of deaf children.

Nevertheless, a subgroup of the deaf sample, consisting of 17 of the 21 partially hearing children, were able to complete all the verbal tests. The findings on these tests enable us to study the verbal abilities and handicaps of this highly selective group of hearing-impaired children. In this section we therefore address ourselves to an analysis of the verbal items of the verbal scale of the Wechsler Intelligence Scale for Children (WISC) and the five main verbal subtests of the Illinois Test of Psycholinguistic Abilities (ITPA). In addition we compared the partially hearing group both with the controls and with the group of children who were previously speech retarded and described as the Residual Speech Retarded Group (see earlier chapters).

Findings

Our findings are simple. They consist of the demonstration of a gradient on all subtests from controls to speech retarded to partially hearing. While the children in the partially hearing group show a significantly poorer performance than the controls on every subtest, the difference from the Residual Speech Retarded Group is significant on only six of the ten subtests studied (see Tables 23 and 24, Appendix 1) and on four of these the differences are on language subtests.

Discussion

The interpretations are again simple—the majority of partially hearing children have a manifest potential for developing certain verbal abilities while the profoundly deaf do not. Nevertheless such achievements of the partially hearing are more limited than those of a group of children with handicaps of speech but virtually none of hearing. These findings are consistent with the hypotheses advanced in the previous section, namely, that the greater the evidence of handicap in the areas of hearing and speech, the poorer the language and cognitive achievements of the child (see Table III).

It is notable that the highest mean score on the WISC verbal subtest is on arithmetic, which resembles the findings by Hine (1970) with his partially hearing sample. He claims that this improved performance is a reflection of the fact that some non-verbal skills are involved in the solution of the items in this subtest. These findings suggest that the more one can enhance the child's hearing through artificial aids the greater the likelihood of increasing the child's intelligence and attainments. Perhaps the most important conclusion from this analysis is that the greatest handicap of deaf children, even when the deafness is not profound, is the area of language (Meadow, 1975).

Principal component analysis

A principal component analysis was undertaken on cognitive data from the total hearing-impaired, Residual Speech Retarded and control group subjects (Fig. 6). The variables included were of the non-verbal type listed in the methods section, the exception being the Schonell Graded Word Reading Test. Only the first two components were considered meaningful:

(i) Component I accounts for 36% of the variance. A study of the loadings on this first component reveals that it has reasonably

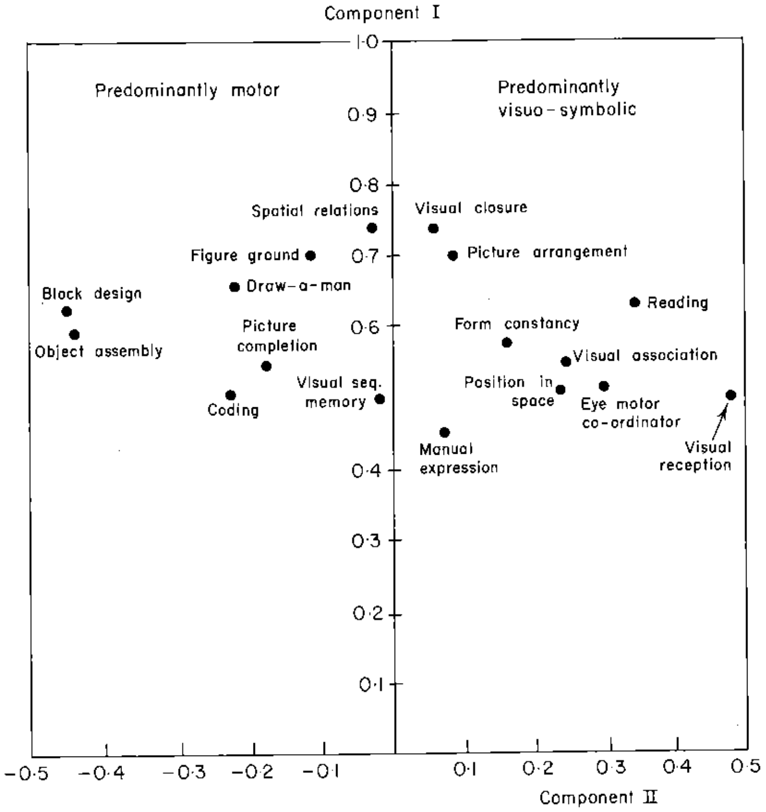


Fig. 6 Principal component analysis of cognitive data for control, residual speech retarded and deaf groups

high positive loadings on all variables included in the analysis. We therefore view it as a general component of intelligence. This is to be expected as this is precisely the type of data which was included in the component analysis.

(ii) The second component is bipolar and accounts for 6·8% of the variance. At the one pole are variables predominantly representative of motor tasks and the pole has been labelled thus. At the other pole are tasks which are predominantly visuo-symbolic in nature and the pole has been labelled visuo-symbolic representation (see Fig. 6 and Table 25, Appendix 1).

From Table 25, Appendix 1, it will be seen that on components I and II the deaf group have a significantly lower score than the controls. On component II the score of the deaf is significantly inferior to that of the Residual Speech Retarded Group. The inferiority of the deaf on what we have described as a non-verbal general component merits explanation. It is possibly because even so-called conventional non-verbal tests may contain verbal elements. This is consistent with Myklebust's (1964) view of non-verbal tests—he argues that it is wrong to regard all non-verbal tests as equally non-verbal because it is likely that some of these tests involve considerable ability of the type commonly referred to as verbal. Reed (1970) also supports this view.

If the mean component scores provided in Table 25, Appendix 1, are located on the map of Fig. 6 then the deaf group would fall into the lower left quadrant of the component map (i.e. negative scores on both the first and second components) and thus lean towards the motor pole. The control group would fall into the opposite positive quadrant and lean towards the visuo-symbolic representation pole. The Residual Speech Retarded Group would fall into the lower right quadrant, i.e. a slight leaning towards visuo-symbolic representation.

This technique of combining cases from three different groups for the sake of component analysis may be open to the criticism that multivariate techniques can be applied only to data from the same population: however, this view is not unanimous (Cattell, 1965).

Interim discussion

It is clearly evident from our results that the overall performance of our hearing-impaired children falls below that of the normal hearing control children on all the cognitive tests administered. The exceptions to this general trend will be discussed later. The finding that the total hearing-impaired group's performance on a non-verbal IQ test falls significantly below that of the control group is only broadly consistent with most of the earlier findings on the deaf. In our view the differences between the findings are likely to be determined by the selectivity of the sample studied. If we had taken only a profoundly deaf sample we would have ended with a jaundiced view of the cognitive ability of deaf children. Indeed, our finding underlines the importance of studying as representative a sample of the hearing-impaired population as possible. This leads to the following conclusion.

Our own results certainly do not support the conclusion that the hearing-impaired obtain scores comparable to the normal hearing population, despite the use of non-verbal performance tests. Possible explanations are as follows:

1 The deaf constitute a heterogeneous group of disorders and the findings of different studies will, in part, reflect this heterogeneity. Different findings may therefore reflect differences in the groups under scrutiny. For instance, there is evidence that the cognitive abilities of deaf children of deaf parents are likely to be less impaired than deaf children with hearing parents (Meadow, 1968). We were not confronted with this complication as only one of our deaf children had deaf parents.
2 Our subjects were younger than those of most of the reported studies. The evidence suggests that the achievement by the deaf on intelligence tests is age-related, that inferiority compared to normal hearing individuals will tend to disappear by the age of 20 and that at the age of 20 the deaf actually score above average on performance items like picture completion, object assembly, block design and digit symbol (Myklebust, 1964). As our subjects are younger than those involved in previous similar studies, the effects of their hearing impairment on their intellectual functioning could well be more marked than is seen in studies using older subjects. We can therefore argue that the deficit on the WISC performance tests shown by our sample could well disappear with age. This younger group should provide us, however, with more information about the earlier effects of hearing impairment on intellectual development.

Educational attainment

The low score of the profoundly deaf group in comparison with the control, Residual Speech Retarded and partially hearing groups (Table II) is consistent with the findings of other research workers (Wrightstone *et al.*, 1962; Meyerson, 1963; US National Demographic Study, 1973; Conrad, 1977). It is of interest to note the gradient which consists of the control group having a mean reading quotient in the 90s, the Residual Speech Retarded and the partially hearing groups mean reading quotients in the 80s and the profoundly deaf group a mean reading quotient in the 70s. Furthermore, a glance at Table 22, Appendix 1, shows that the general delayed group has a mean reading quotient which is similar to that of the profoundly deaf group. Our conclusion must, therefore, be that the partially hearing group is only slightly impaired on educational attainment in terms of reading quotient, as compared to the controls, but that the profoundly deaf group is seriously retarded.

It has often been assumed that the poorer academic functioning of deaf children in residential schools for the deaf, as compared with deaf children in special classes in ordinary schools or in integrated classes in ordinary schools, is determined by three main sets of factors: first, living in a special environment away from normal home conditions; second, isolation from the verbal and social stimulation which is usually available in ordinary school from one's normal peer group; third, the selection of the deaf children for residential education on the basis of multiple handicaps. While it is tempting to suggest that the poorer educational attainment of our profoundly deaf group has been determined by their residential educational environment it should be remembered that their poor attainment is consistent with the pattern of findings on other cognitive tests, and also that the educational attainment of our deaf group has been based on a reading test which is essentially a verbal test. Hence, a more likely explanation for the poor attainment of the profoundly deaf group is that it is mainly a function both of the severity of deafness and of the multiplicity of handicaps which are commonly found in deaf children in residential settings.

Finally, as recently pointed out by Meadow (1975), the relationships between eduational functioning, school environment and family variables are complex and, indeed, there may be important interaction effects between such variables. For instance, she has demonstrated that residential schooling appears to be associated with more favourable functioning on certain tasks in the case of deaf children of deaf parents as compared with deaf children of hearing parents.

Some final comments

Explanation of handicaps in terms of models of intelligence

After a penetrating analysis of the structure of the main models of intelligence, Hearnshaw (1975) concludes,

> 'The pioneers in the scientific study of intelligence, Spearman, Burt and others, endeavoured to replace faculties by statistically established factors, and this endeavour has persisted to the present day, and to the elaborate factorial structure proposed by Guilford (1967). These endeavours, though an advance on faculty psychology, have not, however, been wholly convincing.

There is an element of arbitrariness in factorial solutions, and it would seem that unless the questions are posed, and the measure selected, on the basis of much more penetrating theory about the nature of intelligence, factorial analysis cannot provide convincing answers.'

Our own results suggest that the use of any one model of intelligence is too narrow for a meaningful interpretation and understanding of the complexities of cognitive functioning of deaf children. The factorial structural model has been useful for the interpretation of certain patterns but for others a teleological type of explanation of an appropriate adjustment to a 'silent' world is more meaningful. A similar approach can be advanced in relation to an understanding of cross-cultural differences in intellectual performance (Vernon, 1969). The implication of this is that man will use his intelligence to adapt to any personal limitations and environmental constraints as exemplified by the high ability on manual expression of the profoundly deaf.

The study of the intellectual performance of the deaf has had a long history, while the study of the intellectual performance of the culturally deprived and minority groups is of comparatively recent origin. The deaf child and culturally deprived child in fact have much in common, because the deaf child is basically deprived. He is deprived of language and the normal exposure to sound and speech and the wealth of information which the normal child usually obtains through his auditory modalities. In addition, he is subject to the negative attitudes confronting any minority group in our culture, and further, his intellectual and educational performance is consistent with that of children of minority groups (see Jensen, 1969; Jencks, 1972). Our background data suggest that he might be deprived of all the more adventurous explorations indulged in by hearing children. We would like to suggest that the poorer performance of a child from a different culture or deprived environment can be seen in the same light as the poorer performance of the deaf child. On the one hand, his poorer performance may be due to non-exposure or limited exposure to certain life experiences, intellectual games and language to which the average child in our culture is subject, and, on the other hand, he may perform worse on some tasks because they do not tap abilities which are meaningful to his particular existence.

Husen (1975) claims, 'different socio-cultural settings vary in the demands they make on intelligence. They not only require different amounts but chiefly different kinds of intelligence. Consequently, each social context demands and trains just the variety of intelligence that is needed for that particular setting.' This view sheds some light on our own findings. Our profoundly deaf children are superior in manual expression because their social context demands and trains that variety of their intellectual ability which is needed for their particular setting. However, as they grow up and become more integrated in the main stream of our culture, it becomes increasingly necessary for them to improve their ability to cope with and manipulate abstract symbols. This is a complex subject which goes beyond the brief of this book.

Considering that we are in most cases dealing with very early deprivation in the deaf, it certainly supports the arguments by investigators such as Clarke (1968) and Kagan and Klein (1973) that the effects of even severe early deprivation may not be reversed without concentrated effort. Society provides intensive help in the form of special schools, specialized teachers and small classes, available from an early age to school leaving age in an attempt to overcome the effects of that deprivation. The earlier impressions of favourable outcome associated with pre-school compensatory programmes have now been put into a less optimistic but more balanced perspective by empirical research. Hence while one would support such a lobby to promote pre-school programmes for deaf children, the authoritative conclusions (Bronfenbrenner, 1976) regarding the effectiveness of such programmes in the case of underprivileged children have important implications in the case of hearing-impaired children.

Cerebral dysfunction

On the basis of our biographical and psychological assessment a case could be made for the existence of an important degree of cerebral dysfunction in our hearing-impaired sample, particularly in the profoundly deaf group. In a previous chapter we described excesses of major postnatal illnesses in the profoundly deaf group compared with the controls. The same was true for epileptic fits. While the partially hearing had some excess in comparison to the controls these were usually not significant. The other evidence in support of a cerebral dysfunction hypothesis derives from psychological testing. At its best this is usually 'soft' and indirect evidence (Birch, 1964). In our study the psychological evidence available is mainly from the use of the Frostig Developmental Test of Visual Perception on which children with varying degrees of brain damage have been found to show a marked paucity of performance (Maslow *et al.*, 1964, p. 497).

Both our hearing-impaired groups scored significantly worse than their normal counterparts on the Frostig Test, and the partially hearing group had a significantly higher scatter than the controls on the subtests of both the WISC and the ITPA. The subtest for the profoundly deaf group on the WISC and ITPA has not been calculated because only the non-verbal subtests could be administered to this group. Superficially, our findings might be considered as supportive evidence of cerebral dysfunction in our hearing-impaired groups. However, such

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evidence is weakened by doubts about the validity of the Frostig Developmental Test of Visual Perception as a psychological indicator of cerebral dysfunction. Corah and Powell (1963) factor-analysed the Frostig and found it to tap little more than general intelligence and chronological age. Their findings appear to refute the claim that five separate perceptual factors are measured by the Frostig. It is for this reason that we have concentrated only on the overall Frostig score in this project: while some clinicians might interpret the lower scores on the Frostig as evidence in support of significant cerebral dysfunction amongst our hearing-impaired subjects, we would not give very much weight to this evidence. Furthermore, though the high subtest scatter might be suggestive of cerebral dysfunction, it might also merely indicate that the hearing loss has affected their performance on certain subtests to a greater extent than on other subtests. While the same arguments in favour of an organic hypothesis apply to the interpretation of some of the subtest scores on the WISC performance scale, it must be emphasized that even here (see Table 22, Appendix 1) the general pattern of subtest scores bears little resemblance to patterns which are clinically considered to be characteristic of cerebral dysfunction.

Nevertheless, we cannot ignore the fact that organic factors are often important causes of deafness. Nor can we ignore the possibility that cerebral dysfunction may have contributed to the poorer performance of our hearing impaired group, particularly the profoundly deaf, but we have no way of estimating the extent of this contribution.

Conclusion

As a group, the hearing-impaired children performed significantly worse than their normal counterparts on the vast majority of the non-verbal cognitive tests. But it would be an oversimplification, if not erroneous, to conclude that hearing-impaired children of junior school age are 'less intelligent' than normal hearing children. It is more helpful to consider the hearing-impaired in terms of their cognitive strengths and weaknesses. A more meaningful overall summary is provided by a study of the principal component analysis where a pattern emerges which is consistent for each component. The first component measures general intelligence and on this the controls do best, the Residual Speech Retarded Group obtain an intermediate score and the deaf do worst. On the second component, which is a bipolar dimension of 'visual symbolic ability versus motor ability' the mean score of the hearing-impaired group falls at the motor pole, that of the controls at the visual symbolic pole and the Residual Speech Retarded Group in between. Such findings suggest differences in cognitive style between the groups of children. We believe that these findings reflect a difference of learning strategies between deaf and hearing children, with the former responding to readily observable, manipulable and meaningful stimuli and the latter coping more comfortably and spontaneously with the more abstract type of tasks. It is not the first time that researchers have concluded that the deaf learn more through doing and seeing than through speaking and hearing. However, we do not see this as absolute as we do not deny the value of helping the hearing-impaired to make maximum use of residual hearing and/or oral communication, however elementary.

Such comments ignore the fact that the deaf are not a homogeneous group. We have used one simple classification, namely, the division of the hearing-impaired into profoundly deaf and partially hearing subgroups. Indeed, the patterns elaborated above are much more typical of the profoundly deaf than of the partially hearing. In many ways, the partially hearing resemble the normal control group while the profoundly deaf almost always have a significantly depressed cognitive profile compared to that of the controls. However, the other major characteristic of the profoundly deaf group is the patchiness of the pattern of their subtest scores. This is most clearly highlighted on the ITPA where the profoundly deaf have a subtest score higher than all the other groups studied. Thus while profound deafness adversely affects most cognitive functions, it would seem that certain functions may actually be enhanced on the one language ability where hearing loss is no impediment because the mode of communication used can be considered to be a variant of sign language and is therefore more meaningful to the deaf child. Nevertheless, our findings suggest that hearing loss makes an important contribution to the poorer intellectual functioning of hearing-impaired children.

This appears to contrast with the findings of Conrad (1977) who found 'no significant effect of hearing loss on non-verbal intelligence'. We have examined his data and it is clear that there is an overall trend in the same direction as we have found in relation to extreme degrees of hearing loss. Even so, account needs to be taken of certain important differences between the two studies. The deaf sample in Conrad's study were school leavers aged 15–$16\frac{1}{2}$ years and so were much older than our sample. We have already acknowledged (p. 167) the possibility that the significant effect of hearing loss on the intellectual functioning of our deaf groups could well be more marked than is the case in studies using older subjects. Furthermore, Conrad has only used the Raven's Progressive Matrices Test (1960) whereas we used a wider range of non-verbal tests which included the WISC performance scale. In our study the pattern of cognitive impairments is consistent across the tests we used and this leads us to consider that our findings are valid for this younger

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We were also able to study the functioning of the partially hearing group on verbal subtests of the WISC and the ITPA (in contrast to the profoundly deaf group who could not validly complete such tests). On the subtests the partially-hearing invariably fared significantly worse than the controls but this pattern was not as consistent in relation to the Residual Speech Retarded Group. The one surprising finding is that the partially hearing group, despite usually doing worse than the specific speech delayed group on verbal subtests, are better at reading.

In this chapter we also provided evidence that the functioning of handicapped children is related to the number and severity of their handicaps. The most obvious impediment of hearing-impaired children is deafness but such children are also likely to suffer from degrees of brain damage and intellectual impairment. These handicaps are interrelated and it is no easy task to tease out the importance of the direct and interactive effects of each of these in relation to later performance. Our findings lead us to take the stance advanced by Lewis (1968) that language and thinking are complexly interrelated in contrast to the view of Furth (1966a, 1971) who sees language and thought as largely independent.

In conclusion, the finding that the cognitive test scores of our deaf sample are depressed, might lead to the erroneous conclusion that deaf children of primary school age are simply 'less intelligent'. Such a conclusion would be an oversimplification and is belied by the fact that our results indicate that, while profound deafness widely affects most cognitive functions, certain intellectual abilities may in fact be enhanced, with the profoundly deaf scoring better than their hearing counterparts. For instance, the profoundly deaf performed significantly better than their normal hearing counterparts on the one language ability test where hearing loss is no impediment, namely, the 'manual expression' subtest of the ITPA. In contrast, those with some hearing, i.e. the partially hearing subjects, in general obtained a pattern of scores which is similar to that of the normal hearing sample.