Appendix 1
Supplementary tables

Part I—The speech retarded study

Chapter 1

Table 1 *Schooling*

Special placements	Total = 19
(a) ESN schools	8
(b) Spastic schools	1
(c) Deaf schools	2
(d) Training centre	3
(e) Subnormality hospitals	2
(f) Not at school—ineducable	3
Ordinary schools	Total = 83
	Grand total 102

Chapter 3

Table 2 *Psychological tests*

		Controls	Residual speech retarded	*Significance*
WISC full scale IQ	m	96·26	88·3	[c]
	s.d.	9·9	10·96	
WISC verbal IQ	m	92·5	84·3	[c]
	s.d.	9·97	9·19	

(*cont.*)

Table 2 (*cont.*)

		Controls	Residual speech retarded	*Significance*
WISC performance IQ	m	101·17	94·94	[b]
	s.d.	11·04	13·27	
WISC V/P discrepancy	m	8·69	10·41	NS
	s.d.	10·75	10·77	
Frostig (motor perceptual quotient)	m	95·99	86·82	[c]
	s.d.	11·91	14·07	
Harris DAM (conceptual maturity)	m	96·35	92·4	[b]
	s.d.	9·93	9·11	
Skemp (visual concept formation)	m	23·52	21·83	[b]
	s.d.	1·53	2·44	
Birch (auditory visual integration)	m	6·23	5·02	[b]
	s.d.	2·8	2·03	
Purdue Pegboard (manual dexterity)	m	8·64	8·1	[b]
	s.d.	1·29	1·48	
Imitation of gesture[a]	m	30·86	34·10	[c]
	s.d.	5·60	6·65	

[a] The lower the score, the better the performance, the higher the score, the poorer the performance.
[b] $p < 0{\cdot}01$ [c] $p < 0{\cdot}001$ NS = not significant

Table 2A *Educational attainment*

		Controls	Residual speech retarded	Significance
Reading quotient (Schonell)	m	93·94	80·38	[c]
	s.d.	19·15	15·68	

Table 3 *Distribution of WISC scores*

	WISC full scale		*scale IQ*		*Performance IQ*	
	Controls					
	a		b		c	
	n	%	*n*	%	*n*	%
116 or more	4	4	2	2	12	12
101–115	35	35	24	24	44	44
86–100	49	49	53	53	37	37
71–85	12	12	21	21	7	7
70 or less	0		0		0	0
Total	100		100		100	

	WISC full scale IQ		*Verbal IQ*		*Performance IQ*	
	Residual speech retarded					
	d		e		f	
	n	%	*n*	%	*n*	%
116 or more	1	1·25	0	0	6	7·34
101–115	11	13·75	7	8·75	25	30·48
86–100	37	46·25	30	37·50	34	41·46
71–85	26	32·50	37	46·25	16	19·51
70 or less	5	6·25	6	7·50	1	1·21
Total	80		80		82	

Note Appropriate cells have been collapsed to produce 2 × 4 table for chi-squared with 3 d.f.

a *vs* d	$\chi^2 = 24$	$p < 0{\cdot}001$
b *vs* e	$\chi^2 = 23$	$p < 0{\cdot}001$
c *vs* f	$\chi^2 = 9{\cdot}8$	$p < 0{\cdot}01$

Table 4 *Speech and language measures*

Measure	Controls[a] (n = 101)		Residual speech retarded (n = 80)		*Significance*
	m	s.d.	m	s.d.	*t* test
1 *ITPA*					
Psycholinguistic quotient	91·3	10·1	80·9	10·2	*c*
Representational level—scaled score	32·7	3·6	29·1	4·0	*b*
Automatic level—scaled score	33/8	6·0	30·8	6·2	*c*
Psycholinguistic age (months)	81·5	5·1	73·2	9·1	*c*
2 *Sentence analysis*					
Mean words per sentence	13·2	2·4	11·2	2·6	*c*
Sentence complexity	36·7	7·2	32·6	9·7	*b*
Content score	30·0	6·2	25·3	7·9	*b*
Incomplete sentences	0·38	0·69	0·9	1·6	*b*
3 *EPVT*	94	10·8	81·2	11·6	*c*

(*cont.*)

Table 4 (*cont.*)

Measure		Controls[a] (n = 101)	Residual speech retarded (n = 80)	*Significance*
4 *Communication style* (follows Bernstein)		Absolute nos	Absolute nos	Chi-squared
Grade	(i) Highly elaborated	7	3	$\chi^2 = 14{\cdot}5$
	(ii) Elaborated	35	13	d.f. = 2
	(iii) Moderate	43	35	
	(iv) Restricted	16	26	[c]
	(v) Highly restricted	0	3	

[a] For some tests n = 100
[b] p <0·01 [c] p <0·001

Table 5 *Assessment of speech at seven years using Edinburgh articulation test*

		Controls (n = 100)	Residual speech retarded (n = 80)	Statistical difference
Correct score	m	59·5	52·5	
	s.d.	8·6	12·4	p <0·01
Immature errors of articulation	m	4·9	9·9	
	s.d.	6·2	7·6	p <0·01

Table 6 *Distribution of immature errors of articulation*

Range	Controls	Residual speech retarded
0–5	65	24 (30%)
6–14	26	40 (50%)
15+	9	16 (20%)

Sig. χ^2 = 21·9, 2 d.f., p <0·01

Table 7 *Principal component analysis—controls plus Residual Speech Retarded Group*

	Factor I variance 33·8% general	II 4·9% bipolar
Variable	*Weight*[a]	*Weight*
ITPA auditory association	0·82	0·26
ITPA grammatic closure	0·82	0·23
EPVT (vocabulary comprehension)	0·79	0·10
Bus story information	0·76	0·15
ITPA auditory closure	0·75	0·22
WISC vocabulary	0·75	0·25
WISC picture arrangement	0·72	−0·00
ITPA verbal expression	0·72	0·10
Schonell reading	0·72	0·23
Bus story sentence length	0·71	0·22
ITPA visual closure	0·67	−0·27
WISC information	0·66	0·19
Frostig spatial rel.	0·66	−0·36
figure ground	0·61	−0·38
ITPA auditory seq. memory	0·65	0·17
ITPA auditory reception	0·65	0·18
Harris DAM	0·59	−0·30
Integration auditory/visual	0·58	0·06
Bus story complex sentence	0·63	0·25
Skemp visual concepts	0·60	−0·12
WISC arithmetic	0·62	0·15
WISC object assembly	0·53	−0·44
WISC picture completion	0·45	−0·39
WISC block design	0·58	−0·37
Integration haptic/visual	0·21	−0·36
Purdue—manual dexterity	0·55	−0·35
ITPA sound blending	0·55	0·30
WISC similarities	0·41	0·26
Intepretation	General cognitive ability	Perceptual motor organization *vs* verbal ability

[a] For convenience only the highest weights have been included thereby reducing the number of variables from 44 to 28

Table 8 *Principal component analysis: group comparison*

	Controls (n = 100)		Residual speech retarded (n = 80)		*Significance*
	m	s.d.	m	s.d.	
Component I (general cognitive ability)	1·6271	3·175	−1·9751	3·7013	p <0·001
Component II (verbal ability *vs* perceptual-motor organization)	0·2154	1·362	−0·2681	1·587	p <0·02

Chapter 4

Table 9 *Psychiatric disorder rated by psychologist*

Severity	a = Controls	b = Residual Speech Retarded Group	c = pathological speech retarded group	*Significance* 5%	1%
Nil	92	58	1		
Some	9	21	3	a *vs* b	a *vs* c b *vs* c
Marked	0	3	14		
Other	1	2	0		

Table 10 *Psychological assessment—child's attitude*

Feature	*Degree*	a = Controls	b = RSRG	*Significance* 5%	1%
Level of confidence of child	high	89	55		
	moderate	12	26		a *vs* b
	poor	0	1		
Attention span of child	good	63	30		
	moderate	35	44		a *vs* b
	poor	1	8		

Table 11 *Cor*
guage

IQ and LQ
IQ and behavi
LQ and behav

n =

[a] p <0·05
[b] p <0·01
[c] p <0·001
LQ = Language
Behaviour = Ru
Traditionally, g
test but good b
with high IQs te
poor behaviour,

Table 11 *Correlation analyses—behaviour, intelligence and language*

	Controls	Residual Speech Retarded Group
IQ and LQ	0·74[c]	0·83[c]
IQ and behaviour	−0·30[b]	−0·26[a]
LQ and behaviour	−0·41[b]	−0·35[b]
n =	100	80

[a] $p < 0{\cdot}05$
[b] $p < 0{\cdot}01$
[c] $p < 0{\cdot}001$
LQ = Language quotient on ITPA;IQ = Verbal intelligence on WISC; Behaviour = Rutter 'B' Scale total score.
Traditionally, good intelligence is denoted by a high score on an IQ test but good behaviour is denoted by a low score. Hence if children with high IQs tend to have good behaviour and children with low IQs poor behaviour, then a negative correlation can be expected.

Table 12 *Comparison of means of controls and of the three subgroups of speech retarded children—cognition and language*

Measures		a = Controls (n = 100)	b = Early walkers (specific delay) (n = 24)	c = Int. walkers (intermediate group) (n = 31)	d = Late walkers (general delay) (n = 22)	*Significance* 5%	1%	0·1%
Cognitive								
Frostig (Vis. Percept.)	m	95·9	86·8	90·9	78·8	b *vs* d	c *vs* d	a *vs* d a *vs* b
DAM (Draw-a-Man)	m	96·4	94·9	92·6	87·3	c *vs* d	b *vs* d	a *vs* d
EPVT (Eng. Pic. Vocab)	m	94·0	84·6	82·4	76·5	—	b *vs* d a *vs* b	a *vs* d a *vs* c
Prudue (Manual Dex.)	m	8·6	8·5	8·1	7·6	b *vs* d a *vs* c	a *vs* d	—
Birch A/V integration	m	6·2	5·1	5·0	4·9	a *vs* d a *vs* c	—	—
Birch H/V integration	m	7·5	7·5	7·4	7·1	—	—	—
Skemp memory concepts	m	7·7	7·7	6·9	6·2	—	a *vs* d b *vs* d	a *vs* c
Skemp paired association	m	18·6	18·6	16·6	16·0	—	b *vs* d a *vs* c a *vs* d	—
Skemp visual concepts	m	23·5	22·9	22·0	20·7	b *vs* d	—	a *vs* c a *vs* d
Imitation of gestures[a]	m	30·9	32·7	34·6	35·9	—	—	a *vs* c a *vs* d
Full scale IQ (WISC)	m	96·3	91·2	88·5	83·3	a *vs* b b *vs* d	—	a *vs* c a *vs* d
Performance IQ	m	101·2	98·9	97·7	88·6	b *vs* d	—	a *vs* d
Verbal IQ	m	92·5	85·4	84·8	81·2	—	a *vs* b	a *vs* d a *vs* c
Reading quotient (Schonell)	m	93·9	82·5	81·0	76·2	—	a *vs* b	a *vs* c a *vs* d
Language quotient (ITPA)	m	91·3	84·1	82·2	76·2	—	a *vs* b	a *vs* c a *vs* d

							a *vs* d
Full scale IQ (WISC)	m	96·3	91·2	88·5	83·3	a *vs* b b *vs* d	— 	a *vs* c a *vs* d
Performance IQ	m	101·2	98·9	97·7	88·6	b *vs* d	—	a *vs* d
Verbal IQ	m	92·5	85·4	84·8	81·2	—	a *vs* b	a *vs* d a *vs* c
Reading quotient (Schonell)	m	93·9	82·5	81·0	76·2	—	a *vs* b	a *vs* c a *vs* d
Language quotient (ITPA)	m	91·3	84·1	82·2	76·2	—	a *vs* b	a *vs* c a *vs* d
Syntax								
Sentence complexity (global score)	m	36·7	33·7	33·8	30·9	—	a *vs* d	—
Frequency of use of different types of sentence complexity								
simple	m	4·15	5·41	5·32	4·77	a *vs* b a *vs* c	—	—
simple-plus	m	2·67	2·91	3·03	3·23	—	—	—
compound	m	1·58	1·29	1·52	1·41	—	—	—
complex	m	5·62	4·70	4·58	3·72	a *vs* c	a *vs* d	—
Information content	m	30·0	26·8	25·8	23·7	a *vs* b	a *vs* c	a *vs* d
Mean sentence length	m	13·2	11·4	11·4	10·7	—	a *vs* b	a *vs* c a *vs* d
Incomplete sentences[a]	m	0·4	0·8	0·9	1·1	—	a *vs* c a *vs* d	—
Speech								
Correct articulation	m	58·5	54·3	52·0	56·6	a *vs* b	—	a *vs* c
Immature errors[a]	m	4·9	9·8	10·5	7·6	a *vs* b	a *vs* c	—
WISC verbal/performance discrepancy (mean of P minus V IQ)		8·7	13·2	9·6	7·5	a *vs* b	—	—

[a] The lower the score the better the performance; the higher the score the poorer the performance. On all other variables the higher the score the better the performance.

Owing to volume of data the standard deviations have been excluded.

Table 13 *ITPA subtest scaled scores of normal controls, specific speech delayed, intermediate and general delayed groups*

	a = Controls (n = 101)	b = Specific speech delayed (n = 24)	c = Intermediate (n = 31)	d = General delayed (n = 22)	*Significance*		
					5%	1%	0·1%
Subtest	m	m	m	m			
Auditory reception	33·14	30·20	29·90	27·73	a *vs* c	—	a *vs* d
Visual reception	28·87	28·75	27·61	24·36	—	—	a *vs* d
Auditory association	33·80	28·33	26·87	25·55	—	a *vs* b	a *vs* c a *vs* d
Visual association	31·11	29·71	28·39	26·46	a *vs* c	a *vs* d	—
Verbal expression	36·94	34·79	34·07	32·73		a *vs* b	a *vs* c a *vs* d
Manual expression	32·80	31·71	31·07	29·27	a *vs* c	—	a *vs* d
Grammatic closure	36·80	29·42	29·35	25·77	—	—	a *vs* b a *vs* c a *vs* d
Visual closure	30·11	29·25	27·16	24·05	a *vs* c	—	a *vs* d
Auditory sequential memory	34·14	29·83	30·42	28·46	—	a *vs* b a *vs* c	a *vs* d
Visual sequential memory	33·80	31·83	31·26	29·10	a *vs* c	a *vs* d	—
Supplementary subtest							
Auditory closure	25·38	18·12	19·45	18·04	—	—	a *vs* b a *vs* c a *vs* d
Sound blending	47·14	43·70	44·03	43·41	—	—	a *vs* b a *vs* c a *vs* d

Table 14 *WISC subtest scaled scores of normal controls, specific speech delayed, intermediate and general delayed groups*

Subtest	a = Controls (n = 100)	b = Specific speech delayed (n = 24)	c = Intermediate (n = 31)	d = General delayed (n = 22)	*Significance* 5%	1%	0·1%
	m	m	m	m			
Information	8·65	6·54	7·29	6·36	—	a *vs* c	a *vs* b a *vs* d
Comprehension	7·19	6·96	6·42	6·04	—	a *vs* d	—
Arithmetic	10·22	9·67	9·10	8·14	b *vs* d a *vs* c	a *vs* d	—
Similarities	8·94	7·54	7·55	7·45	—	a *vs* b a *vs* c a *vs* d	
Vocabulary	9·05	7·50	7·58	7·18	—	—	a *vs* b a *vs* c a *vs* d
Picture completion	10·80	11·75	9·87	9·86	b *vs* d	—	—
Picture arrangement	9·37	8·33	8·29	7·45	a *vs* b a *vs* c	—	a *vs* d
Block design	10·50	10·00	9·39	8·50	b *vs* d a *vs* c	a *vs* d	—
Object assembly	10·33	9·54	9·58	9·04	—	—	—
Coding	9·79	9·17	9·10	6·95	b *vs* d	—	a *vs* d

Chapter 6

Table 15 *Correlation matrix—data included in first principal component analysis*

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1 Social class												
2 Sex	00											
3 EPVT	−29[b]	34[b]										
4 A–V integration	−30[b]	−02	33[b]									
5 Communication code	35[b]	−02	−42[b]	−42[b]								
6 Right/left differences	09	03	−19	−20	13							
7 Imitation of gestures	07	07	−25[a]	−20	32[b]	20						
8 Immature errors of articulation	15	16	−05	−14	18	−03	11					
9 Hearing impairment	25[a]	−26[a]	−26[a]	−15	14	12	−03	03				
10 Scatter WISC	−16	21	32[b]	23[a]	−22[a]	−16	−20	−16	−06			
11 Scatter ITPA	−12	−13	−17	00	−14	−07	00	−02	17	09		
12 General milestone delay	00	−01	−27[b]	−07	09	32[b]	19	02	−04	−20	16	
13 Language literacy index mother	24[a]	11	−08	−23[a]	08	−03	−18	28[b]	06	20	08	07

[a] Significant at 5% [b] Significant at 1%
Error scores—variables 1,5,6,7,8,9 (10,11), 12,13.
Positive scores—variables 2,3,4,10,11.

Chapter 7

Table 16 *Principal component analysis—A*

Variables	*Component I*	*Component II*
Verbal communication (child)	0·41	−0·16
Occupational social class (parent)	0·33	−0·29
Imitation of gestures (child)	0·28	0·13
Right/left differences (child)	0·25	0·15
Specific speech delay (child)	0·21	0·28
English Picture Vocabulary Test (EPVT) (child)	0·45	0·11
Auditory visual integration (child)	0·39	−0·21
WISC scatter (child)	0·30	0·34
Hearing (child)	0·22	0·01
ITPA scatter (child)	−0·02	−0·12
Language literacy index (mother)	0·08	−0·52
Good speech and articulation (of child)	0·09	−0·46
Sex (male) (child)	0·13	0·33
Variance	21%	13%

Table 17 *Principal component analysis—B*

Variables	*Component I*	*Component II*
1 Social class	0·11	−0·21
2 Language literacy of mother	0·03	−0·22
3 ITPA representation	0·28	−0·03
4 ITPA automatic	0·28	−0·05
5 WISC performance IQ	0·26	0·19
6 WISC verbal IQ	0·24	−0·05
7 EPVT	0·24	0·09
8 Frostig—visual perception	0·22	0·14
9 Skemp visual concepts	0·23	0·24
10 Harris Draw-a-Man Test (conceptual maturity)	0·20	0·20
11 Imitation of gestures	0·15	0·08
12 Verbal communication code	0·22	−0·22
13 Sentence complexity	−0·22	−0·24
14 Sum of spoken words	0·24	0·28
15 Mean sentence length	0·25	−0·25
16 Renfrew Bus Story content score	−0·26	−0·05
17 Little evidence of use of incomplete sentences	0·09	−0·35
18 Good speech articulation of child	0·07	−0·27
19 WISC scatter	0·12	0·28

(*cont.*)

[a] Significant at 5% [b] Significant at 1%
Error scores—variables 1,5,6,7,8,9 (10,11), 12,13.
Positive scores—variables 2,3,4,10,11.

Table 17 (*cont.*)

Variables	*Component I*	*Component II*
20 Cross commands (right/left differentation)	0·13	0·23
21 Simple commands (right/left differentiation)	0·10	0·28
22 Specific speech delay	0·09	0·29
Variance	37·6%	8·8%

Only variables with a loading of 0·09 or more on the first or second component have been included. Sum of spoken words does not necessarily reflect verbal facility or quality of language.

Chapter 8

Table 18 *Family and social data*

Features	A = Normal hearing	B = Partially hearing	C = Profoundly deaf	*Significance* A *vs* B	A *vs* C	B *vs* C
Adverse social risk scale (mean score)	1·19	1·28	0·72	NS	1%	5%
Father—satisfactory breadwinner	70%	89%	90%	1%	NS	NS
Family regularly obtained magazine	39%	75%	75%	1%	1%	NS
Father belongs to library	32%	63%	43%	1%	NS	5%
Mother belongs to library	43%	47%	38%	NS	NS	NS
Child belongs to library	53%	58%	25%	NS	1%	2%
Child regularly reads books	61%	68%	22%	NS	1%	1%
Child reads comics	61%	63%	28%	NS	1%	1%
Mother reads to child	67%	83%	83%	NS	NS	NS
Father reads to child	64%	88%	96%	2%	1%	NS

Table 19 *Intra-family factors and deafness*

Feature		A = Controls	B = Partially hearing	C = Profoundly deaf	*Significance* A *vs* B	A *vs* C	B *vs* C
		%	%	%			
No disagreement on child rearing		66	84	94	NS	2%	NS
Joint parental decisions on health		23	53	55	1%	1%	NS
Joint parental decisions on finance		35	74	68	1%	1%	NS
Joint husband and wife leisure outings in previous months	0–1	51	11	12			
	2–5	32	53	62	1%	1%	NS
	6–9	17	36	26			
Leisure outing of wife alone in previous months	0–1	49	11	12			
	2–5	36	53	62	1%	1%	NS
	6–9	15	36	26			
Critical remarks by mother about child	none	18	50	42			
	few	42	16	45	2%	2%	NS
	some	28	16	6			
	many	11	16	6			
Positive remarks by mother about child	many	28	72	84			
	some	29	28	10	1%	1%	1%
	few	30	0	6			
	none	12	0	0			

Table 20 *Parent–child interactions*

					Significance		
		A = Controls	B = Partially	C = Profoundly			

Table 20 *Parent–child interactions*

Feature		A = Control	B = Partially hearing	C = Profoundly deaf	*Significance* A *vs* B	A *vs* C	B *vs* C
		%	%	%			
Mother–child communication: regular and daily		88	63	50	2%	1%	NS
Father–child communication: regular and daily		64	50	27	1%	NS	NS
Confiding in parents: usually		62	42	50	5%[a]	5%[a]	NS[a]
Discipline mainly administered by: mother		35	68	71	5%	1%	NS
father or jointly		65	32	29			
Prohibition score	0–5	45	25	21	5%	5%	NS
	6–9	55	75	79	almost		
Mothers perception of importance of speech (as needing to be corrected)		65	78	87	NS	2%	NS
Avoidance of baby talk by mother		60	83	34	NS	2%	1%
Expectations (a) Shopping		50	42	25	NS	1%	NS
(b) Usually tidies toys		54	16	22	1%	1%	NS

[a] Based on a 2 × 3 chi-square test

Table 21 *Rankings of mean scores—ITPA*

	Controls		Specific delay		General delay		Partially hearing		Profoundly deaf	
	m[a]	r[b]	m	r	m	r	m	r	m	r
Visual reception	28·9	1	28·7	2	24·3	4	25·8	3	22·9	5
Visual association	31·1	1	29·7	2	26·5	4	29·2	3	26·0	5
Manual expression	32·8	2	31·6	4	29·2	5	31·8	3	34·5	1
Visual closure	30·1	2	29·2	3	24·1	5	30·7	1	24·7	4
Visual seq. memory	33·8	1	31·8	3	29·1	5	32·1	2	29·3	4
Sum of ranks		7		14		23		12		19
Rank of Index of handicap (See Table III, p. 160)	1		2		3		4		5	

[a] m= mean [b] r = rank
High rankings e.g. 1 or 2 = high achievements
Low rankings e.g. 4 or 5 = low achievements

Table 22 *Rankings of mean scores—WISC and other tests*

Table 22 *Rankings of mean scores—WISC and other tests*

	Controls		Specific delay		General delay		Partially hearing		Profoundly deaf	
	m[a]	r[b]	m	r	m	r	m	r	m	r
Picture completion	10·8	2	11·7	1	9·9	4	10·0	3	9·3	5
Picture arrangement	9·4	2	8·3	3	7·5	4	9·6	1	7·1	5
Block design	10·5	1	10	3	8·5	5	10·1	2	9·2	4
Object assembly	10·3	2	9·5	4	9	5	10·8	1	10·1	3
Coding	9·8	2	9·1	4	6·9	5	10·8	1	9·7	3
Sum of ranks		9		15		23		8		20
Frostig	95·9	1	86·8	2	78·8	5	83·4	3	81·9	4
Draw-a-Man	96·4	1	94·9	2	87·3	5	91·4	3	88	4
WISC performance scale	101·2	2	98·9	3	88·6	5	101·9	1	93·6	4
RQ	93·9	1	82·5	3	76·2	4	87·6	2	74·4	5
Sum of ranks		5		10		19		9		17
Rank of Index of handicap (See Table III, p. 160)		1		2		3		4		5

[a] m = mean [b] r = rank

Table 23 *WISC verbal scale subtest scores of control, residual speech retarded and partially hearing children*

Tests		*Groups*			*Significance*	
WISC		A = Controls	B = Residual speech retarded	C = Partially hearing	A *vs* C	B *vs* C
Information	m	8·7	6·9	6·2	1%	NS
	s.d.	2·2	2·2	2·4		
Comprehension	m	7·2	6·6	5·1	1%	1%
	s.d.	1·9	1·9	2·8		
Arithmetic	m	10·2	9·1	8·2	1%	NS
	s.d.	2·8	2·3	2·4		
Similarities	m	8·9	7·5	5·4	1%	1%
	s.d.	2·3	2·2	2·7		
Vocabulary	m	9·1	7·5	6·5	1%	NS
	s.d.	1·9	1·7	2·5		
Verbal IQ	m	92·5	84·3	76·7	1%	1%
	s.d.	9·9	9·2	13·8		

Table 24 *ITPA verbal subtest scores of controls, residual speech retarded and partially hearing children*

Tests		*Groups*			*Significance*	
ITPA		A = Controls	B = Residual speech retarded	C = Partially hearing	A *vs* C	B *vs* C
Auditory reception	m	33·1	29·2	18·6	1%	1%
	s.d.	6·8	6·1	6·6		
Auditory association	m	33·8	27·2	19·4	1%	1%
	s.d.	7·5	7·5	9·7		
Verbal expression	m	36·9	33·9	30·4	1%	1%
	s.d.	3·2	3·37	3·3		
Grammatic closure	m	36·8	28·7	16·0	1%	1%
	s.d.	7·6	7·7	14·5		
Auditory seq. memory	m	34·1	29·9	28·6	1%	NS
	s.d.	5·9	5·2	4·8		

Table 25 *Cognitive style data of hearing-impaired, residual speech retarded and normal control groups. Based on principal component analysis*

Measures	A = Controls (n = 100)		B = Residual speech retarded (n = 80)		C = Deaf (n = 54)		*Significance*	
	m[b]	s.d.	m[b]	s.d.	m[b]	s.d.	C *vs* A	B *vs* C
Component I (a) 'Mental ability'	1·129	2·073	−0·701	2·617	−1·044	1·150	[a]	NS
Component II (b) 'Motor ability' *vs* 'Visual-symbolic' ability	0·281	1·091	0·047	0·938	−0·594	1·048	[a]	[a]

[a] statistically significant at the 0·001 level
[b] mean component score

Appendix 2
Description of test materials

First round assessment (first year)

1 *English Picture Vocabulary Test (i)* (Brimer and Dunn, 1962)
This is a test of vocabulary comprehension designed for children between the ages of five years and eight years, eleven months. The test comprises a series of pictures which are arranged in order of increasing difficulty and the child's task is to identify (usually by pointing) one of a choice of four pictures which has been named by the examiner.

2 *Purdue Pegboard* (Tiffin, 1968)
Although this test has not been standardized for children, its authors assert that it is sufficiently simple and straightforward for use with children. It is designed to measure manual dexterity, a function which, they believe, is largely independent of educational level (Rapin *et al.*, 1967).

3 *Frostig Developmental Test of Visual Perception* (Frostig, 1966)
This is a test designed for the assessment of children's visual perception. Each child is provided with a Frostig booklet and a pencil; his task is to complete five different operationally defined perceptual tasks according to the instruction conveyed by the examiner. In the case of the deaf, instructions are mimed.

The five operationally defined subtests are as follows:

(i) *Eye motor co-ordination*–the child has to draw continuous straight, curved or angled lines between boundaries of various width, or from point to point with guide lines.

(ii) *Figure ground*–This involves shifts in perception of figures against increasingly complex grounds; the child is required to discern figures which intersect with other figures by outlining them with coloured pencils.

(iii) *Constancy of shape*—the child has to recognize certain geometric figures (circles, squares, etc.) presented in a variety of sizes, shadings, textures and positions in space, and to discriminate these from similar geometric figures, by outlining the appropriate figures with coloured pencils.

(iv) *Position in space*—the child has to identify an identical object from a set of five orientated differently.

(v) *Spatial relationships*—this involves simple forms and patterns which the child has to copy from a model alongside the page, by using a choice of dots to guide him.

A perceptual quotient score is derived from the total of the scaled scores of the five subtests.

4 *The Illinois Test of Psycholinguistic Abilities: Revised Edition* (Kirk *et al.*, 1968)

The ITPA comprises 12 subtests, each of which allegedly taps a different aspect of language behaviour (Paraskevopoulos and Kirk, 1969; Hare *et al.*, 1973; Newcomer *et al.*, 1974). It has been found to be a useful diagnostic instrument for children with learning difficulties and language handicaps (Olson, 1961; Bateman, 1965; Gerber and Hertel, 1969; Kirk and Kirk, 1971; Marinosson, 1974).

Although the ITPA has been standardized on an American population it has, like the Wechsler Intelligence Scale for Children, been found to be appropriate for use on an English population (Phillips, 1968; Mittler, 1969; Mittler and Ward, 1970; Marinosson, 1974). Mittler (1968) considers the ITPA to be one of the most promising instruments for the assessment of language that has appeared for some time. Elsewhere he points out that there is wide agreement that the test has considerable value for individual clinical investigation (Mittler and Ward, 1970).

The 12 subtests of the revised edition are, in brief:

(i) *Auditory reception*—ability of a child to understand simple questions requiring a yes/no answer.

e.g. 'Do cats bark?', 'Do babies cry?'

(ii) *Visual reception*—ability of a child to comprehend and recognize the nature of one picture in relation to four other pictures, one of which is similar to that of the stimulus picture. For example, 'See this' (picture of a shoe) 'find one here.'

(iii) *Auditory vocal association*—ability of a child to relate concepts presented orally. This is a type of analogies test, which requires the child to complete the analogy verbally. For example, 'Bread is to eat, milk is to . . .' 'John is a boy, Mary is a . . .'

(iv) *Visual motor association*—ability of a child to comprehend the relationship between visually presented symbols; a kind of visual analogy. For example, the examiner, pointing to four optional picture

items (for instance, a knife, a nail, a needle and a screw) briefly in turn, asks the child 'which one of . . . these goes with this one?' (pointing to a picture of a hammer).

(v) *Verbal expression*—ability of a child to express ideas in words. The child is shown various familiar objects (a ball, a wooden block, an envelope and a button) one at a time, and he is asked to tell 'all about' the object.

(vi) *Manual expression*—ability of a child to express ideas by means of manual gesture and pantomime. For example, pictures of common objects (telephone, camera, etc.) are shown one at a time, whereupon the child is instructed to indicate by appropriate gesture and action his knowledge of each object.

(vii) *Grammatic closure*—ability of a child to deal with various grammatical structures concerning comparatives, prepositions, plurals, superlatives and tenses, in relation to pictures portraying the content of certain verbal expressions. For example, 'Here is a *dog*, there are two . . .' 'This boy is *opening* the gate. Here the gate has been . . .' 'This cat is . . .' (*on* the chair).

(viii) *Visual closure*—ability of a child to seek out and identify an incomplete picture item embedded among various other items. For example, the child is shown the picture of a fish and then is asked to find as many fish as possible, in an underwater scene depicting tropical plants and fish variously scattered around.

(ix) *Auditory sequential memory*—ability of a child to reproduce from short-term memory sequences of digits; this is a forward digit repetition test involving digits ranging from 2 to 8 in length, e.g. '7–9'; '8–2–9–3'.

(x) *Visual sequential memory*—ability of a child to reproduce from short-term memory sequence of nonmeaningful geometric figures presented in visual form.

Supplementary test

(xi) *Auditory closure*—ability of a child to hear and fill in a missing part of a word and then to produce that word in complete form. The incomplete word is spoken by the examiner while the child listens and then tries to reproduce the word complete with its missing part. For example, 'airpla/(airplane)'; 'tele/one (telephone)'.

(xii) *Sound blending*—ability of a child to synthesize the separate parts of a complete word articulated by the examiner. For example, 'c – u – p', following which the child should say *'cup'*; 'b – a – b – i – e – s = babies', etc.

Scoring

The scoring of the ITPA makes provision for raw scores, scaled scores, a psycholinguistic age and a psycholinguistic quotient.

Modifications to wording of certain subtest items

In keeping with Phillips (1968) and Mittler and Ward (1970), one of the present authors (T. F. in collaboration with senior colleagues in the Nuffield Department) has made appropriate changes to the few 'Americanisms' scattered among the various subtests, because such 'Americanisms' were considered to be unfamiliar to our population of children. Changes include the following:

On Auditory reception:		
Item 16	for hatchet	read hammer
	for chop	read bang
Item 30	for barometer	read thermometer
Item 45	for beverages	read liquids
On Auditory closure:		
Item 12	for turtle	read tortoise
Item 13	for pound	read bang
Item 21	for pickle	read sausage
Item 29	for pants	read trousers
On Grammatic closure:		
Item 13	for cookies	read cakes
On Auditory closure:		
Item 11	for / aseball (baseball)	
	read / ootball (football)	
Item 16	for auto / o / ile (automobile)	
	read mo / or / ar (motorcar)	
Item 21	for / an / a / aus (Santa Claus)	
	read Fa / er Chris / ma / (Father Christmas)	
Item 28	for / andy / ar (candy bar)	
	read cho / o / ate / ar (chocolate bar)	

5 *Draw-a-Man Test* (Harris, 1963)
This is considered to be a useful additional measure of children's cognitive functioning and more specifically, their conceptual maturity. Each child is provided with a foolscap sheet of paper and pencil and instructed to draw a man. On completion of the drawing, the child is given a second sheet of paper with the instruction to draw a woman. The average score from the two drawings is used as this is considered to be a more reliable estimate of the child's performance than reliance on any one of the drawings alone. Emphasis of assessment is placed on *graphic* considerations such as, for example, dimensional representation, proportion and perspective, body parts, clothing, etc., as opposed to artistic merit.

6 *Test of Intersensory Performance* (adapted from Birch and Belmont, 1964; Kahn and Birch, 1968)
This is a test designed to provide some index of the child's ability to integrate sensation from different sensory modalities as shown by his ability to perform tasks emphasizing visual, auditory and tactile responses. It has not been standardized on a representative sample and is without norms; nevertheless it is useful for comparing groups of children of similar age.

In the present study the measurement of intersensory behaviour is based on three interrelated tasks as follows:

(i) *Auditory-visual integration test* The child has to identify a visual dot-pattern that corresponds to the patterning of a rhythmic auditory stimulus. In other words, the child is required to translate an auditory stimulus to a visual response.

(ii) *Haptic-visual integration test* The child has to identify by feel the shapes of different geometric designs which are made of wood and to indicate his response by pointing to a visual equivalent. In other words, the task involves translation of a tactile stimulus into a visual response.

(iii) *Haptic-visual size discrimination test* The child has to discriminate between different-sized objects of the same shape by feel and then to match them by pointing to a replica which is arranged among others of varying size alongside the subject. In other words, he has to translate a tactile stimulus into a visual response.

7 *Measurement of Expressive Verbal Grammatical and Syntactical Ability of Renfrew's Bus Story* (Renfrew, 1971)
Renfrew's Bus Story constitutes a useful stimulus for eliciting a sample of the child's verbal language ability and also his sentence complexity and use of grammatical syntax. Each child's Bus Story was recorded on a tape recorder and then transcribed verbatim on paper for analysis and scoring. To save space only a brief description of scoring is reported here. Full details are available from T.F.

(A) *Number of incomplete sentences.*

(B) *Sentence complexity*—this involved an analysis of complete sentences according to their structural or grammatical complexity. Four types of sentence were classified as follows:

(i) *Simple sentences*
That is a sentence without a phrase, or with a phrase used as adjective or adverb in apposition, for example 'The bus ran quickly'.
A simple sentence is assigned a score of 1

(ii) *Simple-plus sentence*
That is a simple sentence with:

(a) two or more phrases, or
(b) a compound subject or predicate with a phrase or predicate and phrase, for example, 'The bus raced down the hill with the driver of the bus'.

A simple-plus sentence is assigned a score of 2

(iii) *Compound sentence*

That is any sentence containing two independent clauses usually joined by a co-ordinating conjunction, 'and', 'but', etc. For example, 'He fell in the pond with a splash and stuck in the mud'.

A compound sentence is assigned a score of 3

(iv) *Complex and/or elaborate compound sentence*

A complex sentence is one which contains one main clause and one or more dependent clauses with:

(a) Noun clause used as: subject, object, in apposition, as predicate nominative, or as objective complement.
(b) Adjective clause.
(c) Adverbial clauses of: time, place, manner comparison, condition concession, cause, purpose, result.
(d) Infinitives.

An elaborate sentence is one which includes more than two independent clauses, or subordinate clauses or phrases. For example, 'When his driver found where he was, he telephoned for a crane to pull him out and asked it to put it back on the road again.'

Either of these sentences is assigned a score of 4

To derive an overall *sentence complexity score* for each child, the number (frequency) of each type of sentence is multiplied by the score for that sentence and the products of these are added together: for example,

3 simple sentences	$= 3 \times 1 =$	3
2 simple-plus sentences	$= 2 \times 2 =$	4
1 compound sentence	$= 1 \times 3 =$	3
3 complex sentences	$= 3 \times 4 =$	12
		22

e.g. Sentence complexity score = 22

(C) *Mean sentence length*

The use of the 'mean length response' index, based on the mean number of words per sentence, is acknowledged by many (Renfrew, 1971; Miner, 1969; Barlow and Miner, 1969, Milgram *et al.*, 1971) to be a relatively satisfactory language performance measurement

technique. According to McCarthy (1954) it represents 'a reliable, easily determined, objective, quantitative and easily understood measure of linguistic maturity'.

For the present study the number of words in the five longest sentences of each child's Bus Story constitutes the mean length response index. This is derived from the number of words in the five longest sentences divided by five. For example, number of words in the five longest sentences = 60/5 = 12. Therefore, mean sentence length = 12.

(D) *Information content of Bus Story*

Each child's Bus Story was scored for its 'factual' information in relation to the original version according to the scoring guidelines of Renfrew. Renfrew provides two groups of 'most common responses'; those which comprise the *main* items and those which comprise the *subsidiary* items. The main items comprise 21 features, each of which scores 2 points (or 1 point for half correct). The subsidiary items comprise 13 features and there is a score of 1 point allowed for each of the items which are remembered in context.

8 *Verbal Communication Code of the Child as Reflected in his Bus Story*

The purpose here is to evaluate the verbal communication code or style of each child. The source of material is Renfrew's Bus Story. Each child's version of the story has been tape-recorded and then transcribed on paper verbatim for analysis and scoring. To save space, details of scoring have been omitted, but they are available from T.F. The rules for evaluating the child's communication code are adapted from Bernstein (1961, 1962). He postulates two main codes of communication—the 'restricted' and the 'elaborated', each of which is distinguished according to use of grammar and syntax, organization of ideas and expression of statements.

Communication code/style is rated along a five-point scale as follows:

highly restricted	restricted	moderate	elaborate	highly elaborated
5	4	3	2	1

(The person who rated each child's Bus Story for his communication code was not connected with the research and was acting independently. As such the rating was a 'blind' exercise thus minimizing effects of bias.)

9 *Children's Behaviour Questionnaire: Child Scale 'B' Form* (Rutter, 1967)

This questionnaire has been standardized on a population of English children of both sexes, aged between seven and 13 years. It is described in detail by the authors (Rutter, 1967, Rutter *et al.*, 1970) and has been used extensively in research. The authors report satisfactory levels of reliability.

Second round assessment (second year)

1 *Skemp Visual Concepts Test* (Skemp, 1967)
This test was devised by Dr Richard Skemp and was intended as the first stage of a test battery which ultimately was aimed at including measurement of various cognitive operations in three separate modalities—visual, auditory and haptic. The test used in this study concerns the visual modality and is designed to assess memory, paired association and concept-formation by tests involving memory cards, paired associates and visual concepts, according to the principle of 'learning-to-learn'.

Although Dr Skemp kindly made available the use of his Visual Concepts Test, unfortunately it has not yet been published. However, some relevant data regarding its construction are provided.

The test has been standardized on a normal sample of young English school children of both sexes, controlled for social class according to father's occupation. This has been done by Dr Skemp in co-operation with other English psychologists for the following age groups and sample sizes of children:

120	5-year-olds
112	5½-year-olds
131	6-year-olds
136	6½-year-olds
139	7-year-olds
Total 638	

Tables of norms are provided for each of the three tests—memory cards, paired associates and visual concepts—and for a total score which is calculated in terms of *raw* scores. However, because the mean age of the children in our study was about 7½ years at the time of doing Skemp's Test, his normative data have not been appropriate. As the children tested were of similar age, and because our study was mainly comparative, the norms are fortunately not necessary.

2 *Schonell Graded Word Reading Test* (Schonell and Schonell, 1960)
This test comprises a representative sample of words of increasing difficulty with the aim of providing an index of a child's reading attainment. The more fundamental aspects of reading, such as word recognition and the look-and-say approach, are assessed.

3 *Lateral Dominance Test* (Harris, 1958)
Each child was tested for hand and eye dominance on the basis of the procedures outlined by Harris.

4 *Right–Left Differentiation* (Harris, 1958; Benton, 1968)
According to Alexander (1965) the complex process of right–left differentiation develops over a number of years and is marked by three stages. The first stage, evident between roughly five and nine years of age, sees the acquisition of the child's ability to discriminate right and left with reference to his own body. The second stage, which occurs between eight and 11 years of age, witnesses the child's ability to differentiate right from left on a person facing himself. The third stage, from about 11 years of age, onwards, represents a gradual expansion of right–left directional sense in relation both to objects and to space.

It is the 'first-stage' of right–left differentiation ability with which the present study is concerned—that is, the child's ability to differentiate between right and left relative to his own body.

Each child is required to differentiate first, right from left in relation to *one side* of his body, and second, in relation to *opposite sides,* as follows:

(i) The child is asked:
'Show me your *right* hand'
'Show me your *left* ear'
'Show me your *right* eye'
(ii) The child is asked:
'Show me your *right* ear with your *left* hand'
'Show me your *left* ear with your *right* hand'
'Show me your *right* eye with your *left* hand'

Scoring for the two sets of instructions is the same. Thus a correct set of responses is rated O. An incorrect or confused set of responses is rated 1.

Note: As the nature of this test is highly loaded on verbal instructions, it was not possible to evaluate the deaf children on right-left discrimination.

5 *Imitation of Gestures* (Berges and Lezine, 1965)
The 'Imitation of Gestures' test devised by Berges and Lezine (1965) is an interesting non-verbal, non-symbolic test; it is described as being concerned with the 'proprioceptive and kinesthetic components (muscle and joint sense) which give us information about our body schema' and which form an important part of the child's sensori-motor organization relative to space.

The material used in the present study is adapted from Berges and Lezine's gestures intended for children aged between six and ten years.

It comprises 20 various hand finger movements and entails the examiner manipulating, with his own hands and fingers, the model gesture to be imitated by the child who is then scored for accuracy of the model.

6 *Wechsler Intelligence Scale for Children* (Wechsler, 1949)
Owing to the fact that the WISC is such a well-known and widely used test in research and clinical fields alike, no attempt is made at describing it in any detail. Suffice it to say that 'the theory underlying the WISC is that intelligence cannot be separated from the rest of the personality, and a deliberate attempt has been made to take into account the other factors which contribute to the total effective intelligence of the individual' (Wechsler, 1949).

The composition of the test facilitates assessment of both verbal IQ and performance IQ separately, and a full scale IQ. To arrive at each of these scores a child is given various subtests subsumed under the verbal scale and performance scale, as follows:

verbal scale:	Information
	Comprehension
	Arithmetic
	Similarities
	Vocabulary
performance scale:	Picture completion
	Picture arrangement
	Block design
	Object assembly
	Coding

The two supplementary tests, namely Digit Span and Mazes were not used in the present study.

From the ten subtests outlined above, verbal, performance and full scale IQs were computed in accordance with the scoring procedures laid down by Wechsler. For the majority of deaf children, only the performance scale could be used, in which case instructions were mimed.

The population mean IQ is 100 with a standard deviation of 15.

7 *Junior Eysenck Personality Inventory* (Eysenck, 1965)
This scale is designed to measure the two major personality variables of neuroticism/stability and extraversion/introversion in children. It is adapted from the well-known adult versions, namely the Maudsley Personality Inventory (Eysenck, 1959) and Eysenck Personality Inventory (Eysenck and Eysenck, 1964) and has been standardized on a large population of British school children.

The JEPI comprises 60 questions—to be answered either Yes or No—for example:

'Do you often need kind friends to cheer you up?'
'Do you sometimes get cross?'
'Do you like going out a lot?'

Of these 60 questions, 24 assess extraversion, 24 assess neuroticism, and 12 constitute the lie scale which is meant to accommodate for conscious attempts at faking. It has been constructed for the age range 7–16 years.

No great claims are made for the validity of the test though it would nevertheless seem to have some potential. Eysenck reports, for example, that its administration to a population of children attending a child guidance clinic revealed that 'the group as a whole was very significantly above the standardization group with respect to neuroticism, and that there was a significant difference with respect to extraversion between children showing extraverted symptoms and those showing introverted symptoms'. Although the test is intended to be self-administered, the method adopted by the examiner was to read the statements to the child and record his response. This was in order to minimize difficulties associated with poor reading ability and to ensure reliable and efficient completion of the test by the child.

8 *The Edinburgh Articulation Test* (Anthony *et al.*, 1971)
The test of the children's articulation was administered and assessed by Mrs E. Scanlon, Principal Speech Therapist, Fleming Memorial Hospital for Sick Children. Briefly, in this test the child has to name various picture-objects; his ability to do this is scored on the basis of his consonant and consonant clusters used as appropriate to describe the various objects. Although this test has been standardized on younger children with norms directed at the age levels 3–5·75 years, it is nevertheless a suitable instrument for older children. As the children in the present study were matched for age, and because this is a comparative study, the fact that reliance has had to be put on raw scores rather than on the age-corrected scores of the norms does not affect our study.

Each child was scored for:

(i) Total number of correct responses which can range from 0 to 63.
(ii) Number of immature errors: this is analysed using a modification of Anthony's (1971) qualitative assessment system. Each immature response is given a score of 1, so that the higher the score the greater the number of immature errors.

9 *Educational Achievement Questionnaire*
This is a crude questionnaire devised by one of the editors (T.F.). Its aim was to obtain simple information concerning the child's educational attainment on the basis of the teacher's report. The teachers were not aware of whether the child was a control or study subject and therefore the effects of bias were minimized.