The association of auditory high frequency weakness with verbal and written comprehension and expression

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THE ASSOCIATION OF AUDITORY HIGH FREQUENCY WEAKNESS WITH VERBAL AND WRITTEN COMPREHENSION AND EXPRESSION

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"The effects of auditory high-frequency weakness on verbal and written comprehension and expression".

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Clinical observation prompted the hypothesis that failure of response to high frequency tones outside the speech range is associated with linguistic impairment. Pure tone audiometric assessment of school children was carried out, special equipment being used to ascertain normal upper limits of hearing. In a representative sample of 209 children the mean upper limits in age groups 7 to 12 were about 18,000 cycles per second, but a significant lowering of limit with age was then apparent, the mean at age 15 being just above 16,000 c.p.s. Further surveys of maladjusted children, retarded readers and educationally subnormal children demonstrated that high frequency auditory acuity is positively associated with intelligence and with introversion.

From 484 children tested 20 cases of relative high frequency weakness (HFW) were selected. The group included 9 boys and 11 girls aged 8 to 13, with a wide range of intelligence. These children were individually tested with a battery of eight measures of linguistic development. They proved to be grossly retarded and inferior to 20 matched controls. The most significant group differences were in speech articulation, vocabulary and oral language development. Paucity of ideas, looseness of expression, limited verbal comprehension and general linguistic retardation were also reflected in written composition and tests of sentence structure and reading comprehension. Only in mechanical word recognition was the HFW group's inferiority not statistically significant. The school histories of these HFW children were characterized by retardation or impairment in speech, language, academic attainment and behaviour.

It is suggested that HFW is not merely a sensory impairment and may more profitably be regarded as an intervening variable. Attention is drawn to psychological aspects of pure tone audiometry, and discussion is in terms of "vigilance", "set", response consistency and extraversion. In addition to their theoretical implications the findings would appear to be of immediate clinical and educational significance.

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I. INTRODUCTION

The present study is the outcome of a clinical observation. The writer was struck by certain similarities (in behaviour, learning difficulties and personality type) between four boys who received remedial tuition from him at a child guidance clinic. Case studies and diagnostic testing confirmed a common pattern of temperament traits, specific problems in communication and learning, school adjustment and behaviour.

These boys, differing in age and intellectual level, were all grossly retarded in reading and writing. Teachers and parents reported that they seemed lackadaisical and apathetic but would occasionally exhibit restlessness, hyper-activity or aggression for apparently insufficient cause. Although generally amenable to discipline they were capable of stubbornness and defiance in response to mild rebuke. In addition, teachers reported that the boys not only had periods of abstraction or "vagueness" but often seemed to misunderstand simple instructions or questions, sometimes giving replies that were irrelevant or ludicrous.

Clinical tests substantiated these reports, indicating in all four cases restricted verbal expression with mild hysteric traits, low persistence levels, low frustration thresholds, poor motivation and pronounced feelings of inferiority in social and learning situations.

So far the picture might be that of many retarded children. But two other characteristics high-lighted this group of boys. Firstly,

they all suffered, or had suffered from defects of articulation. Secondly, their language development was relatively very immature.

Further tests revealed that they were all more than usually dependent upon visual cues for their understanding of speech. It was found that their misinterpretations of questions or commands occurred most consistently when the speaker's lips were masked or when they were not observing his face. This immediately suggested the possibility that the boys were hard of hearing. In the case of one boy this had been suggested earlier and he had been medically examined. Now all four were referred to the school health service for full audiometric and otolaryngological examination. But all four were classified without hesitation by a distinguished E.N.T. consultant as being "of quite normal hearing".

At first sight the obvious hypothesis consistent with most of the facts had been rendered untenable. However, the medical files were accessible to the writer, and examination of the boys' audiograms disclosed an interesting common feature. Each one of them, though within normal limits inside the speech range, showed a distinct drop of up to 45 decibels at 8192 cycles per second (the highest frequency level tested on the commercial audiometer in use). A check of other audiograms from the same clinic, of children both with normal and defective hearing, indicated that the "tailing-off" shown by the four cases under consideration was not merely due to instrumental or operational error.

It was possible, therefore, that the original hypothesis need not be discarded. Although the four boys could not be regarded as conventionally deaf or even hard of hearing, some auditory impairment or perceptual anomaly was implied by their failure to respond to tones of very high frequency. And although their responses to tones within the speech range were in all cases within normal limits, this form of auditory limitation might be a factor contributing to, or concomitant with, their difficulties of learning and expression.

The purpose of this study is to examine the effects or concomitant features of this form of auditory limitation (which will henceforth be referred to as "High Frequency Weakness" or HFW) in language and associated fields of development. The study will not be concerned with the physiological or neurologial aspects of the condition, but a problem to be discussed is whether HFW reflects a physical limitation on the one hand or failure of perception on the other. The standpoint here is operational. The study represents an attempt to observe and classify the behaviour, in specified fields, of children demonstrating this particular limitation of auditory function.

No work of precisely this kind has been done (or, at least, reported) in this or any other English-speaking country. Nevertheless a very large number of researches in various disciplines are of relevance if the present work is to be related to the bulk of evidence regarding the audiological, linguistic and emotional development of children. The list of references to previous work shows that

incursions have been made into physics, audiology, language development, speech therapy, psychometrics, survey sampling, personality study and English grammar, quite apart from the conventional zones of educational psychology.

II. SURVEY OF PREVIOUS LITERATURE

A. AUDITION

1. The Measurement of Hearing

The traditional techniques for the clinical assessment of hearing ability involved the use of whispered speech, watch ticks, hand-clapping, bells and percussion instruments. Most aural specialists still rely upon some of these devices. The need for more precise and controlled methods was partially answered by modifications of the Galton whistle, by pitch pipes and matched tuning forks. But although these instruments enable the frequency of the auditory stimulus to be controlled they have no provision for the modification of intensity and their purity of tone is suspect. The first electrical audiometers, which enabled both these variables to be brought under control, were produced about 1920. They were developed until standards were set in 1938-9 by the American Standards Association, and since then have come into regular use for medical purposes.

The modern audiometer consists basically of an electronic variable audio-oscillator, an amplifier and an attenuator (or intensity control). Frequency of output is measured in cycles per second, and intensity in decibels. Although some instruments provide for continuous tone variability the majority by convention permit only the selection of tones in octave intervals - at 128, 256, 512, 1024, 2048, 4096 and 8192 cycles respectively (or in even steps - 125, 250 and so on up to 8000 cycles).

The attenuator control provides a direct measure of hearing loss, because for the convenience of the operator the zero reference level for each frequency step follows the threshold of the "normal" human ear. This varies according to the make of instrument, but many manufacturers seem to have adopted the American standards of "normal" hearing. These standard "norms" were established in 1936 by the Public Health Service in America, using 31 testers and 17 pure-tone audiometers to test 4,000 people of all ages from eight upwards in temporary clinics in twelve cities. All subjects showing a hearing loss of over 20 db at any of the eight frequencies used were then excluded, and the final norms were based on the results of only 1,242 people. The American National Bureau of Standards then interpreted the thresholds found in terms of sound pressure in an artificial ear, and issued standard pressures as follows:-

Frequency	Reference Pressure in db above 0.0002 dyne/cm^2
125	54.5
250	39.6
500	24.8
1,000	16.7
2,000	16.1
4,000	15.1
8,000	20.9

Standards were not established for frequencies above 8,000 cycles. Similar work is currently in progress at the National Physics Laboratory in this country.

The audiometer intensity control is usually graduated in 5db steps with a range from -10 (meaning 10db "better" than normal) to 100 db. of

loss. This maximum intensity is not provided at the extreme frequencies (128 and 8192 cycles) where the ear does not have such a wide range of response so that a tone of 100 db intensity might well cross the pain threshold.

Test tones are usually reproduced through headphones, so that each ear may be tested separately, and so that any extraneous noise is muffled to some extent.

An interruptor switch enables the operator to control tone duration and check the subject's responses. Masking tones and occasionally microphone speech circuits are provided in the more expensive instruments.

A number of audiometric techniques have been described, but the large majority are basically of the type known in psycho-physics as "the method of limits". The operator explains to the patient or subject that whenever he hears a tone he is to signal by raising his finger. When the tone disappears he is to lower the finger. Practice is then given at 1024 cycles at an intensity well above normal threshold. When the subject has signalled reception the operator cuts out the tone with the interruptor and lowers the intensity to well below the subject's estimated threshold, increasing it in ten db steps until the subject again signals. Intensity is then dropped by five db until the threshold is determined. The test

is then repeated at each frequency above 1024, then at 1024 again, and then at the lower frequencies. The whole procedure is repeated for the other ear. In each case the threshold is marked on the audiogram card and the readings joined to show a hearing loss profile. As with the audiometer itself, the card is printed with normal threshold reference points at the zero level for each test frequency, so that readings show hearing losses in direct relation to the normal reference, and not in absolute intensity.

(With very small children the above technique is enlivened by the introduction of interest-sustaining devices. The child may be allowed to drop marbles into a bowl instead of raising his finger, or a peep-show lights up whenever he signals appropriately. With or without such modifications the testing of young children is a task which requires experience and patience).

For screening or survey purposes a 'sweep' technique is usually employed. Here the operator sets the attenuator at a point just above normal threshold (usually at 10 db) and sweeps through the frequency range. Any subject failing at any point is then tested in full.

2. The Upper Limits of Human Auditory Ability and its Variation with Age

The pure tone of highest frequency which can be detected by a human subject is assumed by most authorities to be in the neighbourhood of 20,000 cycles per second. Others, such as Watson and Tolan (1949) state that few normal adults can detect auditory stimuli of more than 16,000 c.p.s. Stevens and Davis (1938), in what has become the standard work on hearing, do not make any explicit statement about the upper limit of the auditory frequency range, but imply in their graphs that it lies somewhere between 15,000 and 20,000 c.p.s. Like the majority of writers in this field they reproduce composite diagrams from the classic study by Sivian and White (1933) which demonstrate the threshold curves for different frequencies as established by various workers. But Sivian and White were concerned with establishing intensity thresholds under different conditions, not with establishing the range of ability or norms of response. They used only fourteen trained, young adults as observers, and tested them only up to 15,000 c.p.s. Charts and graphs based on their work very often extrapolate their threshold curves up to 20,000 c.p.s., but no empirically determined audiometric data applicable to the frequency range between 15,000 and 20,000 c.p.s. have been published. This omission may have been due to a number of difficulties, but paramount among them are the physical problems of instrumentation and the psychological ones of detection and response. The latter will be discussed at a later stage.

TABLE 1.

The upper limit of Hearing with Age, as determined by the use of the modified Edelmann Whistle. (From Bruner, 1908)

Ages	Number of Cases	White Males Right Ear Mean c.p.s.	Left Ear Mean c.p.s.	Number of Cases	White Females Right Ear Mean c.p.s	Left Ear Mean c.p.s.
5-8	18	17,590	17,463	23	17,267	17,105
9-12	17	17,250	17,370	15	17,430	17,541
13-16	31	17,103	16,946	23	17,335	17,356
17-20	24	16,051	15,773	16	16,495	16,424
21-24	26	16,534	15,679	22	16,738	16,857
25-28	19	15,417	15,740	34	15,524	16,029
29-32	22	15,552	15,880	9	16,370	16,084
33-36	10	14,658	15,002	7	14,050	14,080
37-40	15	12,071	13,249	12	12,576	13,627
41-44	6	12,658	13,542	6	15,374	16,517
45-48	11	13,717	13,947	9	13,659	13,785
49+	10	12,712	13,122	2	12,612	12,913

It is known that the upper limit of hearing diminishes with age, a phenomenon which is termed 'presbycusis.' Watson and Tolan (1949) state:-

> "Although few persons over 30 years of age can detect a tone of 16,000 cycles and many have no hearing above 10,000 or 12,000 cycles, some children and young adults can hear as high as 20,000 and even up to 25,000 cycles." (page 2.)

Modern writers do not usually give references to work which would support such statements; to find this, it is necessary to go back through the literature to the end of the last century. Galton (1883) seems to have been the first to demonstrate presbycusis experimentally, using a high frequency whistle of his own design:-

> "On testing different persons I found there was a remarkable falling off in the power of hearing high notes as age advanced. The persons themselves were quite unconscious of their deficiency so long as their sense of hearing low notes remained unimpaired." (page 38.)

Cuperius (1894), Alderton (1894, 1896), Myers (1903) and Bruner (1908) all reported supportive data, based on the use of modifications of the Galton whistle. Unfortunately, quite apart from practical weaknesses in the use of whistles (which will be mentioned later) it was impossible to calibrate the instruments at that time, and results were reported in terms of length of bore. Bruner's (1908) figures are the most comprehensive and comprehensible. They are presented here in Table 1, the "double vibrations" being expressed as cycles per second. It will be noted that the mean upper limit of hearing shows a regular drop from about the age of twelve, a finding in line with those of the writers mentioned above, although apparently never referred to in subsequent literature.

Modern surveys using pure tone audiometers have not in general used test frequencies beyond 8192 c.p.s. But their findings are reconcilable with those of the early workers inasmuch as they have demonstrated a progressive diminution of hearing acuity for the highest frequencies tested. Fletcher (1953) states:-

> "It is well known that the acuity of hearing decreases as one grows older particularly for the high frequencies. The loss below 1,000 cycles is usually less than 10 db. At 8,000 c.p.s., however, the losses due to age run from 10 db. at forty years to 40 db. at sixty years." (page 137.)

The first pure tone audiometrist to chart these losses with age was Bunch (1929, 1931). His findings were confirmed by the results of the mass surveys conducted by the Bell System Laboratories at the New York and San Francisco World's Fairs in 1939 (Steinberg, Montgomery and Gardner, 1940). At these exhibitions visitors were invited to test their own hearing. Attendants (who recorded their sex and guessed their decade of life) asked the visitors to allow their score charts to be photographed. About 80 per cent of subjects allowed this to be done. Evidently sampling, testing procedures and data recording could be only loosely controlled, but the vast numbers - about 550,000 - make the results of this survey important. At the lowest test frequency of 440 c.p.s., men in the 50 - 59 year age group showed a mean loss of only 6.8 db., and women 10.3 db., as compared with those in the 20 - 29 year age group. But at the highest test frequency of 7040 c.p.s. the older men showed a mean loss of 24.6 db., and the women one of 19.7 db. Similar results were obtained under very similar conditions from 3,666 people at the San Diego County Fair of 1948 by the U.S. Navy Electronics

Laboratories (Webster, Himes and Lichtenstein, 1950).

Subsequently Sataloff and Menduke (1957) reported data for subjects aged 64 to 91. They found very little additional loss after age 65 but considerable variations in the acuity of their oldest subjects. Hinchcliffe (1959) confirmed both these findings on a random sample of subjects in Dumfriesshire. There were significant sex differences at a number of frequencies in favour of the females. (This has been reported in several studies of presbycusis, and is attributed to adventitious acoustic trauma such as the effects of musketry). However, at 12,000 c.p.s., the highest test frequency used by Hinchcliffe, there was no difference between the sexes, as the median loss was more than 70 db., (the instrument's maximum output). This frequency was, in fact, beyond the upper limit of hearing for about a quarter of his subjects aged 55 to 64, and for about threequarters of his 65 to 74 age group. So that these findings are directly comparable with Bruner's, and very similar in trend.

Anecdotal evidence as to this decrease of upper auditory limit with age has long existed in plenty, and results of the phenomenon may be readily observed in everyday life. Galton referred to a Dorsetshire proverb that no agricultural labourer over forty could hear a bat squeak. As a matter of interest the writer lived at one time in a city area which was heavily infested with bats, and he conducted a spot check among neighbouring families as to whether they could hear the beasts squeaking. (The squeak is not to be confused with the super-sonic 'radar' sounds by which bats direct their flight. These are of frequencies

between 50,000 and 100,000 cycles, and possible more). He discovered that although most adults in the immediate vicinity had observed the bat colony swooping between the trees and clinging to the house eaves, none was aware of having heard them. Their children, on the other hand, regarded the squeaks as a commonplace occurrence.

In a delightful passage Galton describes a finding which children, unfortunately, often discover for themselves:-

> "It is an only too amusing experiment to test a party of persons of various ages, including some rather elderly and self-satisfied personages. They are indignant at being thought deficient in the power of hearing, yet the experiment quickly shows that they are absolutely deaf to shrill notes which the younger persons hear acutely, and they commonly betray much dislike to the discovery." (page 38.)

A not uncommon schoolboy sport is to take advantage of the diminished auditory acuity of elderly teachers. It is quite possible for children to communicate with each other without the knowledge of adults by whistling or hissing between their teeth. Middle-aged schoolmasters can often detect the whistles but be unable to locate the sound source, and older ones may be quite unaware of the sounds. Hansell, Scott and Goldney (1960) have suggested that during research into "extra-sensory perception" juvenile subjects may take advantage of the inability of the elderly investigators to hear high frequency tones. And it may well be that the trainers of performing animals, especially dogs, transmit some instructions by the use of whistles which produce sounds of frequencies above the human auditory range.

High frequency whistles can be very distracting and irritating for those who can hear them. One example which has intruded into contemporary society quite recently is the line output transformer

whistle transmitted by ordinary television sets, which is usually of about 10,000 cycles. Young people can find this quite exasperating, whereas their elders may be unable to detect it at all.

The acute hearing claimed for some primitive peoples and for legendary scouts and frontiersmen such as Davy Crocket was probably related to an unusually high frequency ability. But it is just as likely that such people train themselves to perceive and interpret auditory stimuli, just as native trackers do not necessarily have better eyesight than people from other cultures but know what to look for and how to interpret it. It may well be, as Watson and Tolan (1949) suggest:-

> "The evolutionary trend of hearing in civilized man to-day is probably towards less sensitivity, particularly in the higher frequency range, and greater tolerance for noise."

In general, civilized men learn to expect meaningful information to be carried in sounds within the speech range. Such learning involves a lack of 'set' for sounds in the higher frequencies, and less likelihood of response. That new expectancies may be learned and hierarchies of response habits readjusted is implied by the fact that in wartime people learn very rapidly to associate whistles at various high frequencies with the approach of missiles. Such information has direct survival value and a new pattern of response behaviour is rapidly acquired which supersedes older learned patterns. It may be possible, then, that as children mature and their ability to hear high frequency sounds diminished, that this is only in part a function of organic deterioration. Possibly they learn <u>not</u> to respond to such sounds but to favour those frequencies where the likelihood of information content is higher.

Whether this is so or not, it seems evident that the child's environment differs from that of the adult where sound is concerned. What to an elderly adult is a quiet and neutral environment may present a complex of stimuli, meaningful or meaningless, to the child. Whether this relatively high level of input facilitates or hinders the basic learning processes and the acquisition of skills can only be a hypothetical issue at this stage. But one of the objectives of this study is to investigate whether those children whose upper auditory range is limited, as is the adult's, are handicapped in the development of speech and language.

3. "High Tone Deafness"

The previous section was concerned with the upper limits of auditory acuity in normal, healthy people, and although presbycusis is due to atrophic changes in the inner ear these are regarded largely as one of the degenerative changes to be expected as part of the normal ageing process. Among patients suffering from auditory defects, on the other hand, audiologists have long discriminated cases of "high tone deafness". This is usually a "nerve" or "perceptive" loss of hearing, attributable to pathology of the sensory cells or nerve fibres in the inner ear or along the nerve pathway from the inner ear to the brain stem. An outstanding discussion of the pathology of high tone deafness is that of Crose, Guild and Polvogt (1934). In their pathological and clinical examination of 79 cases they were able to identify two general groups. One of these included abrupt high tone losses and showed areas of atrophy of the organ of Corti at the basal turn; the second had gradual high tone loss and the most prominent lesion was partial atrophy of the cochlear nerve supply in the basal turn. Many exceptions were found, however, and in some cases the hearing losses could not be explained in terms of cochlear pathology. Arteriosclerosis was discounted as a cause of the condition. (It appears not to have been clarified whether the pathology of high tone deafness can be distinguished from that of presbycusis).

The other basic type of auditory impairment is "conductive" or "transmission" deafness, terms which cover any disfunction of the outer

ear in cases where the inner ear is normal. In these cases the hearing loss is due to interference with the passage of sounds through to the analyzing system. The commonest causes are the blocking of the external meatus by accumulations of wax, or an inflammation or infection of the middle ear (otitis media). The effect is similar to that of wearing an ear plug; sufferers from conductive deafness retain their ability to discriminate and analyze sounds provided that they are loud enough for them to hear, as in shouted speech. The loss of sensitivity usually covers the whole frequency range at about the same level, but where infection leads to thickening of the ear-drum and the formation of permanent adhesions to the ossicles there is a loss of sensitivity for low frequencies and a retention of hearing for the higher tones.

Hearing loss of the "perceptive" type, on the other hand, tends to be uneven and the high tones are generally more affected than those up to 1,000 c.p.s. Because, as will be seen, many English consonants are characterized by high frequency and weak intensity, people with high tone deafness find it difficult to distinguish between them although they may be able to hear vowel sounds perfectly. For them, speech discrimination is difficult, whatever the overall level of intensity. Shouting does not help them, although they themselves tend to speak loudly because they are unable to hear their own voices normally. Furthermore, they experience an abnormally rapid increase in their sensation of loudness once the threshold of hearing has been crossed. The zone between inaudibility and discomfort is greatly reduced as compared with that of people of normal hearing, this effect being known as "recruitment".

There exists, then a condition which is clinically quite recognizable, variously termed "high tone deafness", "high frequency deafness" or "upper tone loss". But the relationship of this condition with the subject of the present study is not as direct as might at first appear. For "high tone deafness" refers to losses at all frequencies except those below 1,000 c.p.s. - that is to say, to deafness throughout the greater part of the auditory range. In fact, although sanctified by usage, the term is a misnomer. It may be that the "high frequency weakness" with which this study is concerned is a mild form of "high tone deafness" manifesting itself in hearing losses for much higher frequencies. But it may equally well be due to psychological failures of interpretation, set or attention.

4. The Sounds of Speech.

The production and analysis of speech sounds is an extremely complex subject. It is proposed here to give only the briefest of outlines, paying particular attention to that aspect of direct relevance to this study - that is, to the high frequency components of speech sounds.

Man vocalizes basically by making adjustments of his larynx which vibrate the column of air produced by lung action. The vibrations are amplified and modulated by the resonating cavities of the larynx, chest, throat, mouth, nose and sinuses. The frequency of the fundamental tone at the laryngeal level is between 90 and 400 cycles per second, the average male speaking voice being about 128 cycles and the average female being about 256 cycles (middle C), and children's voices being yet higher. The classical oscillographic studies of Crandall (1925) showed how this fundamental tone is, then given the complex but recognizable characteristics of duration, amplitude, temporal change and secondary and transient wave forms which enable the identification of different sounds. The vowel sounds are pitched as above, but contain harmonic components at average frequencies in the neighbourhood of 3,000 cycles which presumably assist in their identification and reproduction.

The majority of consonant sounds are subdivided into fricatives and plosives (or stops), and these two categories are each further divided into voiced and unvoiced groups (see Table 3). They are produced by various juxtapositions of the tongue, teeth, lips and hard and soft palates.

TABLE 2.

THE CLASSIFICATION OF SPEECH SOUNDS AND THEIR SYMBOLS (INTERNATIONAL PHONETIC ASSOCIATION)

	Symbol	Sound as in Word
1. PURE VOWELS.		
Short (7)		
	æ	hat
	e	ten
	i	sit
	ɔ	hot
	u	put
	ʌ	hut
Long (5)		
	a:	far
	i:	speed
	ɔ:	paw
	u:	pool
	ə:	third
2. DIPHTHONGS (10)		
	ai	tie
	ei	play
	ɔi	boy
	ou	mole
	au	cow
	iu	hew
	iə	here
	ɛə	there
	ɔə	more
	uə	sure
3. SEMI VOWELS AND TRANSITIONALS (7)		
	j	y as in yet
	ŋ	ng as in sing
	l,r,m,n,w	
4. CONSONANTS (17)		
	b,d,f,g,h,k,p,s,t,v,z	written and pronounced as in normal script.
	ʃ	sh as in shine
	tʃ	ch as in church
	ʒ	zh as in pleasure
	dʒ	j as in judge
	θ	th as in thin
	ð	th as in then

[The letters c, q, and x are not used in phonetic script.]

TABLE 3.

THE CLASSIFICATION OF ENGLISH CONSONANTS BY TYPE AND POSITION OF ARTICULATION.

	Voiced	Unvoiced	Position of Articulation
FRICATIVES (8)			
	v	f	Labiodental (Lip to Teeth)
	z	s	Alveolar (Teeth to Teeth)
	ð	θ	Dental (Tongue to Teeth)
	ʒ	ʃ	Palatal (Tongue to Hard Palate)
PLOSIVES (8)			
	b	p	Bilabial (Lip against Lip)
	d	t	Alveolar (Tongue against Teeth)
	dʒ	tʃ	Palatal (Tongue against Hard Palate)
	g	k	Velar (Tongue against Soft Palate)
NASALS (3)			
	m		Bilabial
	n		Alveolar
	ŋ		Velar
LATERAL (1)			
	l		Alveolar

The voiced consonants and transitionals (b,d,g,v,z,r and l) are based on low-frequency laryngeal tone with tones of higher frequency superimposed. The voiceless consonants (p,t,k,f,s,ʃ,ʧ, and θ) are produced by interference or interruption of the air stream. In these consonants there is no low-frequency fundamental tone and their recognition and reproduction depends on the appreciation of frequencies in the range of 1,000 to 2,000 c.p.s., with harmonic components of above 7,000 c.p.s. in some cases. The whole field of study of the physical characteristics of speech is extremely specialized and not amenable to more generalization than that above. The spectographic studies of Potter and his colleagues at the Bell Telephone Laboratory (e.g. Potter, Kopp and Green, 1947) and Crandall's (1925) oscillographic analyses contain detailed tables which break down the components of speech sounds. But these readings of the speech characteristics of adult speakers show considerable variations, not only between male and female voices, but between individuals, and there are believed to be wide differences between the performances of individuals on different occasions. Even Fletcher (1953) balks at more than description of selected individual examples. He concludes:-

> "Thus it is seen that the sound waves produced in the air when one is speaking are very complicated.....The general characteristics of such speech sounds have been described, but it is extremely difficult to define each speech sound uniquely in terms of physical quantities." (page 67.)

Speech sounds vary not only in frequency components but in power or intensity. Obviously the fundamental sounds are produced during conversation by the same speaker with differing intensities according

to their position in the sentence and the amount of emphasis given to the sentence or its parts. In spite of this, some speech sounds are always more or less powerful than others, and oscillographic studies such as that of Sacia and Beck (1926) have demonstrated the relative strengths of sounds in adult speech. The same difficulties mentioned above, however, apply to studies of intensity as to those of frequency, so that representative mean intensity figures are not available. But the evidence clearly indicates that where relative powers only are considered, the pure vowels are the most powerful, then the semi-vowels, followed by the plosive and fricative consonants. The weakes speech sound is θ (unvoiced th) which is estimated to have an average phonetic power of about 0.05 microwatt. Table 4 is derived from Fletcher's (1953) summary of the relative intensities of different speech sounds, using the faintest sound as a basis of comparison.

Fletcher has also presented a chart which plots both intensities and frequency characteristics of the various speech sounds, thus giving what he terms "a very rough picture of the true facts". A modified version of his chart is presented here as Figure 1.

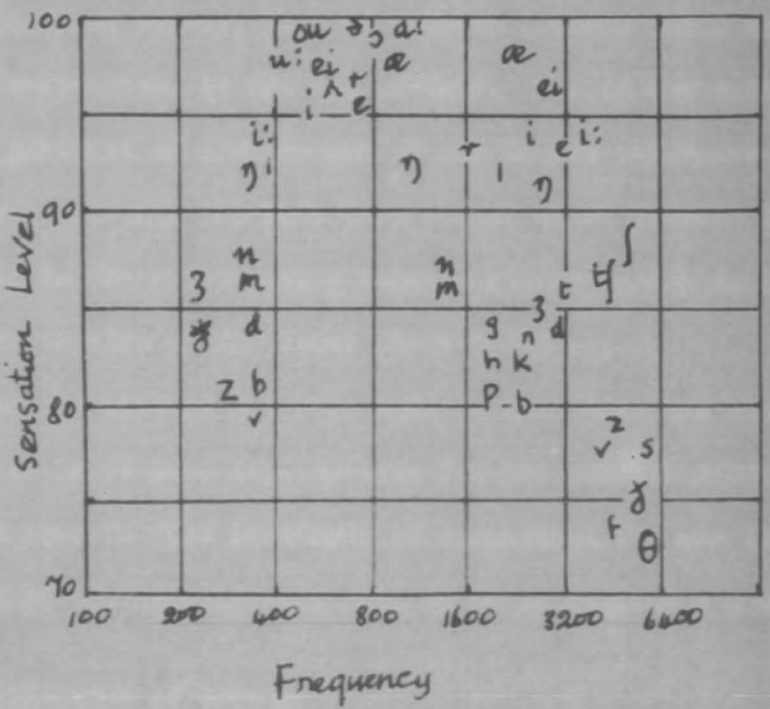
THE RELATIVE PHONETIC POWERS OF THE FUNDAMENTAL SPEECH SOUNDS AS PRODUCED BY AN AVERAGE SPEAKER (MODIFIED TABLE FROM FLETCHER 1953).

ɔ:	680	tʃ	42
a:	600	n	36
ʌ	510	dʒ	23
æ	490	ʒ	20
ou	470	z	16
u	460	s	16
ei	370	t	15
e	350	g	15
u:	310	k	13
i	260	v	12
i:	220	ð	11
r	210	b	7
l	100	d	7
ʃ	80	p	6
ŋ	73	f	5
m	52	θ	1

FIGURE 1.

COMBINED CHARACTERISTICS OF THE FUNDAMENTAL SOUNDS OF SPEECH

(MODIFIED FIGURE BASED ON FLETCHER, 1953).



B. SPEECH, LANGUAGE AND HEARING FOR HIGH-FREQUENCY TONES.

It was originally intended to present here a review of the literature under the above heading. No such work, however, appears to have been reported. As background reading, a very large number of works on speech, language and hearing have been consulted. It would be impossible to summarize such an enormous literature here. Even the classical survey, that of McCarthy(1954a) which covers almost 800 references, is now out of date. But in any case very few of the plethora of studies are of any direct relevance to the present work, and only two have been traced which present data appertaining to the relationship between either speech or language and auditory impairment for tones above 8,192 c.p.s.

However, an attempt has been made to draw together those findings which have at least some implications for the present study, bearing in mind the need to find standards of comparison for use in examination of the experimental data to be subsequently presented.

1. The Development of Speech.

By "Speech" is meant here articulation - the ability to vocalize and to produce appropriately the actual sounds of speech - as opposed to language usage. This is an extremely well-documented field, but most of the major studies have been of pre-school infants, whereas the main concern here is with the criteria to be accepted in studying

the speech of schoolchildren.

For testing articulatory ability the majority of investigators have either transcribed spontaneous speech or asked the children to repeat words after them. Both methods have disadvantages, but in the examination of children of school age the consensus of expert opinion, both among researchers and among practising speech therapists, seems to be that the second method is the one of choice. The examiner prepares a list of common words containing all the consonants and consonantal blends as well as the vowel sounds. He then presents the words individually and in a standardized manner, requiring the child to say them after him. The child's responses are then transcribed phonetically.

Common observation suggests a relationship between age and the ability to articulate, but there have been relatively few direct studies of this development in children over five years of age. Wellman, Case, Mengert and Bradbury (1931) studied the speech sounds of 204 children (white Americans, as in all the studies referred to here) aged 2 to 6, and found a gradual improvement with age, the correlation being + 80. By the age of five, 87 to 90% of the various speech elements were given correctly, wide differences in the difficulty of the various sounds being found. Girls tended to be superior to boys as far as pronunciation of consonants was concerned.

Davis (1937) analyzed 50 remarks obtained under standardized conditions from each of 436 children between the ages of $5\frac{1}{2}$ and $9\frac{1}{2}$ years. Here results are summarized in the following table which shows the percentage of children with perfect articulation in various groups at two age levels.

TABLE 5.

PERCENTAGES OF CHILDREN WITH PERFECT ARTICULATION AT TWO AGE LEVELS (FROM DAVIS, 1937).

Age	Singletons	Twins	Only Children	Socio-Economic Status		Sex	
				Upper Group	Lower Group	Boys	Girls
$5\frac{1}{2}$	76	49	79	73	58	56	73
$9\frac{1}{2}$	90	87	100	93	89	87	95

Poole (1934) showed that median girls achieve "Articulatory Efficiency" by about the age of $6\frac{1}{2}$, and median boys about a year later. She examined the ability of 140 children to articulate 23 consonant sounds in words; the following table summarizes her findings as to the ages at which sounds were mastered:-

TABLE 6.

THE ARTICULATION OF CONSONANT SOUNDS AND AGE

(FROM POOLE, 1934)

Age	Sounds Mastered
By $3\frac{1}{2}$	b, p, m, w, h.
$4\frac{1}{2}$	d, t, n, g, k, (ng), j, y.
$5\frac{1}{2}$	f.
$6\frac{1}{2}$	v, th (as in 'that'), z (as in 'azure'), (sh), l.
$7\frac{1}{2}$	s, z, r, (wh), th (as in 'thin').

As will be seen, the order of difficulty of these sounds as given by Poole has been partially confirmed by many authorities. But although eminent American "speech correctionists" have suggested the use of her data as a guide to what may be expected from the normal child, it would be unwise to regard the age figures as

anything but the most tentative of norms. For not only was Poole's sample size limited, but she reported wide variations with sex, intelligence and socio-economic status. Even less reliance may be placed on Metraux's (1950) "Speech Profiles". She was not primarily interested in the setting up of age norms, and her study of the speech of 207 pre-school children deals with subjects of average or above-average ability. According to the results of these children "vowel production in the child's speech appears to be more than 90 per cent correct by 30 months and consonant production appears to be 90 per cent or more correct by 54 months."

Templin (1957), in one of the most recent and careful investigations, states: "By 8 years essentially mature articulation of speech sounds has been attained." She used a sample of 480 children aged between 3 and 8, and found an increment in articulation ability of only 10% between these ages. Significant differences were apparent between children in upper and lower socio-economic levels, but their intellectual levels were also significantly different. At the same time Templin found that the correlation between intelligence and the various language skills was not consistent. Her girls' articulation was superior to that of the boys, but not significantly so. In a previous study (1953) she had found that girls achieved mature articulation by the age of seven, whereas boys took another year to reach the same level.

West, Kennedy and Carr (1937) in their standard text on speech and its disorders, state:

> "Normally all the sounds of speech are developed by the time the child is seven years old." (page 34.)

It would appear that authoritative opinions agree that certainly by the age of eight the normal child is capable of articulating all the sounds of English speech in an adult manner and by conscious intent. Here, by "normal" is meant any child not suffering from physical handicap or gross mental retardation. This provides a simple criterion, or a norm in reverse. For it is fair to say that any child of eight or older who cannot pronounce one or more phonetic elements (or 'phonemes') is relatively "speech defective". (In practice, of course, the term is not usually applied unless intelligibility is affected).

2. High Frequency Weakness and Defects of Speech.

It has long been a matter of common observation, supported by overwhelming experimental evidence, that children who are severely deaf are grossly delayed in their acquisition of speech. Indeed, such children may never develop correct articulation and speech rhythms without highly skilled teaching and mechanical aids. Minor defects in auditory acuity have often been suggested as the cause of "functional" articulatory defects which often make their appearance in children without organic or intellectual defects, and where no environmental or hereditary causes can be discovered. Evidence relevant to this supposition, however, is surprisingly scant and quite contradictory. Furthermore, it is difficult to compare the work of the various investigators because they have used differing definitions and measures both of auditory acuity and speech defectiveness.

Travis and Davis (1926) tested university students with the Seashore tests of pitch, intensity and tonal memory, finding that "good" speakers were superior to "defective" speakers. Stinchfield and Young (1938) and Morley (1957) in their studies of children with delayed or defective speech, reported impaired auditory acuity as a factor in almost half their cases. Two large scale audiometric surveys of primary schoolchildren have produced inter-related results. Sullivan (1944) found that whereas 22.2% of speech defective children in Minneapolis had hearing losses in one or both ears of 10 decibels

or more, only 18.8% of normally speaking children had auditory loss at this level. Fiedler's (1949) findings are reported from the opposite view-point, but are in close support. He found that whereas 19.28% of children with hearing loss had speech defects, the incidence of the latter among children of normal hearing was only 6.73%.

The studies just cited include the bulk of evidence for a relationship between speech defectiveness and mild impairment in auditory acuity. Almost as many studies have reported negative evidence. Barnes (1932), using university students as subjects, found no relationship between hearing loss and articulation ratings. Howells and Schoolland (1934), although not concerned directly with speech defects, found negligible correlations between speech perception and a battery of tests of auditory acuity which included audiometric results and the Seashore tests used by Travis and Davis. Hall (1938) compared groups of speech defective schoolchildren and university students with matched normal speakers. She found no significant differences whatsoever between the auditory acuity of the speech defectives and that of the normals, and low or zero correlations between articulation ratings and the results of a battery of auditory tests which included acuity. In their review of research on this topic, both Carhart (1943) and Artley (1948) concluded that hearing losses fail to distinguish speech defectives from normal speakers and that auditory acuity is related to articulatory ability only in individual cases of gross defect.

However, a closer analysis of the studies referred to above reveals an interesting feature which neither Carhart nor Artley seems to have taken into consideration. The majority of investigators have either not tested for high frequency acuity or have utilized composite scoring systems which may well have masked the high frequency results. Hall, it is true, did test up to 8192 c.p.s., but although reporting that the auditory perception of speech was more closely related to speech than to auditory acuity, she seems to have made no attempt to control this factor in her analyses of results. So that it is still an open question whether there might not exist a direct relation between articulatory ability and the hearing of high frequency tones specifically. Certainly where more severe upper tone loss exists most authorities flatly state that children have great difficulty in distinguishing and reporoducingmany consonantal sounds. Thus, Sheridan (1948) states:

> "If the 'high frequencies' (4,096 and 8,192 cycles) are lost, as they are with 'inner ear' or 'nerve' deafness, many of the finer sounds, for example 's', 'f' and 'θ', are so distorted as to become unrecognizable, and the vowel sounds, deprived of their distinctive upper harmonics, acquire a flattened unmusical quality, so that eventually they tend to become indistinguishable from one another." (page 14.)

And Newby (1959):

> "The child with a loss for the higher speech frequencies has difficulty in understanding what he hears, yet because of his good hearing for the low frequencies he hears voices perfectly well.....His difficulty in comprehension comes from his inability to differentiate words with the same vowel but different consonants." (page 254.)

Evidence in support of these clinical judgments may be extracted from several of the studies above. In particular, Morley's (1957) intensive and careful study contains data of high relevance. She found that of a group of 280 children referred to a hospital speech therapy department over a period of six years because of delayed development of speech, the cause in 110 cases was insufficient hearing. In her Figure 29 (page 95) Morley gives an abstract of the extent of residual hearing in 91 of these cases. Thirty-nine of these children had some responses to all frequencies up to 8,000 c.p.s., 11 had some response up to 2,000 c.p.s., five up to 1,000 c.p.s., and four up to 500 c.p.s. It would appear, in fact, that over a third might be regarded as suffering from high-frequency weakness in some degree, whilst the large majority would be categorized as showing "upper tone loss".

3. High Frequency Weakness and Language Retardation.

There is now abundant evidence that a child who has difficulty in mastering speech will also tend to be retarded in the development of language skills, including reading. Monroe (1932), Johnson and House (1937), Gibbons (1934), Moss (1938) and Yedinack (1949) have all reported reading retardation in groups of children with articulatory disorders. Arthur (1927), Anderson and Kelly (1931), Monroe (1932), Bennett (1938), Jackson (1944), Robinson (1946) and Yedinack (1949) have similarly reported relatively high incidences of speech defects among groups of backward readers. Strangely enough the evidence for a relationship between articulatory ability and language development is more slender, but Williams, McFarland and Little (1937), House and Johnson (1937), Davis (1937), and Schneiderman (1955) have reported associations between articulatory ability and measures of language such as vocabulary and length of sentence.

It would seem, therefore, to be a reasonable assumption that if HFW affects the acquisition of speech it may also hinder the development of linguistic skills. It is difficult, however, to evaluate the reports of direct relationship of the latter with mild auditory impairment. The results of such studies as have been made are conflicting and inconclusive; this is mainly due to the widely varying methods and criteria of different investigators. A brief survey of the major relevant researches may indicate the complexity of work in this field.

Humphrey (1928), Warwick (1928, Waldman, Wade and Aretz (1930) and Caplin (1937) all reported that hard of hearing children were retarded by 0.4 to 0.7 school years. Sterling and Bell (1830) found a higher percentage of children with impaired hearing among their retarded groups and also among those children with the lowest I.Q.s. On the other hand, Conway (1937) found no retardation except in a small group (12 out of 500) whose hearing loss exceeded 20 decibels. Madden (1931) found that his hard of hearing group showed no verbal handicap and no difference in reading and spelling when compared with normal hearers. Madden suggested that this was because he had matched his pairs for age, sex and other variables including I.Q. which previous workers had failed to do. He also asserted that previous investigators had overlooked those handicapped children who were doing satisfactory school work and had generalized from the more obvious results of the unsatisfactory workers. The term "hard of hearing", he claimed, imparted a halo effect; such children were fundamentally different from the deaf. The latter "live in a non-verbal world and the hard of hearing live in a non-verbal world" and do not have a language handicap.

Sprunt and Finger (1949) however, pointed out that Madden had used as a measure of intelligence a mixed verbal test, the Binet. They claimed that the hard of hearing child with some verbal handicap will have a higher level of intelligence than such a test reveals, so that the "matching" will favour him. When they used a non-verbal I.Q. test for matching purposes they found 28 hard of hearing subjects to be inferior to their controls of normal hearing to a degree equivalent to 0.5 years

of school progress. Similar results had been reported by Prince (1948). Subsequently, however, Reynolds (1955), after careful matching of 36 children with hearing losses of 15 decibels at three frequencies (512, 1024 and 2048 c.p.s.) or 20 decibels at any two of these frequencies, with normal hearers, found no significant differences whatsoever on school achievement or adjustment.

Again, analysis of the methods used by different investigators reveals the fact, of high relevance to the present study, that those workers who have failed to find any association between auditory acuity and linguistic skills have not discriminated between losses in different parts of the auditory range. Two recent major investigators who have made such a differentiation, have in fact reported associations between reading ability and high frequency auditory acuity.

Kennedy (1942), who surveyed the audiometric responses and reading abilities of 433 subjects aged 6 to 20, stressed the importance of auditory weakness for the higher frequencies. Her group were of above average socio-economic status and all of normal hearing, whilst their average reading ability was above normal. Even so, an association was discernible between HF loss (above 2048 c.p.s.) and reading attainment. Over the whole auditory range the correlations between reading ability and hearing were not significant, but:

> "The type of hearing loss, however, seems to be the real determining factor in the relationship of hearing and reading."

Henry (1947) tested 295 normal subjects aged 6 to 17. Factor analysis showed there to be three significant "tone regions" - Low (128 and 256 c.p.s.), Medium (2048 and 2896 c.p.s.) and High (8192

and 11,584 c.p.s.). Henry found a statistically significant association between high frequency loss and reading retardation. The best readers were superior and less variable in their responses to high tones than were the poorer readers. At the medium frequencies the mean differences were still in favour of the best readers, but at the low frequencies differences were negligible.

Only one study has been found which deals specifically with high frequency auditory impairment and general language development. This unfortunately, is concerned not with slight auditory impairment but with severe "upper tone loss". Nevertheless, it is not only an important contribution, but of relevance to all aspects of the present study. Ewing's (1930) study presents clinical details of ten children referred as being "aphasic" because they showed gross defects of speech and language. Ewing found that six of these cases suffered from what he termed "High-Frequency Deafness" as they showed "a marked, binaural, and evenly progressive lack of hearing, for ascending orders of frequencies in sound above 256 v.d." (page 141.). Ewing demonstrated that the children's lack of hearing for the higher frequencies had rendered them incapable of discriminating between sounds of speech. Whereas they could distinguish vowels at six to ten feet, they could distinguish (and even then, usually confused) consonants only at two feet. The speech and language development of Ewing's high frequency deaf patients passed through the same stages, and showed the same differences from normal adult speech as that of normal children. There were not, in fact, "aphasic", but retarded in linguistic

development, although of normal intelligence.

As noted earlier, to term this pattern of auditory loss "High Frequency Deafness" may be somewhat misleading, for the losses described occurred at all but the three lowest of the eight test frequencies - that is to say, over by far the largest part of the auditory range. Nevertheless, the fact that these cases showed increasing loss with higher frequencies makes plausible the suggestion that they represent the extreme of a distribution of high frequency weakness, and that there may will be individuals with relatively less auditory impairment, but whose limitations are reflected in some degree of linguistic retardation.

III. THE PRESENT STUDY.

A. Hypothesis and Predictions.

It is an established fact that children with grossly impaired hearing find difficulty in the acquisition of all the linguistic skills and usually require specialised and devoted help with their education. To a lesser degree, and with less certainty, the same may be said of children who are "hard of hearing" for sounds within the speech range.

To date, few investigators seem to have considered auditory impairment for tones outside the speech range. This is partly because of the technical and psychological difficulties involved in the reproduction of, and the measurement of responses to, high frequency tones. But furthermore in our culture only hearing for speech is of paramount importance. Failure to respond to sounds outside the speech range has not been regarded as a 'practical' issue, nor one of any theoretical interest for psychology.

The basic postulate of this study is as follows:

Postulate

> "That there exist children with what may be termed "high frequency weakness", inasmuch as they show increasing failure to respond to pure tones of increasingly high frequency above 8,000 c.p.s., and that this impairment limits their auditory experience significantly."

Now although the upper limit of the speech range is usually taken to be 5,000 or 6,000 c.p.s., it has been shown that certain consonants (in particular and unvoiced fricatives and plosives) have components above this level. At the same time it may be presumed that for the perfect discrimination of speech the upper harmonics as well as the

fundamental tones must be appreciated. The postulate therefore prompts the following verifiable hypothesis:

Hypothesis

> "That high frequency weakness in children is associated with retardation or distortion in the development of their understanding and articulation of speech."

Some, though not all, previous investigations have indicated a distinct association between various forms of linguistic development. The argument may therefore be extended to the following predictions:

Predictions

> "That such a maldevelopment of speech may hinder the general language development of children, and may similarly hinder their acquisition of reading and of skill in written expression."

B. The Assessment of High Frequency Auditory Ability.

Experimental study of the hypothesis and predictions involves two major tasks - firstly the identification of a sample of children displaying high frequency weakness, and secondly the assessment of their linguistic development. In each case it is necessary to select or construct suitable measurement techniques; and furthermore it must be possible to compare the results of these measures either with established norms or with comparable results of children known to be of unimpaired hearing.

This section is concerned with the technique used for the measurement of auditory ability at high frequencies. The following sections describe the survey which was primarily carried out to establish norms, and three subsidiary surveys which considered two relevant variables - intelligence and personality.

1. Audiometric Instrumentation.

Many of the clinical tests in general use, such as the watch tick or whispered speech, are relatively uncontrolled. But in any case they certainly do not test hearing for the higher frequencies. Similarly, the conventional pure tone audiometer, though instrumentally accurate and reliable, seldom tests for frequencies above 8192 c.p.s. One instrument which is capable of producing sounds well beyond this level is the Galton whistle, which has figured among the "brass instruments" of experimental psychology since the end of the last century. A description of the theory and construction of such a whistle is to be

found in Appendix 'D' of Galton's "Inquiries into Human Faculty." There Galton proudly claims, in reference to individual variations in auditory range: "We all have our limits, and that limit may quickly be found by these whistles in every case." (Galton, 1883. Page 377.)

Unfortunately, the Galton whistle is blown by the squeezing of a rubber bulb. There is, therefore, no control of the intensity of the sound, nor of its duration. Furthermore, in practice the higher notes are lost in the generalized hiss of escaping air and it is impossible to tell to which sound the subject is responding. To his annoyance the present investigator found that he could 'hear' the whistle (which was in perfect order and carefully calibrated) up to its maximum of 42,000 c.p.s.

However, the Galton whistle was used for a pilot survey (Reed, 1953) which is briefly described in Appendix 'A'. It was decided not to use it for further work because it could only screen out the most severe cases. Obviously, any child who cannot hear the high frequency tones of the whistle but also not hear the air-hiss must be suffering from pronounced disability. Furthermore the onus of proof is thrown upon the conventional audiometer, as the screened-out subjects were, perforce, referred back for audiometric examination of the routine type.

Evidently what is required is an instrument with the reliability, calibration and known output intensity of the pure-tone audiometer, but which is capable of functioning well above 8192 c.p.s. and

preferably up to about 20,000 c.p.s. The practical problems encountered in the search for such an apparatus are described in Appendix 'B'. Here it may suffice to state that the instrumentation finally adopted consisted of a Marconi Audio Tester coupled to a high fidelity high frequency speaker and tweeter unit. This equipment allowed the reproduction of pure tones of known and adjustable intensity up to 50 db., and of known and continuously adjustable frequency up to about 22,000 c.p.s.

2. Audiometric Testing Technique.

The same audiometric method was employed throughout all the present series of studies. It was very similar to conventional audiometry.

Each subject was tested individually and alone in a room selected for its relative quietness. Testing was suspended at times when movement was anticipated in the school or clinic concerned. It was not carried on to within fifteen minutes of "break" or "hometime", at which times children might be expected to show signs of inattention or impatience.

The subject was seated comfortably at a distance of six feet from the loudspeaker which was placed facing him at head level. The tester spent a few minutes in putting the subject at ease, discussing games and hobbies; the conversation was brought round to powers of observation and listening ability, mention being made of the fact that these were nothing to do with being strong or clever and that in these respects children were often superior to grown-ups. The tester then explained that he was "interested in finding out how carefully children could listen" and explained that this was nothing to do with school work. He went on:

"In a minute or two I shall show you what loud whistles this machine can make. Every time it whistles I want you to raise your finger like this. Keep it up as long as the whistle goes on, but drop it straight away as soon as the whistle stops. Sometimes it may go Peeeeeep, sometimes just Pip. It may be a high squeaky

whistle or a low rumbly one. It may be very, very quiet, so you must listen very carefully all the time. Now do your best - let's see just how well you can do." With young children it was suggested that they were playing a "game of tracking" and must listen "for a little squeak just like a mouse."

Practice was then given in response to various intensities and duration of tone at 1,000 cycles. A threshold reading having been established at this frequency a "sweep" test was then carried out to make a first determination of upper auditory limit. Testing then re-commenced at 1,000 cycles and thresholds were established by the method of limits (as described in the previous section on audiometry) for each kilocycle up to the highest point responded to by the subject at maximum intensity.

Almost all the children tested showed great interest in this task, and the great majority co-operated wholeheartedly. Difficulties were experienced with the most dull children (as will be reported in the section on the survey of an E.S.N. group) and with a few nervous or over-active children. But contrary to expectation, no problems were encountered among the youngest children tested, and the seven-year olds responded as directively and consistently as any other group.

3. Assessment of Results and the Need for a Survey.

After much consideration it was decided that the most apposite and economical method of obtaining a measure of HFW was to use the upper auditory limit (U.A.L.). This was merely the highest frequency to which the child responded at any intensity. With this in mind

the thresholds for the highest frequencies were determined with extra care, readings being taken on at least four occasions at intervals during each testing session.

It would have been possible, of course, to produce hearing profiles or to average the threshold readings at several frequencies. Neither of these methods, however, would seem to produce a measure as relevant to the interest of this study as the U.A.L.

Before it was possible to identify and examine a group of children with HFW it was necessary to conduct an audiometric survey of a representative sample of the school population. There are several reasons for this:-

a) No audiometric survey, either in Britain or overseas, has ever covered the range of frequencies with which this study is concerned.

b) As a consequence of this, no levels of normal upper auditory limits have been established. As auditory weakness is relative it was necessary to establish some sort of norms of response before children with impaired high frequency hearing could be identified as such.

c) It was necessary in any case to establish norms of response to the particular audiometric apparatus in use.

d) It was thought probable that variables such as age and sex would have to be taken into account, and therefore separate norms might prove necessary to allow for these. In this respect it may be noted that routine audiometric norms have not made such provision.

C. THE MAIN SURVEY.

1. Sampling Procedures.

It was realized that the total number of children who could be tested was severely limited by the element of time. To test one child satisfactorily in the manner described may take between 20 and 35 minutes depending upon his intelligence and persistence. In practice it was found that, allowing for intrumental "warm-up" and adjustment, and for summoning the child and allowing him to settle down, an average of half an hour had to be allowed. On those occasions when arrangements could be made for continuous testing, no more than six children could be seen in one morning. It was estimated that no more than two hours per week could be fitted into working routine, and during many weeks no time could be spared from duty at all.

Furthermore, to limit the possible incidence of effects due to colds and catarrhal infections it was deemed wiser to limit testing to the summer months, of which seven weeks are taken up by holidays.

It was apparent that if the task was to be completed within a two year period the maximum number of children it would be possible to test for the survey was 200. A careful sampling technique was inducated to compensate for this paucity of sample size.

Various studies have indicated that the following variables may be associated with auditory ability:-

a) Age.
b) Sex.
c) Health.
d) Physical development.
e) Intelligence and/or academic status.
f) Socio-economic level.

Several of these variables are inter-related and all are associated to some degree with the school attended and/or with location of the home, so it would seem that the sampling method of choice is area sampling.

The physical, intellectual and behavioural standards of a school are not, however, determined completely by the area from which it draws. Furthermore variables a), b), c), e) and f) above may be shown to be closely related to transfer to selective schools - either those for superior children, or those for the handicapped. In fact, such transfer is responsible for the great majority of cases where the child attends a school not in the geographic area of his home. (The matter is simplified in the present instance by the fact that a good state system had rendered private schools practically non-existent in the area under consideration). Evidently a stratified sampling system is indicated as in the majority of educational surveys. A sampling procedure utilizing both area and stratification principles was therefore employed.

Area Sampling.

The city extends for some seven miles along the north bank of the River Humber. It is roughly semi-circular in shape, extending for some four miles north of the river. It is almost bisected by the River Hull which flows from north to south, and the city centre adjoins the confluence of the two rivers. As in many large cities the residential areas nearest the centre tend to be poor and to a large extent improvement in socio-economic status is associated with

distance away from the centre.

For sampling purposes the primary, unreorganized and secondary modern schools were allotted to three groups according to distance from the city centre. Each of the two outer bands was further divided into two segments, East and West. These five areas were adjusted so as to contain approximately equal numbers of schoolchildren.

Stratified Sampling.

In consultation with local inspectors and senior headmasters, and utilizing external examination results, all local schools were listed in order of academic status. They were found to fall into four groups of roughly equal size. The proportion of children in attendance at selective schools was known.

Forty children were now drawn for survey testing from schools in each geographic sector or area. The individuals were selected at random (head teachers were asked to submit, for instance "The first girl on 2B's register whose name begins with 'H'") but within each group the following limits were applied:-

1) Age. Children were drawn to represent each year group from 7 to 15 inclusive.

2) Sex. Equal numbers of boys and girls were drawn. Later more boys were tested, to reflect their sex's slight real preponderance in the general population and relative preponderance in slective secondary schools.

3) Academic status.
Children were drawn from schools which represented equally the four "academic status" groups. Of the senior school children in the survey 18 (or approximately 22%, as in the whole school population) were drawn from various selective secondary schools.

Altogether a total of 209 subjects (119 boys and 90 girls) were drawn from 47 schools.

It may thus be reasonably suggested that although the survey sample constituted only 0.58 per cent of the total school population within this age range of 36,000 it was more representative than a sample many times as large but drawn in block from only a few schools.

TABLE 7.

THE MAIN SURVEY - UPPER AUDITORY LIMITS (IN KILOCYCLES) THE MEDIANS, MEANS AND STANDARD DEVIATIONS OF THE U.A.L's OF 209 SCHOOLCHILDREN, BY AGE AND SEX.

		Age in Year Groups.								
		7	8	9	10	11	12	13	14	15
Boys	N	10	10	10	15	20	15	15	12	12
	Medians (K/Cs)	18.75	18.75	19.25	18.50	18.0	18.0	17.50	16.50	16.25
	Means "	18.45	18.90	18.65	18.60	18.00	18.06	17.56	16.79	16.66
	S.Ds. "	1.06	0.93	1.85	1.42	1.62	1.15	1.07	1.35	1.38
Girls	N	10	10	10	10	10	10	10	10	10
	Medians (K/Cs)	18.50	18.50	18.50	18.25	18.75	18.50	17.50	16.50	16.0
	Means "	18.10	18.50	18.00	17.85	18.70	17.85	17.15	17.10	15.95
	S.Ds. "	2.23	1.12	1.93	1.84	0.87	2.01	1.20	0.92	0.98

TABLE 8.

MAIN SURVEY RESULTS - ANALYSIS OF VARIANCE

Source of Variance.	df.	Sum of Squares.	Mean Squares.	V.R.	Sig.
Between Ages	8	424.40	53.05	6.03	.001
Between Sexes	1	13.05	13.05	1.48	NS
Between Areas	3	61.52	20.50	2.33	NS
Age x Sex	8	49.31	6.16	-	NS
Sex x Area	3	57.24	19.08	2.17	NS
Area x Age	24	99.65	4.15	-	NS
Residual	161	1415.39	8.79		
Total	208	2120.56			

Note: The final column refers to the levels of significance of the variance ratios according to Table V of Fisher and Yates' "Statistical Tables for Biological, Agricultural and Medical Research." It will be noted that none of the V.R.s except that for Ages was significant. That for ages is highly significant at well beyond the .001 level of probability.

2. Results.

The results of the survey are summarized in Table 7 in terms of median and mean upper auditory limits by age and sex groups. It must be stressed that U.A.L.s here are related only to the particular audiometer used. They represent the highest frequencies to which the children responded under the conditions described earlier and when the instrument was adjusted to its maximum output of 50 decibels. But apart from providing 'norms' for the instrument these findings are of considerable interest, both from the point of view of the present study and from that of audiometry in general.

Within this sample there was found no dichotomous or bi-polar distribution of hearing responses. The distributions of results were continuous at every age level, as might be expected with normal, healthy subjects. Furthermore, an examination of the standard deviations in Table 7 will show that variability between subjects was relatively slight at all age levels. In fact, no subject in this sample was found to have an U.A.L. below 12 K/Cs. and none above 21 K/Cs. This consistency is as noticeable among the younger age groups tested as among the older ones.

As well as its implications for individual differences in this field, this finding may be regarded as indicating high reliability for the testing method in use. Further support for this claim is provided by the fact that the results of subsequent subsidiary surveys were closely comparable with those of this main survey.

Table 8 presents the results of an analysis of variance of the main survey data in terms of three main factors - sex, age and social area. This demonstrates that the data depart from homogeneity only where age is concerned. Neither sex, area, nor any of the first-order interactions can be shown to have had any significant effect in this analysis.

The lack of difference between areas is not surprising, in view of contemporary social fluidity and improvements in welfare and health services. It is probable that half a century ago there was a close correlation between geographic area, social status and the incidence of, for example, catarrhal complaints, middle ear infections and general poor health. Such a relationship has been largely modified by generally improved standards of living and the provision of improved school health facilities, welfare clinics, free meals and milk. Similarly, the differences between social classes have to some extent decreased, along with accelerated fluidity of shifts between classes. Finally, the large slum clearance programmes and the continuing development of vast corporation housing estates in the city's outer suburbs are radically altering the association between social class and neighbourhood. It may be, of course, that a more refined breakdown of areas might have revealed differences. For there is known still to be a close correspondence between academic achievement and schools attended which is not explicable only in terms of school premises and staff. However, although in this survey an association between high frequency auditory response and intelligence

was noticeable, no such relationship was noticed between response and social background.

The lack of difference between the means for the sexes is more surprising. As mentioned earlier it is known that male adults show prebyscusis earlier and more severely than do females, and there has been authoritative support for a similar sex difference among schoolchildren. Conway (1937), in his survey of 500 Toronto children, found twice as many boys as girls with upper tone loss, and this finding was confirmed by Beasley (1938) and Ciocco (1937, 1938). These workers, however, were referring to all losses above 2,048 c.p.s. In a more recent survey, Kennedy (1942) used test tones up to 9747 c.p.s. The differences between the sexes in this study varied with age, and were seldom significant. There was a tendency for boys to have superior auditory acuity in the younger groups, and girls in the older groups. On the whole, girls showed more improvement in acuity with age than boys, but the reverse applied at the highest test frequency. On the other hand, Henry (1947), who tested her subjects up to a frequency of 11,554 c.p.s., found no sex differences in mean loss at the low and medium frequencies, but high tone loss for boys was reliably greater than for girls.

The above investigators were, of course, not primarily concerned with testing for upper auditory limits. For studies which were concerned with the upper limits of hearing and its variation with age and sex, it is necessary to go back to the literature of the late nineteenth and early twentieth centuries. At that time, as

discussed above, research of this nature was hampered by primitive measuring instruments and faulty methodology. However, Bruner (1908) presents data which are surprisingly similar to those of the present survey. His mean figures for mean U.A.L.s (translated into terms of c.p.s.) of age and sex groups were presented in Table 1. Bruner offers no statistical analysis of his figures, but states that the sex difference for each age group is too small to possess any high reliability. But in almost all groups the females have a slight superiority over the males. The differences become smaller, however, with successively younger age groups, until, in the youngest group of all there appears a slight difference in favour of the boys.

Perhaps the most striking and unexpected feature of the main survey figures is that there occurs a noticeable drop in mean U.A.L.s after the age of twelve. The analysis of variance shows that between age groups differences were significant at the .001 level of probability. Comparisons by t-test were therefore made between age-group means, and Table 7 shows that significant differences exist in the boys' results, between the means of the 14 and 15 year age groups and those of all other ages up to 13. In the girls' results, the 15 year means differ significantly from those of all the other age groups, whilst the 14 year means do so in two instances. There would appear, in fact, to be evidence here for a tailing-off of response to very high frequencies which makes its appearance at puberty.

This is reconcilable once again with Bruner's figures and with one of Ciocco's (1938) reports. In re-examining the acuity of 552

schoolchildren after an interval of five years he found that in the group as a whole the incidence of high tone loss had increased by 300 per cent compared with 20 to 30 per cent increase of losses at lower frequencies.

The present finding may also foreshadow the steady decline in upper frequency response which has been found in adulthood. It is tempting to suggest that the two findings are part of the same continuum, which might be expressed diagrammatically thus:-

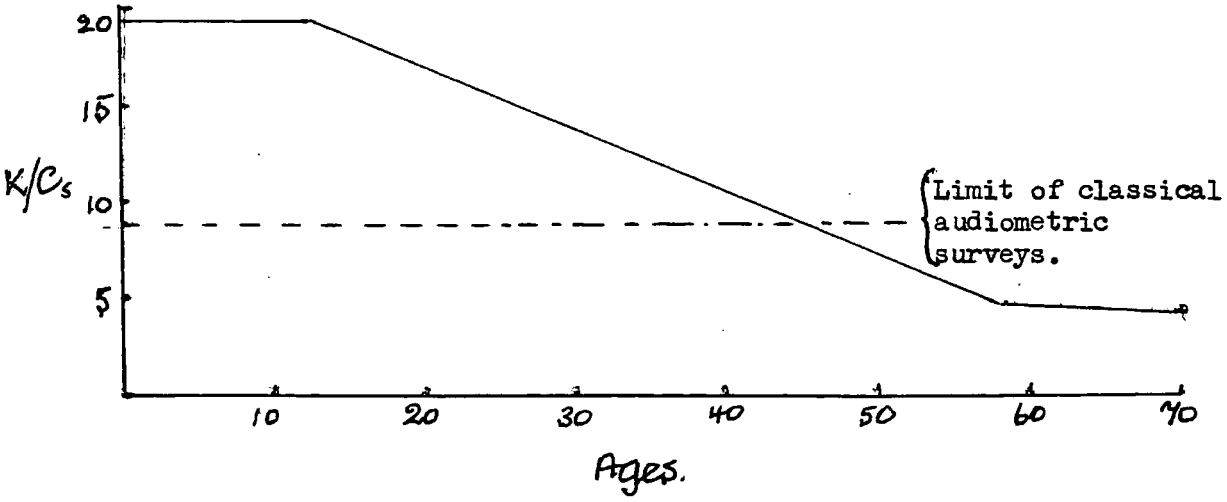


Figure 2. **Suggested Decrease in Upper Auditory Limit with Age.**

D. FURTHER SURVEYS OF THREE SPECIAL GROUPS.

1) Child Guidance Clinic Cases.

Eighty-six children currently attending for treatment at a Child Guidance Clinic were tested audiometrically, using the same apparatus and procedure as in the school survey. These children were of both sexes and were aged from 7 to15. They had been referred to the C.G.C. for a variety of forms of maladjustment, by teachers, parents or medical officers. Those with suspected brain injury or with other physical disabilities were excluded, and the present group includes only those who were intellectually intact and whose emotional/behavioural symptoms were relatively mild.

Table 14 shows the means of the group's upper auditory thresholds (in kilocycles, at 50 decibels) by sex. Comparison with the general survey 'norms' will show that these results are in good accordance. There is, in fact, no reason to suppose that this C.G.C. group represents anything other than a random sample from the general population as far as auditory ability is concerned. Again, no difference in ability between the sexes was observable, and a tendency towards a progressive diminution of upper HF limit with age was apparent.

a) Classification by Intelligence and Personality.

The intelligence of each child had been tested as a routine on his referral to the C.G.C. In all cases the test used had been a mixed verbal/non-verbal individual test, the Terman-Merrill Revision of the Stanford Binet (Form 'L'), which is undoubtedly the individual test

most widely used with children in this country. It was thus possible to compare audiometric findings with the results of a well-standardized and carefully administered individual intelligence test.

Secondly, the C.G.C. situation facilitated the categorization of these children in terms of clinical personality variables. No standardized test had been found which enabled a satisfactory assessment of personality to be made in objective terms. But case histories, school reports, observational data and interview findings were available, coupled with the professional experience of the clinic staff. On the basis of these findings the consultant psychiatrist in charge of the clinic was asked to diagnose each of the present cases under one of three headings:- "Anxiety State", "Hysteric" or "Emotionally Immature". After prolonged discussion, comprehensive lists of the behavioural traits appropriate to each group were agreed upon and used as diagnostic criteria.

These were as follows:-

a) "Anxiety State". This category included cases of morbid timidity, reserve, failure to mix socially, over-absorption in fantasy, phobias, obsessions, undue worry, most 'panic attacks', compulsions, some cases of wandering, stammers, some enuretics, masturbation fears, some nigh terrors, many nail-biters, and other comfort or tension-reducing habit formers if characterized by anxiety. A rough working hypothesis as to the types of behaviour manifested by such children would be that they are over-socialized in Mowrer's sense, and have low thresholds of breakdown in the face of stress. They are responsive to stimuli from within, tend to be self-critical and self-punishing. In Freudian terms such cases have over-developed super-egos and egos, but primitive uncontrolled id formation.

b) "Hysteric". This category included cases of aggression, bullying, pilfering, many sex offences, exhibitionism and attention-gaining generally, destruction, some truancy,

defiance, temper tantrums, most encopresis cases and over-dramatization. A working hypothesis would be that these children are under-socialized, lacking insight and self-criticism. They are responsive to stimuli from without and react behaviourally to stress by punishing the environment. They are impulsive and attention-gaining. In Freudian terms they have poorly developed super-egos, often with high ego and id development.

c) "Emotionally Immature". Children classified under this heading would be those whose social/emotional development was regarded as not having kept pace with their chronological age. This might be high-lighted by over-dependence, fear of leaving the mother, infantile speech, language retardation, over-lability of mood and behaviour, some cases of tantrums, difficulties of social adjustment with children of the same age as compared with younger groups, babyish expressions or gestures. The behaviour of such children is problematic only inasmuch as it is more appropriate in younger children. They are not over-reactive to environmental stress, but react as would normal, younger children.

There are many symptoms which might well be common to all three groups, whilst it is often difficult to gauge what is an 'abnormal' stress, and what a 'normal' reaction. Furthermore, the majority of C.G.C. cases show a multiplicity of symptoms. However, consideration of the constellation of reactions alongside the types of precipitating stress in the context of the case history, coupled with observation of the child in a play group usually led to reasonably confident categorization. In the majority of cases the results of projective techniques were also available, whilst in cases of doubt diagnosis would be left until considerable insight had been obtained during psychotherapy.

The reasons for the choice of these three categories were as follows:-

a) Psychiatric nomenclature varies considerable with the orientation and predispositions of psychiatrists. These three categories, however, are among those in most general use in child psychiatry. The very crudity of the grouping should mean that a majority of 'eclectic' psychiatrists could reach agreement in classifying the majority of C.G.C. cases.

b) Much psychiatric nomenclature is difficult to reconcile with psychological theory. The first two of the present categories however, clearly correspond to introversion and extraversion in maladjusted children, whilst the third takes account of the fact that many C.G.C. problems are not so much a question of reactive behaviour as of anomalies in development.

A number of psychological differences between introverts and extraverts have been isolated, both in general behaviour and in experimental perceptual and learning tasks. Introverts are believed to be characterized by persistence, high levels of aspiration, rigidity and relatively high levels of drive and conditionability. Extraverts, on the other hand, show low persistence, low levels of aspiration, low rigidity, drive and conditionability.

c) These categories enable use to be made of both historical and current information. The operational definitions weight the consideration of observable behavioural evidence as opposed to subjective judgments, and tend to minimize controversial aetiological theorizing.

B. The Relationship of Intelligence to Clinical Categories.

The means and standard deviations of the Intelligence Quotients of the C.G.C. children are presented in Table 10. It will be noted that the mean I.Q. of the whole group approaches normal (I.Q. 99.29) although the spread (S.D. 21.82) is somewhat wider than would be expected in the population as a whole.

Table 10 also shows the figues for the group by sex. No significant difference was found between the mean I.Q.s of boys and girls.

The same table also shows the mean I.Q.s of the separate clinical groups. It will be noted that the mean I.Q. of the Anxiety group (I.Q. 108.73) is higher than that of the Hysteric group (I.Q. 103.5) and that this also applies when boys and girls are considered separately. The mean I.Q. of the Emotionally Immature group (I.Q. 84.3) is well below both the others, but this finding was to be expected in view of the criteria used in defining this group. It is a matter of general observation that there is a close relationship between emotional and intellectual retardation.

Table 11 shows the significances of the differences between the mean I.Q.s of the three clinical groups. That between the Anxiety and the Hysteric groups proved to be quite insignificant. But the differences between the means of both these groups and that of the Emotionally Immature group was significant at the .01 level of probability.

C. The Relationship of Intelligence to HF Auditory Ability.

The distribution of Upper Auditory Limits by I.Q. classes for the whole group is presented in the form of a contingency table, Table 12. Here a degree of positive association between these two variables is apparent. This was examined precisely by calculating product moment correlation coefficients not only for the whole group, but for the group broken down by sex. The correlation coefficients for boys proved to be + 0.473, for girls + 0.443 and for the total group + 0.442. These correlation coefficients are all significant at the 0.05 level of significance.

These findings indicate a positive association between intelligence and auditory acuity for high frequency sounds. Two points should perhaps be made here. The first is that no causal association is implied; indeed, the coefficients, although significant, are not of an order to suggest even that intelligence is the major factor operating in the establishment of HF auditory acuity. The second point is that the fact that any degree of association of HF ability and intelligence exists at all suggests that relative HFW is unlikely to be a physical disability in the way that myopia is. This will be discussed later.

To be strictly accurate it must be added that just as "intelligence", as used here, means "behavioural responses in an individual, mixed intelligence test", so "auditory acuity" here means "behavioural responses in an individual pure tone audiometric test". The possible implications of this will also be discussed later.

D. The Relationship of Clinical Categories to HF Auditory Ability.

The distribution of Upper Auditory Limits by clinical categories for the whole group is presented in the form of a contingency table, Table 13. Although there is considerable overlapping of U.A.L.s between clinical groups it is noticeable that whereas the median for the Anxiety group falls at 19 K/Cs that for the Hysteric group falls about 1500 cycles lower, whilst that for the Immature group falls slightly more than 1000 cycles. The means and standard deviations of the U.A.L.s by sex and clinical category are presented in Table 14. As in the case of I.Q.s, the Anxiety group means for both boys and girls are higher than those for the Hysteric group whilst those of the Immature group are the lowest of all. It will be seen from Table 15 that the differences between the U.A.L. means of the Anxiety group and the Hysteric group and between those of the Anxiety group and the Immature group are both significant at the 0.01 level of probability. The difference between the means of the Hysteric and the Immature groups is significant at the 0.05 level.

The difference between the Immature group and the other two may, of course, be attributable to the significant difference in intelligence noted previously. No such significant difference was found, however, between the intelligence levels of the Anxiety and Hysteric groups. So that it is not unreasonable to adduce that the difference between these two in auditory acuity is attributable to personality differences. On the criteria used here it would seem

that the HF auditory acuity of hysteric children is significantly below that of children diagnosed as suffering from anxiety states.

Although caution must be employed in generalizing from clinical groups to the normal population, it may be suggested that relative weakness in the detection of, and response to HF pure tones is related to the degree of extroversion displayed by the subject. This is not to imply that the extrovert has poorer "hearing" than the introvert, but that his behaviour in the audiometric situation is less conducive to the production of desired responses or at least that it is less consistent.

E. Summary of C.G.C. Findings.

a) No sex differences were observed either as regards intelligence or auditory acuity.

b) A positive and significant association was found to exist between level of intelligence and degree of HF auditory acuity.

c) An association was detected between clinical categorization and HF auditory acuity, inasmuch as the Anxiety group tended to make audiometric responses which were superior to those of the other two groups.

FURTHER SURVEYS OF THREE SPECIAL GROUPS.

2. Educationally Subnormal Children.

Forty children who had been officially ascertained as E.S.N. were given pure-tone audiometric testing. Their ages ranged from 9 to 15 and their I.Q.s (as assessed by school medical officers using the Terman-Merrill Revision of the Binet test) ranged from 50 to 75.

The results of these children (see Table 16) divide them roughly into two groups:-

a) Those of I.Q. 65 and above (a division which included almost all those in attendance at ordinary schools). The performance of these children on the audiometric test was quite consistent with the results obtained during the general survey. A few of them, indeed, demonstrated quite high auditory acuity, responding with confidence and accuracy.

b) Those of I.Q. 50 - 64. With few exceptions the children in this group were so inconsistent in their responses that it proved impossible to establish definite thresholds at high frequencies. It seemed that this did not reflect sensory limitations (although in many cases these children were of very poor general physique) so much as difficulties in carrying out this type of task. They found it difficult to "attend" for the period necessary to complete the test, which itself took longer than with normal children because of the necessarily extended explanation and practice period. They displayed relatively high distractibility as compared with children of normal intelligence.

A further important factor seemed to be that their threshold of discrimination was higher than that of normal children. Several children in this group seemed to understand the task, but as the auditory stimulus became fainter they would respond apparently at random or to slight visual stimuli. For instance, one subject began to respond to changes in light as the sun appeared between

clouds. It might well be hypothesized that in these very dull children the channels of sensory input have not become completely discrete. The organism may be regarded as responding to any stimulus without clear differentiation, as though the filters postulated by communication theorists have not developed. Certainly this suggestion is given plausibility by the diffuse and relatively undirected behaviour of many subnormal children.

It is known that sensory functions are often defective in subnormal people, but there have been scarcely any adequate audiometric surveys of subnormal populations. Birch and Matthews (1951) did carry out such a survey on all the patients in a mental deficiency hospital in the age group ten to nineteen years. They found that only 67% of these children had hearing within normal limits. Dunsdon (1952) tested twenty-seven children in a school for the cerebrally palsied. Only two of these children had normal hearing.

Hilliard and Kirman (1957), in discussing the frequent association between mental and physical handicaps, state:

> "Little is known about the anatomical basis for the hearing abnormality in mental defectives, but the loss is usually much more marked towards the higher end of the audible range of pitch. The deafness is often only partial but may still be sufficient to prevent the child from hearing speech or from distinguishing consonants.....Testing for deafness in backward children is often very crudely done." (page 256.)

The authors go on to discuss the difficulties of testing the hearing of dull children.

In his classical textbook on mental deficiency Tredgold (1949), having stated that defects of hearing are "fairly common in aments"

goes on to make some observations which are very germane to the comments made earlier in this section.

> "Some of these conditions may be due to developmental anomalies or disease of the peripheral organ, but others are of central origin. Even where no actual deafness is present the acuity and range of auditory perception is usually below the normal. It not infrequently happens, however, that a defective child is thought to be deaf who is not really so, for many defectives who pay no attention to commands, to the sound of a whistle, or to noises of many kinds, will at once turn when a spoon and plate are rattled, showing that the cause is not deafness, but lack of interest and attention." (page 91.)

One further consideration of relevance may be mentioned here. The majority of these E.S.N. children would indubitably be graded clinically as "hysteric" on the operational definition used in the present work. Bearing in mind the findings reported above with regard to the child guidance clinic cases, it may well be suggested that this E.S.N. group represents a lower continuum of the hysteric group, with certain features of behaviour yet more pronounced because of lower intelligence.

FURTHER SURVEYS OF THREE SPECIAL GROUPS.

3. Retarded Readers.

If HFW is associated with difficulties in language development it may be anticipated that any group of severely retarded readers will contain a relatively high percentage of children with this type of auditory limitation. As noted earlier the evidence regarding a connection between reading skills and mild defects of hearing of any kind is far from consistent. Even when mild defects exist within the speech range, there has not been reported any conclusive evidence of their association with reading difficulties. But in any case few would suggest auditory limitation as the main cause of reading retardation, the aetiologies of which are known to be complex and individual. Children may fail to master reading because of limited intelligence, absences, poor or uneven teaching, faulty visual discrimination, poor motivation, home disturnbances, dislike of the teacher and many other causes which may affect the learning process separately, cumulatively or in combination.

However, such authorities as Burt (1950) and Schonell (1948) have stressed that auditory weakness is directly responsible for many reading problems, and that furthermore its existence is not suspected in many cases. Evidently the high frequency auditory assessment of a group of reading failures may throw some light upon this problem. It would seem important however, to select cases where there was no doubt that very severe difficulties had been faced. Preferably such a study would examine children of average intelligence

and of post-infant age, who were complete non-readers. As Vernon (1957) has pointed out many studies of reading retardation are of dubious relevance because the subjects do not include cases of severe retardation. Probably one reason for this is that despite the views of many educational pessimists, illiterate children are quite rare. In a survey conducted by the Ministry of Education (1957) it was found that of 1,741 senior children and 1,374 junior children only two juniors and no seniors were totally unable to read. Even in the area of a large education authority it often proves impossible to assemble a group of such children, and the investigator may have recourse to collecting a series over the course of several years.

The E.S.N. Group discussed above were without exception poor readers, but this might be expected in view of their limited intelligence. A series of very severely retarded readers with a wider spread of intelligence was collected. These were children who had been referred to the school psychological service or the Child Guidance Clinic after other methods of help had failed. In the great majority of cases they were complete non-readers when referred, but by the time audiometric testing was undertaken they had shown some improvement in reading as gauged by word recognition tests. None, however, had a Reading Age of more than 6.5 at the time of testing. The series included thirty boys and five girls (a characteristic sex difference in this field). None of these children had figured in any of the other surveys.

Although 21 of the 35 children proved to have U.A.L.s below the equivalent age means of the main survey, in only four cases is the difference greater than 2 standard deviations. Table 18 shows that the group mean U.A.L. is 17.22, which is very close to the general mean for the child guidance clinic group. The number of girls in the present group is too small for valid comparison, but there would appear to be no significant difference between the sexes in this, as in the other surveys. Six of these children achieved thresholds of 19 Kilocycles or above. So auditory limitation is certainly not the only factor operating towards the group's retardation.

Table 19 shows the distribution of U.A.L.s by I.Q. Unfortunately this group contains no child with an I.Q. above 108, and a preponderance of children with I.Q.s between 80 and 94. Nevertheless, some trend is to be found in the contingency table towards the association between intelligence and high frequency acuity that was noted in the child guidance survey. It is of interest that the present distributions are closely comparable with those in the relevant I.Q. range of Table 12 where the parallel figures for the child guidance cases were presented. Furthermore, comparison with the distribution figures for the E.S.N. group (where the maximum I.Q. is five points below the minimum one of the backward readers) indicates that the trend in the former group is towards a lower continuation of that in the retarded readers group.

If the present group is now split according to personality type the effect noted among the clinic group is at once clearly noticeable. As before, the children were psychiatrically classifed where possible as "anxiety state" or "hysteric". Those who could not be so classified were entered as "Mixed or Dubious". Many of these children fell into the latter class. This was to be expected, as many of them did not present any exaggerated emotional reactions or behavioural traits which might have facilitated classification. Several of them showed over-dependance upon their mothers or slight immaturities of speech without this being so pronounced as to warrant their inclusion in an "immature" class. Others showed withdrawal or anxiety, but only regarding their school failure, whereas their behaviour at home or in play groups did not substantiate their classification as "anxious."

Tables 17 and 18 show the means and standard deviations of I.Q.s and U.A.L.s in terms of clinical categories. As in the child guidance clinic survey, the "Anxiety State" children have an insignificantly higher mean I.Q. and a significantly higher mean U.A.L. than the "Hysteric" children. As might be expected the "Mixed" group results fall between the other two. All the six children with U.A.L.s of 16 kilocycles or less had been classified as "Hysteric", and four of them had I.Q.s of 80 (three cases) or 82 (one case). At the other extreme, of the six children who achieved threshold readings of 19 kilocycles or above, four had been classifed as "Anxiety State", and only one as "Hysteric." Only two of them had I.Q.s in the eighties.

To summarize, there does seem to be some association between limited high frequency auditory ability and retardation in reading. But this may be attributable to the variables of intelligence and personality, the associations of which with HF ability have already been noted. This group of severely retarded readers contained more hysteric children than anxious ones, and although it included no E.S.N. children it did contain a majority with I.Q.s below the average. In general those of its members who were classifiable as "anxious" and those of average intelligence had quite high U.A.L.s.

E. AN EXPERIMENTAL STUDY OF CHILDREN WITH HIGH-FREQUENCY AUDITORY WEAKNESS - METHODS.

1. Subjects and Matching Procedures.

As has been noted, the audiometric survey revealed no indication of any dichotomous distribution of upper auditory threshold. "High Frequency Weakness" may therefore be regarded as a relative lack of ability (or, to be more precise, a relatively limited response) compared with the sample norms, which themselves vary with age. For present purposes it was decided to classify as H.F.W. those subjects whose upper auditory limits fell two standard deviations or more below the means of their age-groups.

The consistently narrow spread of results in the survey has already been emphasized. Of the 209 children tested in the main survey only 4 girls and 1 boy were found to have given responses outside this lower limit.

Further cases of HFW were found by examining the School Health Service records (totalling over 600) of all children still at school who had been audiometrically examined by the medical services. Where any audiogram showed a pronounced upper tone loss the child was traced and re-tested on the Marconi equipment. Thirty one such children were tested. It may be noted here that the majority of these S.H.S. re-tests proved not to be cases of HFW. Their original results were presumably attributable to temporary catarrhal and other physical conditions or to differences in motivation or testing procedure.

It will be recalled that 161 children had been tested during the surveys of special groups. A further 40 children in attendance at the child guidance clinic were also tested subsequently. Requests to head teachers for the referral of possible cases of HFW led to 23 more children being tested.

Thus a total of 464 children were given full audiometric testing using the Marconi apparatus, as well as the 739 children who had been tested with the Galton whistle.

From all sources 15 boys and 15 girls were found. Unfortunately these numbers were reduced by removals from the area, school-leaving and, in one case, committal to an approved school. The numbers of subjects finally included in the experimental group were 9 boys and 11 girls, a total of 20. The sources from which they were drawn are given in Table 2.

Although the majority of language tests to be used had been standardized on English populations, variations between areas and socio-economic groups have been found to be pronounced, whilst the effects of different types of education must be of central importance. To compare the developmental levels of a group of subjects only with the published norms would be of dubious value. As a finer control, therefore, each experimental subject was paired with another child matched as far as possible for:-

a) Age.
b) Sex.
c) Socio-economic status.
d) Non-verbal intelligence.
e) Area.
f) School and class.

Selection of possible controls in the cases of variables a), c) and e) was easily made by considering children in the same school class (f)). This narrowed down possible matches to about five in each case. From these a final selection was made on the basis of score on the non-verbal test of intelligence.

As will be seen it was found possible to select controls of the same sex who were of suitable age to within three months and within the same intelligence bracket to within 5 percentile points.

Any assessment of language development is obviously crucially related to intelligence. But the normal "verbal reasoning" group tests or the "mixed" individual tests involve a large measure of the very language abilities which in the present study it is intended to isolate. The use of a non-verbal test of reasoning is clearly indicated. It was decided to use Raven's Progressive Matrices, a widely used non-verbal test which utilizes meaningless figures to gauge the subject's capacity for the formulation and development of systems of relations. It involves observation, analysis, learning and reasoning. Its author claims that a subject's final score "provides an index of his intellectual capacity, whatever his nationality or education" (Raven, 1956, p.1).

The test is known to be of high validity and is satisfactorily standardized down to the 8-year level. (A "junior" version exists, but is less satisfactorily standardized and insufficiently discriminative). Its scores may be interpreted in terms of percentile ranks or of mental ages.

One note of caution may be sounded with regard to the use of the Matrices with children. Walton (1955) has noted the relatively low scores achieved on the test as compared with results on individual tests of intelligence. He attributed this finding to the administration of the test by inexperienced testers. A more important factor is probably that of motivation. Quite large discrepancies may be found between the results of children when they are tested in large groups and when they are tested individually or in small groups. Furthermore, the test is probably less effective with children or dull or anxious adults when it is presented (as it commonly is) as a speed test, with a time limit of twenty minutes. Some such factors may well have been responsible for the results which led Gaskill (1952) to conclude that the test was not suitable for deaf children, because half his subjects scored below average.

2. Tests of Speech and Language Skills.

In preparation for the assembly of a battery of speech and language tests the literature was searched for evidence as to which aspects of linguistic function were most highly correlated with general language development. The most suitable tests were then selected from among those available in terms of validity, objectivity of scoring, reliability and, where possible, the provision of English "norms".

a) Speech Articulation.

The Francis Phonetic Word List.

Errors of articulation may be noted during observation, but a more usual and objective method is to require the subject to repeat each of a list of words known to contain the sounds and sound-combinations in general use in the English language. Such a list was prepared for the writer by Mr. T.R. Francis, L.C.S.T., a senior speech therapist and audiologist. It includes all the consonantal sounds in the three positions - initial, medial and final - in which they can appear in words. The test is reproduced in Appendix E. The words were spoken in a standardized manner (by the same tester throughout), the speaker's face being shielded from the subject to preclude visual cues. Errors in response were noted phonetically.

As reported earlier, children aged eight and above should make no errors, so that even one incorrect oral reproduction may be regarded as evidence of a defect or immaturity of speech. In order to provide some score representing the degree of defect a method reported by Barker (1960) was used in the present study. A numerical score is

assigned to each sound according to the number of times that sound would probably occur in a sample of 100 sounds. Such a method provides a numerical estimate of intelligibility, because as Barker points out the inability to produce an oral sound not in common use cannot be considered as severe a problem as the inability to produce more frequently used sounds. By subtracting the total error scores from 100 the tester may derive an Articulation Score which indicates the percentage of the subject's speech which theoretically, should be intelligible to the listener. Unfortunately, this method depends upon the extensive word counts carried out in the Bell Telephone Laboratories in America, which may not be absolutely comparable with speech habits in this country. However, no such reliable data have apparently been yet reported for English speakers in the British Isles.

Evidently, neither the Francis word list nor the Barker scoring method can give any indication of the rhythm or cadence of speech, which contributes to intelligibility, being often itself defective and reflecting immaturity and auditory handicap as well as possible organic impairment. For this aspect of speech reliance had to be placed on the tester's subjective judgment.

In judging the correctness of articulatory responses local accent and dialect must be taken into account. In the present instance due allowance was made for local speech anomalies after consultation with Mr. Francis, who had long professional experience in the area and who had made a study of local speech sounds and their derivations.

b) Vocabulary.

The Mill Hill Vocabulary Scale (Raven).

That the child's vocabulary correlates highly with other measures of linguistic development has been reported by many investigators, including Williams and McFarland (1937), Schonell (1948), Yedinack (1949) and Schneiderman (1955).

Size of vocabulary increases rapidly after the establishment of the first few appropriately-used words. Many studies have reported this increase, the rate of which slows down at about five years of age. By then most children's vocabularies are so large (M.E. Smith, 1926, for example, estimated the mean vocabulary at five years as 2,072 words) that complete enumeration becomes impracticable and sampling methods have to be used. Serious methodological problems are immediately encountered, regarding the choice of representative words, their "meanings" and acceptable definitions. But over-riding these technical difficulties is the fact that, as with other aspects of language development, vocabulary acquisition varies considerably with socio-cultural environment. Not only are there enormous individual differences, but for instance, American "norms" are not applicable to English children.

Evidently, the present need is for a sample vocabulary test which has been standardized on English children, preferably of the area to which the experimental subjects belong. No locally standardized test existed. Of the several available tests that chosen was the Mill-Hill Scale. This consists of two parallel series of words graded for

difficulty of meaning. If the subject is unable to read or write he is required to explain the meaning of each word as it is read out by the tester. This is known as the "Oral Definitions Form" of the test. Otherwise he is asked to read each word in Set A and write down its meaning, and for each word in Set B to select a synonym from a group of six words presented with it. Scores may be interpreted in terms of percentiles or of "Vocabulary Ages" in years and half years. Separate norms are provided for children doing the Oral or Written form of the test. (Raven, 1954).

c) Oral Language.

Watts' English Language Scale.

Watts (1944) has pointed out that linguistic development may be regarded as consisting, on the one hand, in the gradual accumulation of a stock of words useful for naming purposes and on the other hand, in the growth of an ability to put words together for the expression of what one may wish to say about the objects, ideas, etc., named. For the present study the vocabulary test may be regarded as a direct estimate of the development of the first process. The choice of measure of the second presents more difficulty.

The child's linguistic development is shown by his ability to select the most apposite words and combine them appropriately in continuous speech. The mass of studies of sentence development reflect, then, not only the pedagogic interest in grammar as a central school subject, but the psychological interest in children's understanding. As the child matures his comprehension of ideas and his perception of relationships improve. If his use of language is developing normally, his increasing awareness will be expressed in an increasingly complex sentence structure. McCarthy (1954) summarized her own work and that of many other writers to show a steady increase in the complexity of children's verbal sentence formation, from the single word stage at ages 4 to 12 months up through the complete sentence stage at about 4 years. By about this age compound and complex sentences number 6 to 7% of the total of comprehensible responses and remain at about the same proportion in the speech of

9½ year-olds. (Few investigators have studied the oral language development of children of school age, but major reports confirming this increase in sentence complexity among schoolchildren have been presented by Davis (1937), Watts (1944) and Harrell (1957)).

A relatively standardized way of gauging this level of complexity would be to require the child to describe a series of situations in which an increasing number of objects or ideas was presented in an increasingly complex relationship with each other. The child's level of mastery of language should be indicated by his ability to describe the situations succintly and in appropriate sentence form. "Norms" could be established according to the degree of complexity which could be handled by subjects of various ages. This is exactly what Watts (1944) has attempted to do in his English Language Scale. Although not in wide use it seems to be the only test of its kind standardized on English children.

The test consists of 36 pictures arranged in six year-groups from 4 - 5 to 9 - 10. The child is required to describe each picture orally, starting with the words, "This is a picture of ....." The first two pictures of each set are used as examples, the tester describing them for the child in the desired form. The pictures increase in complexity of content, demanding increasing ability in English usuage if they are to be described neatly. Criterion examples are provided, enabling scores to be allocated which can be interpreted in terms of "Language Age".

d) Written Language.

i) Written Composition.

The free composition is the conventional and most convenient way of collecting data for the assessment of a child's level of linguistic skill and ability for self-expression. For this study each child was merely required to write an essay on the subject of "Home". The main problem was that of deciding upon the type of assessment most appropriate to the present investigation. The normal school "essay marking" approach was discarded as being too subjective and insufficiently discriminative for present purposes. Instead the literature was again searched for those features which had proved to be readily and objectively determined and which correlated most highly with other indices of linguistic development.

Authorities such as Burt (1950) and Schonell (1948) have reported that the amount written may be a useful criterion of children's attainment in written composition. There is abundant evidence that the number of words written increases with age. In this country Schonell (1948), in an examination of different types of essay topics, found regular increases between ages seven and thirteen. In America the normal children in Heider and Heider's (1940) study showed regular increases between ages eight and thirteen, after which there was a slight drop in length, whilst Harrell (1957) found regular increases between ages nine and fifteen. Ford (1954), studying the essays of New Zealand schoolchildren, found regular increases between ages seven and twelve.

In the present investigation, therefore, the first measure used for assessing the written compositions was simply the number of words written initially.

Traditionally grammarians have proposed the sentence as the natural linguistic unit - the equivalent of the complete thought. Jesperson (1924), however, has distinguished between "free expressions" and "formulas" the latter being forms which are incapable of variation. And Watts (1944) has pointed out that the natural linguistic unit may be a word or a phrase or a sentence. The chief objection to the use of the sentence as a unit in the analysis of written material is that put forward by LaBrant (1933). She pointed out that it is impossible to determine what constitutes a sentence unless the punctuation is perfect. The division of children's compositions into sentences, then, must be to some extent arbitrary, particularly when the children are young, retarded or linguistically immature.

LaBrant advocated the study of clauses instead of sentences, because the identification of predicates is simple and objective, whilst the psychological importance of the clause has been shown by Piaget (1927) and Jesperson (1922). The measure she suggested was the 'subordination index' which is the ratio between the number of subordinate clauses used in a piece of writing and the total number of clauses used.

LaBrant's own study demonstrated that clause usage is a significant indicator of language development. In a detailed analysis of compositions by 986 pupils there was a significant increase in the subordination indices between ages 8 and 16, the correlation being

higher with chronological age than with mental age. Similar findings were reported by Frogner (1933) and Harrell (1957). Watts also used this method, but his English children used a far greater proportion of dependent clauses than their American counterparts. Also Watts insisted that the percentage and variety of subordinate clauses used was directly related to intelligence rather than to chronological age. Despite these differences all these studies support LaBrant's basic claim.

In the present study, therefore, the sentence structure of each composition was analysed, and "subordination indices" computed. When a composition was regarded as being too short for analysis results to be reliable, the child was asked, at a later date, to write another composition on the subject of "What we did in the school holidays" so that no sample of writing should be less than 100 words in length. (In the event, as will be seen, it still proved necessary to discard the work of several of the HFW group).

Although it was now possible to compare the experimental subjects with their matched controls, no general "norms" existed for comparison with wider populations. The standards of written compositions vary considerably with such factors as race, geographic area and educational methods and demands, as well as with individual factors. It would obviously be outside the scope of this study to attempt the establishment of appropriate norms. As a rough guide however, a small sample of compositions was collected locally and analysed. The results, for what they are worth, will be presented here for comparative purposes.

d) Written Language.

ii) Schonell's Test of Sentence Structure.

Whilst the written composition represents a sample of the child's free written language, it was felt that a "forced choice" situation comparable to the Watts oral test would also be of value. The Schonell Test of Sentence Structure (Schonell and Schonell, 1950) has many similarities to the Watts test. It is a timed test of English usage and comprehension, consisting of seven groups of short sentences. The child is required to combine each group (numbering between two and four sentences) into one long sentence. The series increases in complexity, demanding an increasing ability to handle subordinate clauses and phrases and the use of conjections and other connectives. Marks are allocated according to the differing merits of varying sentence joinings. Scoring principles and specimen sentences are provided, enabling numerical scores to be awarded which may be interpreted in terms of "English Ages".

e) Reading Ability.

There is an embarrassment of choice of measures of skill in reading, as well-standardized tests of proven value exist in plenty. It was decided that two tests should be selected, representing the two most widely accepted aspects of reading - word recognition and prose comprehension. Two well-known tests were ventually chosen because not only are they of accepted validity but because they are in such general use that Reading Ages determined by their use are readily comparable with other findings.

(i) Word recognition.

Schonell's Graded Reading Vocabulary Test.

This is a test of simple word recognition with spoken responses. The child is presented with a test card, in appropriate print, of words which are arranged in order of difficulty. The list is divided into groups of ten words, each group representing one year of "Reading Age". Ages 5 to 15 are represented in this way. The basal level is taken to be 5.0 years, and each correct response counts as one-tenth of a year, the final "Reading Age" of any child being calculated by totalling correct responses and adding 5. Thus a child who gave 32 correct responses would be regarded as having a R.A. of 8.2.

The child is instructed merely to read each word aloud, being given no assistance but being stopped only after a run of twenty consecutive failures.

The Schonell test of "mechanical" word recognition (Schonell and Schonell, 1950) is probably the reading test most widely used in the British Isles. It is well standardized, although there is some doubt as to the current validity of the extremes of its range (Reed, 1953)

(ii) Comprehension.

The Kelvin Measurement of Reading Ability (Fleming).

This is a test of the silent reading and comprehension of running prose. Whereas the Schonell test requires the recognition and oral reproduction of separate and unconnected words the Kelvin

test is designed to gauge understanding of meaning. It consists of five short passages arranged in order of difficulty both of words and content. The child is required to read each passage in turn and to write answers to printed questions about each one. These questions are so designed as to require only one- or two- word answers, errors of spelling or writing being ignored for scoring purposes. Scoring is objective. The test is standardized for years 8 to 12, and scores may be interpreted as Reading Ages or standardized scores.

F. AN EXPERIMENTAL STUDY OF CHILDREN WITH HIGH FREQUENCY WEAKNESS - RESULTS.

1. The Subjects - Sex, Age and Intelligence.

As may be seen in Table 21 of the twenty children identified as having some auditory high frequency weakness eleven were girls and nine boys.

Their ages ranged from 8 years elven months to 13 years eleven months.

Age:	8	9	10	11	12	13
Numbers:	1	0	5	5	5	4

Although no conclusions as to age distributions can be drawn from such a small sample it is of interest that the younger age groups tested in the survey did not yield more possible HFW cases. Especially is this so in view of the difficulties of audiometric testing. It had been expected that, quite apart from organic auditory impairment, limitations of understanding and attention in the younger children would be reflected in inconsistency of response and wider scatters of performance thresholds. In practice this was not so.

On the other hand, as has already been pointed out, the majority of children in the experimental or HFW group were identified from clinic records and school referrals. Such sources may provide biassed samples by excluding very young children. Teachers may suspect pupils of having some mild degree of hearing loss but not refer them for audiological or psychological examination except as a last resort, whereas more obvious cases of deafness are usually identified

before starting school. In the same way, and very relevant to the present issue, many retarded readers are not referred for special examination by outside specialists until their last year in the primary school when their teachers realize that progress is not being made despite the prolonged application of ordinary class-room methods.

Thus the composition of the present HFW group provides no evidence for a linkage of HFW with sex and only the most dubious suggestion of an increased occurrence after the age of nine.

Where intelligence is concerned (see Table 22) the Progressive Matrices test results range from 13 to 46, with percentile rankings from less than the 5th percentile in 4 cases up to the 75th percentile in 2 cases. Twelve of the twenty children achieved percentile rankings of 25 or less. The following table shows the distribution of rankings in the whole group.

Percentiles:	Less than 5	5	10	20	25	30	40	45	50
Numbers:	4	0	5	1	2	0	1	2	3

Percentiles:	Less than 60	70	75	75+
Numbers:	0	0	2	0

The positive skew of this distribution is to be expected in view of the association between I.Q. and HF audiometric response which was noted in the study of the child guidance clinic cases. However the existence of 5 cases at or above the 50th percentile would seem to negate the possibility that HF ability is merely a function of intelligence. But, it may be that the present group includes more than one type of HFW. Limited ability to respond to HF

audiometric testing may be due not only to sensory handicap but to defects of comprehension and attention, which may explain the association with personality variables noted in the surveys of child guidance clinic children and retarded readers.

2. Test Results.

a) Speech Articulation.

The Francis Phonetic Test.

It will be recalled that studies of articulatory development have indicated that substantially mature articulatory ability is normally attained by the age of 8. It is not to be expected that any test of this ability will be able to discriminate between members of a normal group of children of the age levels with which this study is concerned, as the great majority should attain perfect scores. Only the 'speech defective' minority should make any errors at all. It is not surprising, then, that no errors whatsoever were observed in the responses of the present control group when local dialect usage was discounted. Thirteen of the HFW group, on the other hand, made some articulatory error, a difference between the groups which is statistically highly significant (p is below the 0.005 level). Their error scores are presented in Table 23 along with each child's percentage 'level of intelligibility' according to Barker's (1960) figures. From the latter it will be seen that in the majority of cases the loss of intelligibility due to articulatory errors was small. On the other hand several of these children displayed other speech anomalies which are also noted in the table. Of the twenty children the speech of two, cases H and O, might be regarded as being seriously defective. To a stranger their speech would be scarcely comprehensible. That of two others, cases A and I, would also certainly give some

difficulty, being noticeably slurred and generally immature. The speech of the remainder was quite intelligible, but even the unskilled listener would probably notice the 'babyishness' of cases J, N, P, R and T.

The distribution of types of error is presented in Table 24. It will be noted that the most common errors were made in reproduction of the following consonants:

TABLE 9.

CONSONANT SOUNDS MOST COMMONLY MISARTICULATED BY THE HFW GROUP.

Sound			Number of Cases
Initial	θ (unvoiced 'th') as in	"thumb"	7
Medial	θ	"panther"	6
Final	θ	"bath"	6
Initial	's'	"sun"	3
Medial	's'	"pencil"	7
Final	's'	"house"	2
Medial	't'	"letter"	4
Medial	ð (voiced 'th')	"mother"	3
I.,M.,F.	ʃ (unvoiced 'sh')	"shoe"	3
Initial	'p'	"penny"	3

It will be noted that the list includes three of the unvoiced fricatives, voiced 'th', and two of the unvoiced plosives (see Table 3). The unvoiced consonants and voiced 'th' are, it will be recalled, the speech sounds of highest frequency. It might plausibly be suggested that the difficulties found by so many members of the present group in reproducing such sounds is associated with their poor performance on high tone audiometry in that both are attributable to sensory limitation. It must be pointed out, however, that in only one instance was an error made on the 'f' sound which is not only the second weakest speech sound but one of those of highest frequency (see

Table 4 and Figure 1). Furthermore, the voiceless 'th' and 's' are also among the last sounds to be mastered during normal development by children without impaired hearing, and are the most frequently misarticulated by pre-school children with delayed speech (Stinchfield and Young, 1938).

Sheridan (1948) has pointed out that, although the voiceless 'th' and 'f' sounds have been shown by Fletcher (1929) to be those most commonly mistaken, this is not so among children with impaired hearing. Her conclusion regarding misarticulation of these two consonants was:-

> "In the majority of cases the defect appears to be one of listening rather than of hearing.....The mistake is so common in young children of both sexes as to be almost constant, but by 6 years the child should have corrected it by ear." (page 20.)

The articulatory weaknesses displayed by the HFW group may therefore reflect organic impairment. But they may also reflect general retardation of the faulty development of attention and discrimination. A combination of all these factors may, of course, be involved.

Whatever the cause may be, the association between HFW and articulatory errors seems fairly clear. Furthermore, seven of the HFW group had received speech therapy at some time. Two of these made no error on the Francis test, having previously been stammerers as opposed to dyslalics. Also it was noted that the intonation of nine of the group was infantile or faulty. Of these two had made no errors on the Francis test. So that a total of no less than seventeen of the HFW group could be regarded as having a current or previous speech disorder of some type.

b) Vocabulary.

The Mill Hill Vocabulary Scale.

	Percentile Ranks												
	5	5	10	25	30	40	50	60	70	75	90	95	95+
HFW	10	3	2	2	0	0	1	0	0	2	0	0	0
Controls	2	3	0	1	0	1	5	1	0	5	2	0	0

On the Vocabulary test ten of the HFW group achieved scores which graded them below the 5th percentile, only three children scoring at or above the 50th percentile. Results are presented in Table 25. The superiority of the control group is statistically significant beyond the 0.005 level of probability, this being one of the two tests where no HFW child was superior to his matched control.

Such a finding implies that at least where these children are concerned, there is a clear association between relatively poor response to HF auditory testing and a limited vocabulary. Scores on a vocabulary test are usually taken as an indication of the size of acquired vocabulary. It may be objected, of course, that such scores do not necessarily imply a limited repertoire, but a limited ability to define, explain or identify words. Theoretically this may be so, but functionally, as far as general usage and, more specifically, class-room performance are concerned, the outcome is the same. Such children are relatively limited in verbal comprehension and expression.

Some striking discrepancies emerge between the groups' performance on this test and on the parallel Progressive Matrices test of intelligence. HFW cases C.D. and F, who scored at or above the 50th percentile on the Matrices here achieved scores at only the 25th,

10th and less than the 5th percentiles respectively. The control group, on the other hand, tended to achieve higher percentile ratings on the vocabulary test than they had on the intelligence test.

In fact the HFW group proved to be relatively retarded in their acquisition of vocabulary. This suggests that under normal conditions children with HFW benefit less from educative processes than normal children of equivalent intelligence and opportunity.

c) Oral Language.

Watts' English Language Scale.

	"Language Ages"									
	5½	6	6½	7	7½	8	8½	9	9½	10
HFW	1	2	5	1	5	4	2	0	0	0
Controls	0	0	0	0	4	7	1	4	4	0

Individual results on the Watts test are presented in Table 26, while the distribution of equivalent Language Ages is summarized above. Only six of the HFW group achieved a Language Age of 8 or above, the highest score in this group being equivalent to a L.A. of 8-11, and the lowest 5-9. Of the controls sixteen achieved a L.A. of 8 or above, the highest L.A. being 9-9 and the lowest 7-6. In no case did a member of the HFW group achieve a better score than his matched control. The difference between the groups on this test was significant at well beyond the 0.005 level of probability.

No child achieved a perfect score, equivalent to a L.A. of 10-0, and the general discrepancy between C.A. and L.A. of even the controls may be interpreted as indicating that the test is either of faulty standardization (being too difficult at the top end) or that it is inappropriate for older children. This, however, does not impugn the test's validity, whilst the spread of the present results indicates that it is quite discriminative.

The types of error made by the HFW group were consistent with retardation in language development. They may best be described with the help of examples of incorrect responses made to each "Stage" of the test, and illustrative graded examples of responses from both

HFW and control children are presented in Appendix D (pages 162 - 168). In general the HFW children's responses were consistently those appropriate to younger children. As a group they tended to use simple sentences. Sometimes these were crudely joined by the use of 'and'; the use of more sophisticated connective devices proved to be beyond the capacity of almost all of them. Less than half of them could use any relative pronouns correctly, whilst at the nine to ten year level, which demands the use of a subordinate clause linked by the relative 'which', only two HFW children produced any correct responses at all. The responses of fourteen of these children were characterized by an inability to express more than one set of actions in the same sentence, a level of linguistic skill which has been attained by normal children before the age of eight.

Quite clearly the HFW children are relatively retarded in the development of spoken language. It seems unlikely that this can be the outcome of faulty comprehension, as the content of the pictures is commonplace and readily understood by children, whilst each stage is preceded by explanation and examples. In the worst cases, A, Q and T the majority of responses were merely enumerative statements, such as "A lad and he's in the water", or "A girl and her hat's off." In studying responses at this level it is difficult to disentangle the outcome of limited intelligence from that of immature language development. It is presumed that in general a close association exists between the two. But that in these instances the latter is merely the result of the former is a suggestion that cannot be taken

for granted. The control children, of similar age and intelligence, achieved much higher Language Ages than their HFW counterparts. Furthermore the HFW member of the most intelligent pair in the study, case B, achieved one of the poorest results with a Language Age of only 6-8, whilst his control achieved the highest L.A. of all these children (9-9).

Two other points are worthy of mention. The first is that the HFW children tended to use less graphic verbs than the controls (for example, "holding" as opposed to "hugging") and less colourful descriptions. This was noticeable in all cases except C.

Secondly, and perhaps related to this, the HFW children tended towards inaccuracy or vagueness of statement. For instance they commonly referred to a toy in one of the pictures as simply a "doll". The majority of the controls correctly observed that the drawing portrayed a golliwog. In the next picture an object dropped by a boy was described by many HFW children as a "ball" (incorrect) or as a "pot" (generalized), whereas the controls usually correctly specified a "cup" or a "vase". The scoring is not affected by such differences, so that inaccuracy and vagueness is not reflected in the already low Language Ages attained by many HFW children. It is open to doubt whether this tendency is due to sensory/perceptual factors or is related to attention or set.

d) Written Language.

i) Written Composition - Number of words written.

	Number of Words.					
	Nil	50	51-100	101-150	151-200	200+
HFW	2	6	5	5	2	-
Controls	-	2	4	8	2	4

Cases A and T proved to be quite incapable of writing words and their attempts have therefore been excluded from the analysis. Several other experimental cases produced very primitive attempts, but these consisted of letter groups which could be clearly identified as "words" so that it seemed reasonable to include them in this part of the analysis.

As stated earlier no suitable population norms have been published; to provide a rough comparative guide, therefore, essays on similar topics were drawn from small but reasonably representative samples of local children at each age level. Table 27 contains the means and standard deviations of the results and in Table 28 the relevant sample figures are presented alongside each of the experimental results. Compared with the sample results, the experimental group wrote much fewer words per composition. In six cases the total was three or more standard deviations below the appropriate sample mean. None of them achieved a total above the sample mean, and only two, cases C and F, scored less than one standard deviation below it.

The controls, on their part, were also less productive than the samples. But only two of them produced totals which fell three or more standard deviations below the sample means, whilst six of them were within one standard deviation. Control cases B and N produced

totals above the sample mean.

The superiority of the control group over the experimental group is statistically very significant, so that whether the sample tentative 'norms' are reliable and relevant or not, there seems little doubt that the HFW children as a group are severely limited in their output of words when writing a "free" composition. But whether this limitation is a valid indicator of linguistic weakness depends upon the quality of the writing.

Templin (1950) who examined 850 deaf and hearing children in her study of development of reasoning, found that the written language of the deaf children was more immature than that of the hearing. But she noted that the deaf children tended to use more words in description or explanation than did the hearing, because of their lack of precise vocabulary. The brighter children of normal hearing also used more words - but these reflected more complexity, detail and precision.

In the present instances, as will be seen, the paucity of words written by these children did not represent conciseness of presentation and economy of style. It was associated, apparently, with a paucity of ideas and with clumsiness and immaturity of language usage. It would seem that in this case at least, a grossly restricted output has been a valid index of poor content and undeveloped form.

d) Written Language.

ii) Written Composition - Subordinate Clauses.

		Subordination Indices							
	Could not be analyzed	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36+
HFW	5	4	3	4	1	0	2	1	0
Controls	0	1	3	3	5	4	1	2	1

The compositions of no less than five of the experimental group had to be excluded from this analysis. Cases A and T had proved to be unable to write words at all. The compositions of cases G, H and I, although composed of recognizable word groups, were so short and primitive that clause analysis was impossible.

For example, case G, a boy aged almost twelve, of average intelligence, was unable to write more than the following despite urging. His handwriting was quite legible and sense may be made of what he wrote:-

> "In th summer holbooday I wold lick to go to brten of a day or tous or some where els lick scarbara or bridlington some over bnow lik frans or there or germany or even span blackpool and meet famos pepole like the army gam at the hyerdorn in black-pool."

Case H, a boy of twelve, of just below average intelligence, produced the following in legible handwriting. He was quite pleased with his effort, which refers to the excitement of the recent re-decorating of his home:-

> "My houes is a Red houes are and. I you some. Red on for littel houes and put some Red on you. and But"

Case I, a boy of almost twelve, well below average intelligence, wrote legibly:-

> "I lot to go to onse and ton the paten and rat the paten watn my paten and see ot wde wied"
> (I like to go to Hornsea and take the pigeons and race the pigeons with my pigeons and see who would win.)

Even when the work of its five worst members is discounted the HFW group proves to be much inferior to the control group where clause usage is concerned (see Table 30). The difference between the group subordination indices is statistically highly significant, falling below the 0.005 level of probability.

Of the fifteen members of the experimental group whose compositions could be analyzed, it will be noted that four used no subordinate clauses at all. Only experimental cases D, N, O, Q and S achieved a subordination index within one standard deviation of the appropriate tentative 'norm' mean. In only one case, that of D, was the experimental group member's index above that of his control, whilst in only three cases, D, O and S, did it fall above the 'norm'.

As a group the controls were somewhat below average. But thirteen of them achieved subordination indices within one standard deviation of their respective 'norms'. However, only three of them, cases B, O and S, achieved indices above the appropriate norms.

These results indicate a decided immaturity in the development of the HFW group's written language. They parallel the poor results attained on the Watts oral test of language development. These children tend to express themselves in short, disconnected phrases or sentences. This is not a question of economy or condensation of expressed ideas; it is more suggestive of concreteness or even poverty of thought. Some examples may make this more clear. In each case a comparable excerpt from the composition of the control pair is presented, with chronological and reading ages.

Case: K. C.A. 11-10. R.A. 9.7

"I live on Longhill Estate. It is very nice there. It is the bigers Estate in Hull. I have a very nice house. It is on Waveney Road."

Case: Control K. C.A. 12-0. R.A. 7.9

"At home we have a television and a radiogram and if I have nothing to do I wach the tele ore I listen to the gram."

Case: E. C.A. 12-0. R.A. 12.2

"At home on a night I do my jobs and then I watch television and about half past ten I go to bed. In the morning I get up at 6 o'clock and make my mum and dad a cup of tea and get washed and go to school."

Case: Control E. C.A. 11-9. R.A. 12.3

"(My father) takes all the fishing orders of the trawlers that go to Iceland and fish. Last week one of the trawlers came back damaged and had to be repaired in St. Gorges dry Dock."

Case: B. C.A. 12-7. R.A. 14.0

"Home is everybodys favourite place. I like to be at home best of all. I live in Marlborough Ave. My bedroom faces the Avenue, every morning the sun shines in through my bedroom window."

Case: Control B. C.A. 12-4. R.A. 13.3

"In the house at the corner of the street, which is our house, there was a hustle of wrapping paper, because all the family were wrapping there presents up and the dog lay like a dead monster on the best chair, and the cat lay on top of it asleep, and sound."

In each case the HFW child's excerpt seems to be only a catalogue of description or serial action. With increasing intelligence (K is below average intelligence, E is quite average, and B is well above average) it is true to say that some development of ideas takes place.

But although on this scanty evidence the children shine through as well-meaning home-loving and amiable, their expression is flat and the content lacking in interest. Their matched controls, on the other hand, writing on the same topics, manage to evoke personal qualities and relatively vivid images. The most intelligent boy infuses immediate life into his simple tale with his made-up or misused word "hustle", which is at once onamatapoeic and suggestive of the busy atmosphere, whilst a pleasingly humorous and apt image is evoked by his "dead monster on the best chair."

It is of interest that the HFW children's subordination indices bear little relation to the results on the Schonell word recognition test, for many of these children who showed such poor ability in the handling of sentence structure showed themselves, as will be seen, capable of quite reasonable levels of mechanical reading. Thus the four children B, E, K and M, who used no subordinate clauses in their compositions achieved Schonell Reading Ages of 14.0, 12.2, 9.7 and 12.2 respectively. The cases A, G, H, I and T, whose compositions had to be excluded from analysis, had Reading Ages of 8.6, 8.4, 7.1, Nil and 8.3 respectively.

d) Written Language.

iii) Sentence Structure.

	English Ages												
	No Score	8	8-0	8-6	9-0	9-6	10-0	10-6	11-0	11-6	12-0	12-6	13+
HFW	8	1	3	4	1	1	0	1	0	0	0	0	1
Controls	0	3	2	5	2	2	3	2	1	0	0	0	0

Table 31 presents each score on the Schonell test of sentence structure and its equivalent "English Age" according to the test manual. Eight of the HFW group made no score at all, and another scored only 2, which is below the basal score (of 3) to be allotted an English Age in the norms. None of the control group failed to score, but three of them scored below 3. In all but two cases the matched control was superior to his HFW counterpart, and the difference between the groups is statistically significant at the .005 level. The test proved to be too difficult for the majority of these children and was therefore not discriminative among the low scorers. Of the controls only four achieved English Ages within one year below their Chronological Ages, and none attained an E.A. above his C.A. In five cases the C.A. - E.A. discrepancy was four or more years. Of the HFW group one boy, B, did in fact achieve an E.A. above his C.A., but no others scored E.A.s within a year of their C.A.s, whilst in eight cases the discrepancy was four or more years.

That the test is in any case insufficiently discriminative at the bottom end is indicated by the fact that each additional mark between 3 and 6 represents an increase of six months E.A. in the norms provided. Nevertheless this type of test would seem to be a

valid and ingenious method of gauging ability in the construction of sentences. The fusing of simple sentences into compound or complex ones may be done with increasing skill by the use of conjections, by inversions, by the substitution for the simple sentences of adjectives and adverbs or adjectival or adverbial phrases, or clauses. These grammatical devices are progressively more difficult to handle correctly, but the most difficult method is, of course, not always the most appropriate. The best method in any particular instance will be that which is grammatically correct and stylistically agreeable. Furthermore it must express the ideas contained in the original simple sentences concisely, with clarity and precision. The majority of those HFW children who scored at all on this task used only the simplest of joining words and usually failed to present their material either gracefully or aptly. A selection of representative examples have been collected from the answers given to test "Group 3". Here the child is required to make the following three short sentences into "ONE complete sentence in the best and most sensible way you can."

Group 3. (1) Tom Hunter was a young cabin boy.
(2) Tom Hunter saved the ship.
(3) The ship was in danger of striking a rock.

(Each of the examples will be preceded by its writer's chronological and reading ages for comparative purposes).

The crudest method used by a child whose work was scoreable, was that of HFW case K, who merely ran the simple sentences together:-

Case: K. C.A. 11-10. R.A. 9.7

"Tom Hunter was a young cabin boy Tom Hunter saved the ship the ship was in danger of striking a rock."

The most commonly used technique was to insert simple joining words, such as "and", "so" or "because."

Case: D. C.A. 10-11. R.A. 11.3

> "Tom Hunter was a young cabin boy and Tom Hunter saved the ship because the ship was in danger of striking a rock."

This is a somewhat more developed method than that of the first example, but the consequential "because" is not apposite. The next example avoids this, but in so doing adds some information to the original and deletes more.

Case: M. C.A. 13-11. R.A. 12.2

> "Tom Hunter was a young cabin boy and Tom Hunter new the ship was in danger so he saved the ship."

Both these examples are noticeably cumbersome. The next, although it introduces slightly less common conjections, is equally lacking in economy:

Case: C. C.A. 13-4. R.A. 12.7

> "Tom Hunter was a young cabin boy when Tom Hunter saved the ship for the ship was in danger of striking a rock."

This boy's control produced a version which, whilst being factually less correct and structurally equally weak, at least strives towards condensation:

Case: Control C. C.A. 13-7. R.A. 12.3

> "Tom Hunter was a cabin boy, the ship struck the rock and he saved it."

Similarly, the next example represents a development towards condensation, with its avoidance of repetition in the use of 'it', and an appropriate use of the slightly less common conjection, 'when'.

Unfortunately, complete success is not attained, because the writer's linguistic development has not yet encompassed a consistent use of relative conjunctive pronouns:-

Case: S. C.A. 11-10. R.A. 13.3

"Tom Hunter was a young cabin boy he saved the ship when it was in danger of striking a rock."

Full marks on this item were allotted to both B cases. Even here, however, the HFW member's version, though quite legitimate, is cumbersome by comparison with that of his control:-

Case: B. C.A. 12-7. R.A. 14.0

"Tom Hunter who was a young cabin boy, saved the ship which was in danger of striking a rock."

Case: Control B. C.A. 12-4. R.A. 13.3

"Tom Hunter was a young cabin boy who saved the ship when it was in danger of striking a rock."

The above are all examples of varying degrees of maturity in sentence structure. Those HFW children who completely failed this test, however, showed a lack of prerequisite comprehension. HFW cases, A, E, H, I, J, N, R and T did not apparently understand how to go about the task. This was not primarily due to reading disability, for the test instructions were read through with each child by the tester and the first two test items involve only words which they were capable of recognizing. But these children either wrote nothing, or merely copied out words at random. Cases A and T proved to be unable to write. The others seemed to be hampered by a lack of reading comprehension and fluency. These children could read the individual words mechanically,

but could not read and understand the sentences as wholes. This example is fairly characteristic. It was written slowly and neatly:-

Case: R. C.A. 10-6. R.A. 7.9

"The ship was in danger a rock Tom Hunter a young cabin boy was Tom Hunter saved the ship."

In a few cases where the instructions seemed to be understood, and the test sentences could be read, the content was misinterpreted.

Case: Q. C.A. 11-8. R.A. 11.1

"Tom Hunter was a young cabin boy who tried to save the ship the ship was not in danger because it didn't strick the rock."

The great majority of the HFW cases seem, then, to fall into two groups:-

a) Those who were unable to understand the nature of the task. Many of these were unable to read and write with sufficient skill to achieve success in any case.

b) Those who comprehended the instructions and had the necessary basic skills to carry them out, but proved to be severely retarded in their ability to construct sentences.

Seventeen of these children in fact, demonstrated on this test a gross immaturity in linguistic development.

Only one of the controls could be regarded as falling into group a) above, although six others might well be classed in group b).

Symptomatic of this retardation are the lack of precision and conciseness in expression which characterized the performance of the HFW group.

e) Reading.

i) Word Recognition.

	Reading Quotients						
	60	61-70	71-80	81-90	91-100	101-110	111-120
HFW	3	3	4	2	3	3	2
Controls	-	2	3	4	6	3	2

As may be seen in Table 32, on the Schonell word list only one child (I) among the HFW group was unable to recognize and orally reproduce any word. Nine others, however, achieved Reading Ages two or more years below their chronological ages. But five achieved R.A.s beyond their C.A.s, the most superior reader being child B, whose R.A. was 14.0 as against his C.A. of 12-7.

The control group did not include any non-readers, but seven of its members showed a discrepancy of two or more years between C.A. and R.A. Five achieved R.A.s beyond their C.A.s, the best score being that of B's control whose R.A. was 13.3.

Although the average score of the controls was superior to that of the HFW group this was mainly due to a pronounced superiority of the control member in only five of the pairs. The mean difference was significant only at a level of probability between 0.10 and 0.05, which is not sufficient to disprove the null hypothesis. This test was the only one in the battery where the difference between the groups was not sufficiently great to achieve a satisfactory level of statistical significance.

It would evidently not be valid to claim that children with HFW are less proficient on this sort of test than their controls. This may seem strange in view of the differences on the vocabulary test.

However, ten of the HFW group had received some form of special remedial help with their reading over and above the class methods common to both groups. Their R.A.s may therefore be regarded as having been inflated as compared with those of their counterparts in the control group, none of whom had enjoyed such extra tuition. But any real improvement in reading ability as the result of such specialist help would be reflected also in the test of reading comprehension. As will be seen, this was not so.

The same reason weighs against the alternative explanation that among children with auditory limitations there is a tendency to seek compensation by the development of extra ability in the perception of visual symbols. Gates and Chase (1926) reported this in an examination of the reading ability of a group of deaf children, and it has also been suggested by Madden (1931) and Kennedy (1942).

A more likely explanation is related to the remedial help received by members of the HFW group. It is usual during such courses of remedial tuition to measure progress at regular intervals with word recognition tests, of which the Burt and the Schonell tests are those in most common use, so that it is possible for children in remedial groups to acquire a specific facility in their use. Indeed, Curr and Gourlay (1953) have suggested that the apparent improvements shown as a result of remedial teaching may be spurious if demonstrated in this way, the gains shown not being transferred to other types of reading ability. Curr and Gourlay (1960) and Collins (1961) have subsequently offered evidence which is claimed to support this view.

In the present case it does seem possible that the extended and specialist remedial work done with half of the HFW group resulted in an improvement in the recognition of certain words or in the performance of a certain type of reading test. But that this improvement did not extend to the acquisition of vocabulary, comprehension, verbal expression or language development. If this is so it has direct implications for educational theory and practice.

e) Reading.

ii) Comprehension.

	Percentile Ranks															
	<5	5	10	20	25	30	40	45	50	55	60	70	75	80	95	95+
HFW	6	1	1	1	2	4	2	0	0	0	1	0	1	0	1	0
Controls	0	0	2	0	3	1	3	0	2	0	1	2	2	3	1	0

On the Kelvin test of reading comprehension (see Table 33), only three of the HFW group achieved results above the 50th percentile, no fewer than six being below the 5th percentile. The control group, on the other hand, included none below the 5th percentile, whilst eleven of the group ranked at or above the 50th percentile, six of these being at or above the 75th percentile. The score distributions of the two groups are, in fact, almost opposite in trend. The difference between them is highly significant, T being below the 0.005 level of probability.

Evidently the HFW group was very inferior to the controls where reading comprehension was concerned, despite the remedial attention many had received. That this is not attributable merely to difficulties in mechanical reading is shown by the findings reported for the Schonell test. On the other hand, the method of matching should have controlled intelligence and reasoning ability. It would seem that the Kelvin test has high-lighted real differences between the groups in verbal reasoning or the use of language. This is despite the fact that the test proved to be dubiously standardized and, as reference to the raw scores will indicate, crude in discrimination.

G. AN EXPERIMENTAL STUDY OF CHILDREN WITH HIGH FREQUENCY WEAKNESS - CLINICAL AND EDUCATIONAL ANOMALIES IN THE EXPERIMENTAL GROUP.

The extent to which a group of children have drawn attention to themselves as being abnormal or immature in relation to their fellows may be gauged directly by the amount of extra attention, help or tuition which their elders have seen fit to provide for them. Obviously this will vary with the perceptivity and criteria of the responsible adults and with the variety and amount of extra help provided by the community. Thus some parents, teachers, doctors or welfare workers may not notice that a child is unduly timid. On the other hand one or all of them may notice his handicap, but because of insufficient or unsuccessful child guidance facilities in the area they may be unable or unwilling to refer him for psychological help.

Where the present group of children was concerned ample facilities existed for specialist help in the spheres with which this study is concerned - the language skills, speech, hearing and emotional adjustment. They may be listed according to their degree of "specialization":-

a) Sporadic coaching by a teacher or member of staff.

b) Transfer to the school's "remove" or backward class. Such a class is organized with small numbers and a curriculum especially designed to help those children who are retarded in the basic school skills.

c) Admittance to one of the L.E.A.'s remedial reading groups. These groups consisted of about a dozen children, usually of average intelligence, who would receive intensive coaching by a specialist teacher for half a session (two periods) daily.

d) Transfer to the L.E.A.'s special school for E.S.N. (educationally subnormal) children. Such children would generally be of less than 75 I.Q. and would only be so transferred where the ordinary school could not make satisfactory provision, where the child was not making progress commensurate with his ability, and where the school medical officer, the head teacher and the parent were all in agreement.

e) Referral to the School Health Service for special medical examination. Where a head teacher feels that a child's hearing, speech ability or general development are in doubt the school medical officer may seek the advice of a paediatrician or E.N.T. specialist.

f) Referral to the Speech Therapy Clinic. This is staffed by qualified speech therapists and caters for children with speech defects - functional, developmental or organic.

g) Referral to the School Psychological Service. Help might be sought from the school psychologists. These may test and advise, or see children individually or in a small group within the school for remedial tuition.

h) Referral to the Child Guidance Clinic. This is staffed by a psychiatrist, psychologists and social workers. Advice and/or therapy is provided for children with emotional, behavioural or educational problems. Intensive educational help is generally only provided when help under paragraphs a), b), c) or d) above has failed to produce results.

Table 34 shows the numbers of children in the experimental group whose histories revealed referral for extra help under the above headings. It is immediately apparent that the group is noteworthy not only for past referrals but for multiple referrals. Some measure of comparison is provided by the fact that the control group included only four such instances. And three of these appear in the table only because the matching procedure required control children to be drawn from the same classes as the experimental subjects. Cases A and G were currently in school "remove" classes, whilst case T was currently in attendance at the E.S.N. special school.

It must be borne in mind, of course that the 'referral' weighting of the experimental group is to some degree attributable to the fact that some of these cases were identified in the first instance by a search of the School Health Service files, whilst others were identified during the Child Guidance Clinic survey. (It will be recalled that cases D, H,I, O and R were identified from S.H.S. records, and cases B.F.G.N.S. and T were identified from current C.G.C. cases). Furthermore, there is a tendency for those children referred to the C.G.C. as reading problems to have already received some extra help, referral of such cases to the clinic being in the nature of a last resort. But although a total of fifteen of the experimental group were found to have attended the C.G.C. at some stage, only two had been referred primarily for remedial reading. Six had been referred for aggressive or immature behaviour and four for enuresis. The reasons for referral are listed in Table 35. The foregoing points do not, in any case, explain the multiplicity of referrals of the children in the HFW group. As shown in Table 36, fifteen of the twenty children had been referred for more than one type of help, and of these no less than six had had four or more referrals. The average number of referrals for the group is three.

To compare these referral figures with those from the school population as a whole would be a task outside the limits of this study. However, Table 36 presents the estimated incidence of relevant handicaps in school children. Of more practical importance are the numbers actually referred, and the table presents approximate annual referrals in the particular school population (of 46,000 children) from which the present cases were drawn. Unfortunately this takes into account

neither re-referrals (children who have been referred in previous years) nor multiple referrals (where the same children figure in more than one referral total). It does indicate, however, that under no heading are more than 0.5% of the school population referred in any one year, whilst the total annual referrals under all these headings compose less than 2.2% of the school population.

A rough estimate of <u>total</u> referrals in the whole local school population at any one time may be arrived at by multiplying these annual referral figures by ten.

It seems definite at any rate, that as a group, the HFW children have drawn attention to themselves far more and in more ways than normal children. They have been regarded as retarded or abnormal in speech, hearing, language, reading or behaviour or, more commonly, in some combination of these.

IV. DISCUSSION.

1. Some theoretical aspects of the Relationship between High Frequency Auditory Weakness and Language Retardation.

Basically, the results of the experimental study have shown there to be a relationship between HFW and various aspects of speech and language retardation. This supports the main contention of this study as expressed formally in the original hypothesis and the predictions therefrom. There still remains, however, the formulation of a theoretical structure which will embrace both this main finding, and the subsidiary findings regarding the association of HFW with intelligence and personality variables.

It will be recalled that the initial postulate which prompted the central hypothesis was that there existed children with HFW. The second part of the postulate was: "And that this impairment limits their auditory experience significantly." It will now be considered whether this second part is the only, or indeed the main, reason why HFW should be associated with language retardation. Various other possibilities may well be examined:-

a) "HFW, by limiting communication for the young child, may retard the development of reasoning ability."
This suggestion would explain the association found between HFW and the results of intelligence tests. And inasmuch as "Hysteria" is associated with the development of social understanding and the learning of ethical codes, insight and so on, it might be argued that at one level the "Hysteric" child lacks reasoning power, or at least, social intelligence. The slow development of language, as well as the acquisition of reading and writing skills, would be explained on this argument, as part of a general weakness in learning ability.

Unfortunately there is no conclusive evidence that mild defects of hearing do retard the development of reasoning ability. In fact even the evidence regarding intellectual limitations in the severely deaf is in doubt, as much depends on the type of intelligence test used. Gaskill (1952) reported substantially normal distributions of I.Q.s of severely deaf children in deaf schools. If it cannot be clearly demonstrated that children with defective hearing within the speech range have poor reasoning ability, it is very unlikely that intellectual limitation can be the result of mild impairment of acuity for frequencies well outside the speech range.

b) "HFW may cause frustration and feelings of social isolation as ordinary deafness is reported to do."
On this argument language retardation, including poor reading would be explained in terms of "protest", or unwillingness to accept the losses in emotional security and dependence implied by increasing maturity. This might involve regression or retardation in the spheres of emotional and language development as well as in intellectual development, and involve behaviour classifiable as "Hysteric" or "Immature."
However, the emotional problems reported to be suffered by deaf people have not been reported for the hard of hearing, except by Madden (1931) who observed more shyness and solitariness among his not very representative group of schoolchildren. But even if Madden's observations are of general applicability, they describe behaviour which is more akin to that displayed by the children classified in this study as "Anxiety State", and not at all to the outgoing characteristics of the present "Hysteric" classification. Reynolds (1955) using personality tests, rating scales and observation found no significant differences between the adjustment of a group of hard of hearing children and matched controls.

Both the above suggestions, as well as the original postulate, imply that HFW is an actual sensory limitation or organic handicap of some kind. But the very fact that an association was found between high frequency ability and intelligence test results may plausibly be regarded as implying that HFW is not a simple physical handicap as is, for instance, myopia.

Furthermore, as suggested earlier, it must be borne in mind that pure tone audiometry, despite its general acceptance and "scientific" pretensions, is only testing one facet of hearing, and that very indirectly. The cases of HFW identified in the present study might more precisely be described as children who failed to respond to pure tones of high frequency, rather than as children who were unable to hear high tones. Strictly speaking, no conclusions can be drawn about their sensory thresholds or organic limits: basically, what has been described is their form of behaviour in a specific and artificial situation. It may be that more theoretical headway would be made by regarding them, not from the view-point of the hearing clinic, but from that of the conventional experimental psychological laboratory. This at once suggests a third possibility:

c) "HFW is not a sensory impairment at all, but a reflection of weak or inconsistent perception or attention. In this case it is not a causal condition, but may be regarded as having the status of a mediating variable."

The various implications of this will be discussed at length in the next two sections.

2. Some Psychological Aspects of Pure Tone Audiometry.

Primarily audiometry is an adjunct to audiology, and its main function has been to provide ancillary evidence in the fields of medicine and physiology. At the same time the major problems have been ones of instrumental design, so that the most noted figures in audiometry have generally been physicists. It is fair to say that up to now the history of audiometry has been notably one of preoccupation with the machine rather than with the man. There have, of course, been many studies of audiometric testing techniques, but these have in general been at a very practical level. No published material has been found which studies the basic psychological processes of the audiometric test, although several authorities claim to do so in their chapter headings.

There are two levels of approach here. The first one revolves round the point that audiometry depends upon the subject's response. The tester is dependent upon his subject's motivation, co-operation, his understanding of instructions, his emotional stability, his persistence, his motor co-ordination and so on. The audiometrist can never really define what he is measuring with any more precision than the psychometrist can define what an intelligence test measures. In fact, as Hirsh (1952) points out, to measure hearing is to establish a relation between a measure of physical stimulus and a measure of an appropriate psychological response. But, as psychological laboratory work is continually indicating, this may be a far from simple task.

The second level of this particular issue is related to the question of the extent to which generalizations can be made from any particular group of subjects' responses to this particular situation, and whether the audiometric techniques in use are in fact valid. Here it would seem that the findings of psychology have been insufficiently taken into account. This is strange, because the basic purpose of audiometry is the establishment of thresholds of auditory response, and similar psycho-physical procedures have always been at the core of classical experimental psychology. A few illustrations may here suffice to indicate the sort of criticisms which might be levelled, rightly or wrongly, at audiometric techniques from the psychological standpoint.

A subject's audiogram is defined in terms of the divergence of his responses from "established norms". The latter have been propounded by the makers of the various instruments, although recently surveys have been commenced by such bodies as the National Physics Laboratory. Some "norms" in actual use are based on the results of small numbers of subjects, the majority of earlier audiometers being calibrated to the Bell Telephone Laboratories' findings with "seventy-six normal ears". Such small standardization groups have usually been composed of employees of the firm concerned, who might be highly sophisticated and even trained in this form of response. They would probably be technicians of above average intelligence, and have usually been young in age. Such groups have in fact been, highly selected and far from representative of the general population in

terms of age, sex and socio-economic background.

Other "norms" have been based on the results of large groups of people, such as the American World's Fairs surveys. Such samples are, however, not necessarily unbiassed. Furthermore the testing conditions and procedures are necessarily far less controlled and precise than those of the small laboratory tests. Divergences of no mean order are also apparent between such "norms" as have been established in Britain and those in America (Littler, 1960). In short, "norms" vary according to the make of audiometer, and none of the standardization techniques are as adequate as those considered essential in the construction of, for instance, a reputable intelligence test.

In the same way very little has been reported about the variation in threshold to be expected by the use of different methods, although this has been a preoccupation in psychology. Such little as has been carried out in audiometry has often been the work of psychologists, such as Corso and Cohen (1958). Nor has sufficient attention been paid to re-test reliability, as regards either standardization groups or clinical subjects. This is a particularly strange omission, as it is known that response thresholds vary from second to second (Littler, 1960) from minute to minute (Harris, 1950) and from week to week (Wishik and Kramm, 1953).

Again, psychological researches have shown that sensory responses vary not only with individual discriminatory ability and adaptation levels, but with motivation, with the strength of other stimuli and with the personality types of the subjects. At the same time considerable

increments may be achieved by training.

So far this discussion has been concerned with some limitations of conventional audiometry as a threshold-measuring technique. Another major group of theoretical problems concerns the wider issue of whether pure-tone audiometry is, in fact, the most appropriate technique for the assessment of "hearing" in the full sense. Is the audiogram to continue to be regarded as a significant predictor of behaviour? The information it presents - or purports to present - the subject's threshold for pure tones - is of undoubted value as an aid in medical diagnosis. But that information can only assume psychological meaning if its relationship with behaviour can be demonstrated. This is not so easy a task as might at first appear.

In the first place a pure tone is a laboratory artefact. As noted in the first chapter of this study the human subject is seldom or never required to respond to a pure tone in everyday life. His expectancy as to its significance must be low because it is not, for him, a meaningful cue. To use Brunswik's (1956) terminology it cannot acquire "ecological validity".

Secondly, "hearing" depends upon many variables as well as acuity. Among these are discrimination, set and "listening", and the ability to blend sounds. A complex example relevant to this aspect is the condition described by the Barton Halls (1931) as "congenital auditory imperception" where auditory acuity is normal but the child cannot understand speech. Liberman, Delattre and Cooper (1952) have demonstrated that the identification of a phoneme is a function of its frequency and of the phoneme following it.

Their evidence, as Brain (1962) points out, supports the view that "our auditory perception is determined not solely by the crude auditory stimulus, but by the subject's own motor response and its proprioceptive effects". The importance of motor processes in perceiving has been emphasized from their very different viewpoints by Hebb (1959) and Piaget (1952).

Thirdly, the human subject, as well as many lower animals, can learn to respond differentially and at a very high level of complexity. Smith and Bartlett (1912) found that the auditory thresholds of adult subjects were significantly lowered after practice. Authorities such as Ewing (e.g. 1954, 1960) have continually stressed the benefits received by deaf children through special training. Brereton (1957) claimed that the benefit of better teaching for moderately deaf children could be equivalent to 10 dbs. of hearing or to two extra years at school. Wedenberg (1951) has shown that even children with a 99 per cent hearing loss in both ears can be taught to interpret speech by ear.

In brief, the established theory and methods of pure-tone audiometry seem, to the present writer, to be based in a somewhat ingenuous stimulus-response associationism. For almost a century psychologists have been aware of the dynamic processes in perception which were stressed by e.g. Woodworth (1921), Bartlett (1932), and the Gestaltists. It is outside the scope of this study to discuss further the learning of perception, but a classical review of the subject has been provided by Drever (1960).

3. High Frequency Auditory Response Consistency and Personality Variables.

Pure-tone audiometry might be described in psychological terms as a perceptual-motor task where the subject is required to sustain attention in a certain stimulus conditions and report changes of signal. This sort of situation is very close to what experimental psychologists would define as a "vigilance task". Thus Mackworth (1957) suggested:-

> "....the term vigilance could be regarded as a state of readiness to detect and respond to certain specified small changes occurring at random time intervals in the environment."

It may be that a consideration of vigilance findings might throw some light on the present problem of individual differences, particularly personality variables, in response to high frequency auditory testing.

It will be recalled that the clinical classification of "Hysteria" was regarded as implying symptomatic behaviour in extraverted personalities. According to many theories of personality the extravert's level of aspiration is lower, his persistence less and his behaviour in test situations is marked more by speed than by accuracy, when compared with the introvert. In general, while the extravert may not be poorer in performance than the introvert it would be predicted that his responses would be less consistent.

Where vigilance tasks are concerned Broadbent (1958) offers a summary of results and a discussion. He concludes that:-

> "The results considered in this section are hardly perhaps more than suggestive. Nevertheless, they do give a reasonable probability to the view that extroverts deteriorate more with time in certain kinds of tasks."

Most vigilance tasks have been more prolonged than the average audiometric test. They have varied from durations of twenty minutes up to several hours of "watch-keeping". However, it may be presumed that the performance of children, or subjects of limited intelligence will show deterioration more rapidly because of their higher distractibility, their relative lack of control and their poorer comprehension of the requirements of the task. The behaviour of the E.S.N. subjects in the present study is clearly explicable in these terms. And it may be postulated that the relatively poor acuity for HF tones of the clinic "Hysteric" group represents similar response behaviour, but in subjects with higher intelligence and therefore more control and directivity.

It may be objected that if inconsistency is to be postulated as the basis of this second group's poor performance then it should apply throughout the auditory frequency range and not just at the upper limits with which this discussion is concerned. There is in fact no evidence that this does not happen. But it is in the upper frequencies that the audiometric task becomes perceptually difficult (Corso and Cohen, 1958) so that the effects discussed above will be shown more readily. It may well be that over a suitably protracted period the "Hysteric" subjects would have demonstrated similar inconsistency at lower frequencies in the present study. And indeed this was observable in the performance of the dullest E.S.N. children.

However, the above argument based on the observed inconsistency of the extravert does not explain in full the generally weaker thresholds

of the "Hysteric" groups. For although their performance may be less reliable during each trial than that of the introverts, this should affect their scores as a group only in the sense that the scatter will be wider, not that the mean will be necessarily much lower than that of the introvert group. Some of the individual scores might be well up to the level of the most able introvert. The present findings are that there is very little overlap. Fortunately, this is also predictable from personality theory. Eysenck (e.g. 1957) postulates that an extravert is a person who builds up reactive inhibition (Hull's IR) more rapidly than an introvert, and also dissipates it more slowly. It may be presumed therefore, that in certain tasks the level of response of such a subject will become progressively worse as the task proceeds. In the present case according to this theory, the more time and care that is spent in trying to establish an extravert's "true" thresholds the poorer may those thresholds become.

This seems such a surprising suggestion, and one so central to audiometric theory and practice that a partial experimental confirmation was attempted (Reed, 1961). Subjects were 30 of the clinic group aged between 11 and 15. Fifteen of these had been classified as being clearly extraverted and fifteen as clearly introverted. In each case, after the routine audiometric test procedure the task was prolonged for a further twenty minutes. Testing was limited to frequencies above 8 K/Cs. and no attempt was made to encourage the children, to explain the prolongation or to otherwise increase levels of motivation and aspiration. Threshold scores at the end of this extended period were

now compared with those established at the end of the routine session. It was found that whereas the introverts' thresholds either remained constant within 10 db. or (in three cases) were depressed by more than this amount, the final thresholds of ten of the extraverts were relatively elevated. This difference between the groups is statistically significant at beyond the .001 level. In one sense the introverts could be said to have "kept trying" throughout the test, whereas the extraverts tended to "tail off". Certainly the extraverts' responses were much less consistent than those of the introverts.

Although such a finding has apparently never been previously reported there exists a possible parallel in the well-known experimental phenomenon of "auditory fatigue". Rawdon-Smith (1934, 1936) has shown the existence of a central element in this phenomenon, and Stevens and Davis (1938) have discussed its wide variations among individuals without, however, attempting to explain such differences in terms of personality.

4. Conclusions.

It would be premature to draw any hard and fast conclusions from the above discussion. Nevertheless the evidence considered does seem to point in the same direction - that HFW should not be regarded as a physical impairment which causes difficulties in speech and language development. A more profitable approach, it is suggested, is to see HFW as a particular form of behaviour in a perceptual task, as a response characteristic rather than as an indication of sensory limitation. This approach directs emphasis towards such factors as set and attention. This gives fresh significance to two important findings of the present study - the association between HFW and intelligence, and that between HFW and personality characteristics.

Evidence has been considered which makes it reasonable to regard HFW as a concomitant (rather than as a contributory cause) of limited intelligence and hysteric or immature personality. It may be that unfamiliar high frequency tones are merely one set of cues among many to which dull children fail to attend. Equally it may be that even when conscious attention is paid the dull child fails to register a relatively large proportion of the full range of stimuli available to him. In either case the result would be a poor or inconsistent performance in such tasks as audiometry. It has been noted that the extroverted person, even when of normal intelligence, demonstrates shifts of attention or perceptual response failures in tasks requiring sustained vigilance.

Audiometric response to unfamiliar weak tones may thus be regarded as having the status of an intervening variable. The associated

limitations in expression or comprehension of oral and written language, clearly shown by the present findings, may be regarded as a function of personality. It is not quite clear, however, whether dullness and extroversion alone are involved or whether, as the use of the term "hysteric" implies, maladjustment or emotional immaturity also play a part. The fact that the majority of the HFW children in the present study had been regarded as being in need of special treatment would suggest this. And reference to the case notes in Appendix G will show that as a group they seemed to encounter more problems in adjustment than the majority of children.

An association between emotional maladjustment and retardation or maldevelopment of language skills is not unexpected. Such authorities as Burt (1950) and Gates (1939) have drawn attention to the high incidence of maladjustment among groups of severely retarded readers, although the relationship is far from clear. It may well be, as Fernald (1943) claimed, that the maladjustment is the result of the reading failure rather than its cause. In the field of speech therapy such writers as Morley (1957) have reported that children with defective articulation find difficulty in learning to read, whilst Stinchfield and Young (1938) stressed the emotional strain imposed on children with delayed language development. One of the great authorities on speech and language development, McCarthy (1954 b) pronounces:-

> "Recent research and clinical investigations bring out increasingly the fact that language, and particularly its oral form, speech, is an important indicator of the state of an individual's mental health." (page 514.)

She goes on to stress the importance of emotional security and home atmosphere in the child's acquisition of speech.

There is, then, abundant evidence for the complex interactions of speech, language, reading ability and emotional development, and it may be that the HFW cases discussed here represent a nodal group where failures of development in several spheres co-exist.

Evidently further research in this field is desirable. For although, on the criterion of HFW applied here, only twenty cases were identified, the problem is evidently of clinical and educational significance. Whatever the theoretical implications HFW has been shown to be assocated with retardation in the articulation of speech and immature language development, including gross retardation in reading comprehension and written expression.

V. SUMMARY.

Clinical observation prompted the hypothesis that children who fail to respond to high frequency tones outside the speech range, (and who may thus be unable to discriminate some of the components of consonantal sounds) may show retardation or distortion in the development of their understanding and articulation of speech. From this followed the predictions that the general language development of such children would be hindered as would their acquisition of reading and of skill in written expression.

RESULTS.

Audiometric study of groups of children to ascertain their upper limits of hearing was carried out, using a Marconi Audio Tester coupled to a high fidelity speaker and tweeter unit. This apparatus allowed the reproduction of pure tones of up to about 22,000 c.p.s. at a maximum intensity of 50 db.

A. The Main Survey.

Using area/stratified sampling a group of 209 children (119 boys and 90 girls) was selected as being representative of their age range (7 to 15) in a large city (total school population 46,000). Audiometric survey of this group was undertaken in order to establish provisional norms of response to the test equipment. The survey produced data which may have practical and theoretical importance in their own right:-

a) The distribution of responses in each age group was continuous and high inter-subject consistency was recorded for all groups.

b) No significant differences were found between sexes or between geographic areas (which had been selected as being associated with socio-economic conditions).

c) A significant lowering of upper frequency response limits was found to occur with age from as early as twelve years.

d) With the equipment in use it was found that some children responded to tones of up to 21,000 c.p.s., but the mean from age 7 to age 12 was just above 18 kilocycles, dropping to just above 16 kilocycles at age 15.

B. Three Subsidiary Surveys.

The results of three further surveys of special groups of children were in general agreement with the above findings. These surveys were carried out to investigate whether HFW is associated with intelligence and personality variables, and whether it might be a factor in severe reading retardation.

a) Among 86 children currently attending a Child Guidance Clinic a positive and statistically significant association was found between high frequency auditory acuity and intelligence as determined on an individual mixed intelligence test (The Terman Merrill Revision of the Binet).

b) A significant difference was found between the HF auditory acuity of children who had been psychiatrically classified as "Anxiety State" and those classified as "Hysteric". The operational criteria used in these diagnoses makes it permissible to regard the two clinical categories as being equivalent to "Introverted" and "Extroverted". When the effects of intelligence were discounted the superiority of the first group still held.

c) A group of 35 severely retarded readers demonstrated auditory acuities of wider scatter than the normal group, 21 having "Upper Auditory Limits" below the means of their age groups on the main survey. But this was found to be associated with the distribution of personality types in the group. Those retarded readers who were classifiable as "Anxiety State" or introverted achieved high U.A.L.s. This suggests that HFW is more common among severely retarded readers than among children of normal achievement, but that this may be a function of the distribution of "Hysteric" or extraverted children among such groups.

d) A group of 40 educationally subnormal children contained a large proportion of cases of relative HFW which is in line with findings a) and b) above. Many of these children would be classifiable as "Hysteric", whilst their ascertainment as E.S.N. is based upon their low intelligence. Those members of the group with I.Q.s below 65 were generally unable to respond to high frequency testing with reliability (because of lack of understanding of the task or hyper-distractibility).

C. The Experimental Study.

From a total of 464 children given audiometric tests 20 children regarded as being cases of HFW were identified, using as a criterion a depression of U.A.L. response of more than two standard deviations below the appropriate age "norms" found in the main survey. A "control" was found for each experimental child, matched in terms of age, sex, socio-economic status, non-verbal intelligence and school class. The ages of these children ranged from 8 to 13, and their intelligence levels, as gauged by the Progressive Matrices ranged from the 75th percentile down to below the 5th percentile. The speech, language (verbal and written) and reading abilities of the children were then assessed, using established tests where such were available. It was thus possible to compare the performance of the experimental cases with that of their matched controls and also, in most instances, with standardized norms. The results showed that in many tests both groups were of below average ability. But the children in the experimental group proved to be inferior to their controls in seven out of eight tests.

a) The most significant difference between the groups was in the results of the test of speech articulation (The Francis Phonetic Word List). Whereas none of the control group made any errors whatsoever, thirteen of the experimental group

proved to have some degree of articulatory defect, two being very serious. Two of those HFW children who made no error on this articulation test showed faulty intonation, and another two were amongst those who had received speech therapy in the past. So that a total of seventeen of the twenty HFW cases had some current defect of speech or had displayed defect in the past.

b) On both the Mill Hill Vocabulary Scale and the Watts' English Language Scale no member of the HFW group achieved a better score than did his matched control, the differences between the groups being highly statistically significant on both tests.

On the Vocabulary test ten of the HFW group were below the 5th percentile for their age, and only three of the group scored at or above the 50th percentile.

On the Language test 14 of the HFW group achieved Language Ages of less than 8, whereas 16 of the controls achieved a L.A. of 8 or above.

As a group the HFW subjects showed pronounced immaturity in both the acquisition of vocabulary and in oral language.

c) Free compositions written by the subjects were analyzed, using as measures the numbers of words written and the percentage subordinate clauses (LaBrant). Applicable standard for these two measures have not been published, so similar compositions were drawn from small samples of local schoolchildren at each relevant age level for comparative purposes.

i) The HFW children wrote very much fewer words than either their controls (in fifteen cases) or the sample means. Differences were significant in both cases. Six HFW children wrote a number of words which was three or more standard deviations below the appropriate sample means.

ii) When clauses were analysed five of the HFW group's compositions had to be excluded because they were so primitive as to be incomprehensible. In only one HFW case was the subordination index superior to that of his control, and in only two cases was it above the sample mean. Differences between means were highly significant.

The HFW children as a group showed not only a paucity of output but a paucity of ideas, and clumsiness and immaturity of language usage. Their short, disconnected phrases were flat and uninteresting by comparison even with those of their controls.

d) On the Schonell Test of Sentence Structure eight of the HFW group made no score at all, and only two made a better score than their controls. The group difference was highly significant. Again, the HFW group proved to be grossly retarded in grammatical usage as expressed in their ability to handle conjunctions and inversions and to substitute for simple sentences adjectival or adverbial phrases or clauses.

e) Schonell's word recognition test was the only one in this battery where the HFW group's results, although inferior to those of the control group, were not significantly so. Only one HFW child was totally unable to read, but nine others had Reading Ages two or more years below their chronological ages. However, four of them achieved R.A.s beyond their C.A.s.

On the Kelvin test of reading comprehension the control group was again superior, the difference being highly significant. Only three HFW children achieved results above the 50th percentile, whilst six were below the 5th percentile. This highlights differences between the groups in verbal reasoning and the comprehension of language.

The lack of significant difference between the groups on the test of mechanical reading may be due to the fact that no less than ten of the HFW group had received remedial help with their reading. Regular testing with word recognition tests during such courses of specialist tuition has been shown to impart facility with this particular type of test which does not spread to other, more crucial forms of reading ability.

f) The HFW group had also received many types of educational, medical or psychological help or attention, such as special classes or groups, speech therapy, E.N.T. examinations, child guidance, clinic or school psychological service referrals or E.S.N. examinations. Only one HFW child had not been referred in some way, whilst fifteen of the twenty had been referred for more than one type of help. As a group the HFW children had drawn attention to themselves throughout their school lives as being retarded or abnormal in speech, hearing, language, reading or behaviour, or, more commonly, in some combination of these.

DISCUSSION.

The association found between HF ability and intelligence and personality type, makes it unlikely that relative HFW is a simple sensory loss. It is suggested that insufficient attention has been paid to pure tone audiometry as a psycho-physical procedure.

Responses to pure tone stimuli are not necessarily a crucial index of 'hearing' ability. They reflect various psychological variables. A fruitful approach to the present problem may therefore be from the viewpoint of experimental psychology, and it is suggested that studies of "vigilance" are of direct relevance. Performance in perceptual motor tasks where responses are required to faint and intermittent stimuli are known to be associated with extraversion/ introversion and the present findings are therefore discussed in terms of "set", response consistency and reactive inhibition. HFW may thus be regarded not as a sensory weakness causing retardation of linguistic development, but as having the status of an intervening variable or concomitant.

However this may be, the results of this study have given support to the original hypothesis and substantiated the predictions drawn from it. Evidence has been presented to show pronounced association between auditory high frequency weakness and retardation or distortion in the understanding and articulation of speech, and immature language development, including gross retardation in reading skills and written expression. Although relatively rare the condition may be seen to be of pronounced clinical significance and a potentially important source of educational backwardness.

APPENDIX A

A pilot survey using the Galton Whistle

(Abstracted from Reed, 1953).

APPENDIX A.

Testing Instruments.

The most reliable instrument for gauging auditory acuity is the audiometer, which provides pure tones of variable frequency and intensity. But it was felt that to conduct even a limited survey, a less time-consuming and more easily used instrument was required to "screen off" possible cases. Such an instrument is the Galton whistle. This has an adjustable plunger which, by altering the length of the bore, allows any frequency between 5,000 and 42,000 d.v.s. to be produced. The adjustment is crude, the intensity of sound cannot, of course, be controlled, and the whistle has several other disadvantages as a fine-testing instrument. But it proved satisfactory for the purpose here desired. It was used as described below to sort out children probably suffering some degree of high-frequency weakness. These were then "proved" by full audiometric examination.

Population.

It was decided to limit the survey to children between the ages of seven and twelve, because:-

a) They would be old enough to understand the instructions and co-operate generally:
b) They would be young enough for remedial help to be beneficial for any cases detected should this seem necessary.

The children were all drawn from a city and urban area. The normal school groups were selected to form a representative social and educational cross-section of the area.

Test Method.

Screen testing was made as standardised as possible; but it was impracticable to control background noise, as testing was carried out in classrooms and corridors. However, this merely made the screening criterion more stringent, and did not affect any absolute judgment which would later be made by audiometric test.

The screen test was given individually and in privacy. Each child was told that the tester was going to "make a squeaky sound - just like a little mouse." As soon as he heard it he was to raise his finger to his lips, dropping his hand as soon as he could no longer hear the squeak. He was asked to look at the wall or door, the tester stationing himself at each side in turn, with the whistle in line with the child's shoulder and at a distance of about 4 feet. The tester took care to mask any hand movement as the whistle bulb was manipulated. The whistle was then blown for varying periods, separated by varying pauses, at each of the following frequencies: 5,000; 8,000; 10,000; 15,000; 20,000 c.p.s.

Any child failing to respond correctly or at all to any of these frequencies was given further practice (the tester humming lower notes) and retested after a few days. If he still failed, he would have been given the audiometer test, but in actual fact only the cases reported below failed this screening test, and they were indeed proved later to have high-frequency weakness.

The great majority of children understood the instructions at once and co-operated eagerly.

For the audiometric test, the normal method of ascertaining auditory thresholds (9) was used, except that the children were encouraged to "signal" responses with a glove puppet.

Results.

A total number of 739 children was tested. The distribution was as follows:

	Boys	Girls	Total
Children at Normal Schools (all streams)	227	175	402
Children at Normal Schools presenting problems in reading or behaviour	150	111	261
Children at a Special School for Educationally Subnormal Children (E.S.N. school)	41	35	76
	418	321	739

Of these, a total of six children, all boys, was found to have some degree of high-frequency loss. The distribution was as follows:-

Normal school problems . .	3
E.S.N. school	3

It may be significant to note that:

a) Two of these boys had been referred by schools, and the other four by the psychologist, as possible "hard-of-hearing" cases. One had received treatment, but all were finally pronounced by aural specialists as not suffering any disability of hearing.

b) All six had been referred by schools as finding difficulty in reading.

c) Five of them had also been referred by schools for examination as E.S.N. children.

d) And at different times the same five had been referred as behaviour problems.

Summary.

Of a small sample of 739 children tested, 6 (or .8 per cent.) proved to have high-frequency auditory impairment. All 6 were boys, 3 being in attendance at an E.S.N. school (out of 76 tested), 3 being at normal schools (out of 663 tested). All 6 were regarded as having difficulty in attainment and/or adjustment.

APPENDIX B

Instrumentation.

APPENDIX B.

INSTRUMENTATION.

As discussed earlier, for the purposes of this study an audiometric instrument was required which could produce pure tones at known intensities and of frequencies up to at least 14 kilocycles per second and preferably up to about 20 kilocycles per second. The Galton Whistle is capable of producing tones of the requisite frequencies, but they are neither pure nor of controllable intensity. Commercial clinical audiometers are designed to produce pure tones with variable attenuation, but their upper frequency limits are between 8192 c.p.s. and (in a few expensive models) 11,000 c.p.s.

The technical literature was searched without success, and approaches were made to every reputable audiometer manufacturer and electronics firm in this country. Eventually it was decided that the only instrument which fulfilled the requirements at a suitable cost was the Audio Tester Type TF 894A produced by Marconi Instruments Limited. This is an a.c. mains operated, beat-frequency oscillator. It is directly calibrated from 50 c.p.s. to 27,000 c.p.s., with an accuracy of $\pm$ 2% $\pm$ 5 c.p.s. when allowed to reach thermal equilibrium. (Design details are that two r.f. oscillators employing electron-coupled circuits of similar form, function at a frequency of the order of 270 K/Cs when at zero bar. The outputs from these oscillators are fed to a pentode mixer and the resulting difference-frequency signal is resistance-capacitance coupled, via a continuously-variable gain control, to a duo-triode phase-splitter circuit driving a push-pull

output stage. Three separate output windings on the push-pull transformer provide a choice of source impedances at 600 ohms, 15 ohms and 3 ohms). For use with the 600 ohm output impedance a 0 to 50 db. attenuator is incorporated with manual control in 10 db. steps. This was utilized by inserting matching transformer (600 ohms to 15 ohms) of appropriate frequency response.

The first technical problem, that of finding an instrument capable of transmitting a calibrated pure tone throughout the desired frequency range and at variable intensity, was thus solved. The next, and more difficult problem was that of transmitting this output - that is, of converting it into sound. The normal head-set used with conventional audiometers consists of a pair of magnetic receivers capable of responding only up to 6,000 or 8,000 c.p.s.

Again, advice was sought from a number of electronics firms and from university and hospital audiologists and physicists. It was only after fifteen months of fruitless correspondence and consultation that a practical solution could be found. The major design difficulties are that no electro-magnetic receiver of the ear-phone type is sensitive enough to respond at the high frequencies with which this study is concerned, and that in any case an external ear-phone would not be suitable.

Dr. Littler of the Wernher Research Unit on Deafness stated (in a personal communication):-

> "The auditory meatus resonates above 3,000 c/s and above this frequency stationary wave patterns are set up in the meatus. For example, it is often possible to hear better at high

interest is in functional behaviour, not in the physics of acoustics nor the clinical pathology of deafness. The primary objective was not the establishment of absolute norms, but the making of comparative measures. It was necessary only to identify children whose response to high frequency auditory stimulation was limited relative to that of the majority of their fellows.

Similarly, whereas the differential hearing loss in each ear is of importance for medical diagnosis, the present concern is only with children's behaviour in a particular sound environment. And in practise children "hear" bilaterally, not with individual ears.

Again, because only comparative measurements were required the strict attenuation of background noise demanded by experimental audiology was not essential. For the purposes of this study it was necessary only to ensure a consistent background of sound, and one without any gross distracting stimuli. In the event it proved possible to arrange for the use of test rooms which were considerably more quiet than many which have to be utilized during school audiometric surveys, which probably counter-balanced the attenuation in extraneous noise provided by the use of ear-phones. But this was not prerequisite to this investigation. What was of far more importance was that it was possible to provide a similar auditory test environment for each subject, so that anomalies in response were unlikely to be attributable to external factors.

For all these reasons it was decided to accept the employment of loud-speaker reproduction. Several suitable models were considered,

the one finally selected being a ten inch concentric duplex speaker of very high fidelity with a tweeter unit. Its response curve is comparatively flat up to 20,000 c.p.s. after which it drops considerably.

This instrumentation thus provides the mechanical means of producing pure tones of known intensity over the desired range of frequencies. From the point of view of the acoustical physicist the set-up is open to several criticisms. But provided that the test environment can be held constant comparative measures of auditory acuity can be made with confidence. And, as a matter of interest, not only does this apparatus enable the carrying out of a task not previously attempted, but it is a more sophisticated device than many which have been employed in some of the major studies in this field.

APPENDIX C

The Surveys of Child Guidance Clinic Cases, Educationally Subnormal Children and Seriously Retarded Readers - Tables of Findings and Results.

TABLE 10.

CHILD GUIDANCE CLINIC CASES - INTELLIGENCE QUOTIENT MEANS AND STANDARD DEVIATIONS BY SEXES AND CLINICAL CATEGORIES.

	BOYS			GIRLS			TOTALS		
Clinical Category:	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.
ANXIETY STATE	18	109.61	16.6	8	107.00	13.69	26	108.73	16.34
HYSTERIC	25	103.08	21.33	9	104.67	32.02	34	103.50	24.3
EMOTIONALLY IMMATURE	17	84.47	13.87	9	84.11	12.32	26	84.31	13.7
TOTALS:	60	99.77	20.66	26	98.19	24.45	86	99.29	21.82

TABLE 11.

CHILD GUIDANCE CASES - STATISTICAL SIGNIFICANCES OF DIFFERENCES BETWEEN MEANS OF INTELLIGENCE QUOTIENTS BY CLINICAL CATEGORIES.

++ = SIG. at 1% level.

	ANXIETY	HYSTERIC	IMMATURE
ANXIETY			
HYSTERIC	t = 0.9209		
IMMATURE	t = 6.2247 ++	t = 3.5318 ++	
N	26	34	26

TABLE 12.

CHILD GUIDANCE CLINIC CASES - DISTRIBUTION OF UPPER AUDITORY LIMITS (AT 50 DBS.) BY I.Q. GROUPS.

	Upper Auditory Limits in K/Cs.									
	13+	14+	15+	16+	17+	18+	19+	20+	21+	Totals
I.Q. Groups Below 70	-	1	2	1	1	2	-			7
70-84	-	-	5	5	2	1	2	1	-	16
85-99	1	-	3	2	8	6	2	-		22
100-114	-	-	3	4	4	5	4	1	-	21
115-129	-	2	1	-	2	-	3	2	1	11
130+	-	-	-	-	-	2	5	2	-	9
Totals:	1	3	14	12	17	16	16	6	1	86

TABLE 13.

CHILD GUIDANCE CLINIC CASES - DISTRIBUTION OF UPPER AUDITORY LIMITS (AT 50 DBS.) BY CLINICAL CATEGORIES.

	Upper Auditory Limits in K/Cs.									
	13+	14+	15+	16+	17+	18+	19+	20+	21+	Totals
Clinical Categories										
ANXIETY STATE			-	-	5	6	10	4	1	26
HYSTERIC	-	3	6	2	8	7	6	2	-	34
EMOTIONALLY IMMATURE	1	-	8	10	4	3	-	-		26
Totals:	1	3	14	12	17	16	16	6	1	86

TABLE 14.

CHILD GUIDANCE CLINIC CASES - UPPER AUDITORY LIMITS - MEANS AND STANDARD DEVIATIONS BY SEXES AND CLINICAL CATEGORIES.

	BOYS			GIRLS			TOTALS		
Clinical Category:	N	x	S.D.	N	x	S.D.	N	x	S.D.
ANXIETY STATE	18	19.00	0.969	8	18.750	1.201	26	18.923	1.055
HYSTERIC	25	17.321	1.673	9	17.278	1.825	34	17.309	1.713
EMOTIONALLY IMMATURE	17	16.471	0.806	9	16.000	1.517	26	16.308	1.122
TOTALS:	60	17.583	1.619	26	17.288	1.91	86	17.494	1.716

TABLE 15.

CHILD GUIDANCE CLINIC CASES - STATISTICAL SIGNIFICANCES OF DIFFERENCES BETWEEN MEANS OF UPPER AUDITORY LIMITS BY CLINICAL CATEGORIES.

+ = SIG. at 5% level. ++ = SIG. at 1% level.

	ANXIETY	HYSTERIC	IMMATURE
ANXIETY			
HYSTERIC	t = 4.156 ++		
IMMATURE	t = 8.469 ++	t = 2.537 +	
N	26	34	26

TABLE 16.

EDUCATIONALLY SUBNORMAL CHILDREN - DISTRIBUTION OF UPPER AUDITORY LIMITS (AT 50 dbs) BY I.Q. GROUPS.

I.Q.	Responses invalid	K/Cs. 12+	13+	14+	15+	16+	17+	18+	19+	20+	Totals
Below 55	4	-	-	-	-	1*					5
55 - 59	5	-	1*								6
60 - 64	-	2*	1	1	-	1					5
65 - 69	-	-	-	-	1*	4*	3	1*			9
70 - 75	-	-	-	1*	1	6**	3*	2*	1	1	15
Totals:	9	2	2	2	2	12	6	3	1	1	40

Notes:

a) No sex differences were apparent, so the results of both boys and girls (twenty of each) have been entered in the same table.

* b) Each asterisk refers to one child aged 14 or 15 years.

c) The "Responses Invalid" column includes those cases who failed to respond (two), those whose responses were so inconsistent as to render threshold determination impossible (five), and those who were so distractible that testing could not be carried out (two).

TABLE 18.

SERIOUSLY RETARDED READERS - MEANS AND STANDARD DEVIATIONS OF UPPER AUDITORY LIMITS BY CLINICAL CATEGORIES.

		U.A.L.s in K/C.s	
Clinical Category	N	Mean	S.D.
ANXIETY STATE	9	18.61	0.99
MIXED (?)	12	17.45	0.62
HYSTERIC	14	16.14	1.81
TOTAL GROUP	35	17.22	1.59

TABLE 17.

SERIOUSLY RETARDED READERS - MEANS AND STANDARD DEVIATIONS OF INTELLIGENCE QUOTIENTS BY CLINICAL CATEGORIES.

		I.Q.s	
Clinical Category	N	Mean	S.D.
ANXIETY STATE	9	93.44	10.58
MIXED (?)	12	90.83	6.80
HYSTERIC	14	90.64	10.76
TOTAL GROUP	35	91.17	9.22

TABLE 20.

SERIOUSLY RETARDED READERS - DISTRIBUTION OF U.A.L.s BY CLINICAL CATEGORIES.

Clinical Category	U.A.L.s (at 50 dbs) in K/Cs. Below 15	15+	16+	17+	18+	19+	20+	Totals
ANXIETY STATE	-	-	-	2	3	3	1	9
MIXED (?)	-	-	1	9	1	1	-	12
HYSTERIC	2	3	5	2	1	1	-	14
TOTALS	2	3	6	13	5	5	1	35

TABLE 19.

SERIOUSLY RETARDED READERS - DISTRIBUTION OF U.A.L.s BY I.Q. GROUPS.

I.Q. Groups	U.A.L.s in K/Cs. Below 15	15+	16+	17+	18+	19+	20+	Totals
80 - 84	1	3	3*	3*	1	1	1	13
85 - 89	-	-	1	4*	-	-	-	5
90 - 94	-	-	1	1	2	2	-	6
95 - 99	-	-	-	2	-	-	-	2
100 - 104	-	-	1	2	-	1	-	4
105 - 109	1	-	-	1*	2	1	-	5
TOTALS	2	3	6	13	5	5	1	35

APPENDIX D

The Experimental Study - Tables of Results.

APPENDIX 'D'

THE EXPERIMENTAL STUDY OF CHILDREN WITH HIGH FREQUENCY WEAKNESS - TABLES OF FINDINGS AND TEST RESULTS.

Statistical Note:- Most of the following tables present tests results of the twenty HFW children compared with those of their matched controls. The most powerful test for examining the differences between group means is the t-test. However, to avoid making any assumptions about the distributions of the parent populations it was decided to use a non-parametric test. That chosen as being most appropriate for use with the present data was The Wilcoxon Matched-Pairs Signed-Ranks Test (Siegel, 1956). This test utilizes information about both direction and size in comparing the differences within pairs. It produces a statistic, T, the value of which may be compared with the critical values for various levels of significance for one-or two-tailed tests. In the present instance the direction of the differences may be predicted, so that it is appropriate to regard comparison as one-tailed. The maximum one-tailed test level of significance available for T is the .005 level. To be significant at this level, for N = 20, T must equal or be less than 38. It will be noted that in all but one of those tables where T has been computed it is very much less than this value, implying an even greater degree of statistical significance.

TABLE 21.

THE EXPERIMENTAL HFW GROUP - SEX, AGE, TYPE OF SCHOOL, OCCUPATION OF FATHER, REFERRAL SOURCE AND UPPER AUDITORY LIMIT (AT 50 dbs.).

Case.	Sex.	C.A.	School	Father's Occ'n	Ref.Source	U.A.L. (K/Cs.)
A	M	12-6	Unreorg'd B.	Labourer	Head Master	15.0
B	M	12-7	Bilateral Sec.Tech.	Civil Servant	C.G.C.	14.0
C	M	13-4	Sec.Mod.M.	Male Nurse	Pilot Study	14.0
D	M	10-11	Primary B.	U/Skilled Factory	S.H.S. Records	13.5
E	M	12-0	Sec.Mod.B.	Shop Asst.	Survey	13.5
F	M	13-8	Sec.Mod.M.	Skilled Driller	C.G.C.	15.0
G	M	11-11	Sec.Mod.M.	S/Skilled Floorlayer	C.G.C.	14.5
H	M	12-2	Sec.Mod.B.	Trawler Engineer	S.H.S. Records	15.0
I	M	11-11	Sec.Mod.B.	Painter	S.H.S. Records	14.5
J	F	12-4	Sec.Mod.M.	Disabled Pensioner	Survey	13.0
K	F	11-10	Primary M.	S/Skilled Engineer	Survey	14.5
L	F	10-6	Primary M.	Clerk	Survey	15.0
M	F	13-11	Sec.Mod.G.	Porter	Head Mistress	14.0
N	F	8-11	Primary G.	Meat Porter	C.G.C.	13.0
O	F	10-8	Primary M.	Clerk	S.H.S. Records	13.5
P	F	10-5	Primary G.	Seaman	Head Mistress	14.0
Q	F	11-8	Unreorg'd R.C. G.	Plumber	Head Mistress	15.0
R	F	10-6	Primary R.C. M.	Publican	S.H.S. Records	14.5
S	F	11-10	Primary G.	Motor Mechanic	C.G.C.	15.5
T	F	13-6	(E.S.N.) S.S. M.	Transport Driver	C.G.C.	14.5

+ Legend:

B. = Boys' G. = Girls' M. = Mixed
Unreorg'd. = Unreorganized Senior School.
Sec. Mod. = Secondary Modern School.
(E.S.N.) S.S. = Special School for Educationally Subnormal Children.

TABLE 22.

RAVEN'S PROGRESSIVE MATRICES - RESULTS OF EXPERIMENTAL HFW AND MATCHED CONTROL GROUPS BY RAW SCORES, PERCENTILES AND APPROXIMATE EQUIVALENT MENTAL AGES.

	Experimental				Controls			
Case	C.A.	Raw Score	%ile	M.A.	C.A.	Raw Score	%ile	M.A.
A	12-6	16	< 5	<8	12-6	18	5	8
B	12-7	46	75	14+	12-4	47	75	14+
C	13-4	43	50	13	13-7	42	50	13
D	10-11	39	75	12	10-8	43	75	13
E	12-0	37	c45	11½	11-9	39	50	12
F	13-8	46	50	14½	13-11	43	50	13
G	11-11	36	c40	11¼	12-0	35	c40	11
H	12-2	25	c20	9¼	12-3	28	c20	9½
I	11-11	22	10	8¾	11-8	25	c15	9
J	12-4	15	<5	<8	12-7	18	5	8
K	11-10	13	<5	<8	12-0	15	< 5	< 8
L	10-6	32	50	10½	10-3	31	50	10¼
M	13-11	30	c10	10	13-9	30	c10	10
N	8-11	16	25	<8	8-10	15	25	8
O	10-8	16	10	<8	10-5	18	10	8
P	10-5	23	25	8¾	10-4	25	25	9
Q	11-8	23	c20	8¾	11-5	24	c20	9
R	10-6	15	10	< 8	10-7	15	10	< 8
S	11-10	36	c45	11¼	11-9	39	50	12
T	13-6	18	<5	8	13-3	20	<5	8¼

NOTE: The "Mental Ages" given here are the scores at the 50th %ile for years and half-years given in the norms. These do not go below C.A.8, which accounts for the number of 'less than 8' readings above. The norm for the 8 year old 50th %ile is 18, so that, extrapolating from the table of norms it would appear that all but one of the scores marked above as below 8 are equivalent to a mental age of 7.

TABLE 23.

THE FRANCIS PHONETIC TEST - HFW GROUP ERROR SCORES, PERCENTAGE "INTELLIGIBILITY LEVELS" AND INCIDENCE OF RELEVANT SPEECH FACTORS.

Case	Francis Error Score	Percentage Intelligibility Level	Intonation	History of Speech Therapy
A	6	96.22	Infantile	Yes (Immature)
B	1	99.40	-	-
C	0	100.00	-	Yes (Stammer)
D	0	100.00	-	-
E	5	91.67	-	-
F	2	99.03	-	Yes (Dyslalia)
G	2	97.69	-	-
H	14	78.88	-	Yes (Dyslalia)
I	4	98.63	Infantile	Yes (Immature)
J	2	94.63	Infantile	-
K	1	98.29	-	-
L	0	100.00	-	-
M	0	100.00	-	-
N	0	100.00	Infantile	-
O	11	87.15	Flat	Yes (Dyslalia)
P	1	99.50	Infantile	-
Q	0	100.00	-	Yes (Stammer)
R	6	93.96	Infantile	-
S	0	100.00	Sl. Immature	-
T	5	86.05	Infantile. Jerky	-

NOTE: Whereas 13 of the HFW group made one or more errors, none of their controls made any. That this difference is significant beyond the 0.005 level may be shown by reference to Latscha's (1953) extension of Finney's (1948) tables for the Fisher-Yates test of significance.

TABLE 24.

INCIDENCE OF TYPES OF ARTICULATORY ERROR MADE BY HFW GROUP.

Cases	A	B	E	F	G	H	I	J	K	O	P	R	T	Totals
Initial θ	+	+				+	+			+		+	+	7
Medial θ	+				+	+	+					+	+	6
Final θ	+				+	+	+					+	+	6
Initial s			+				+						+	3
Medial s	+		+	+		+	+			+			+	7
Final s			+			+								2
Initial dʒ			+											1
Medial dʒ			+							+				2
Final dʒ										+				1
I.M.F. ʃ	+		+							+				3
Initial p			+			+						+		3
Medial t	+									+	+		+	4
Final t	+													1
Initial tʃ						+				+				2
Initial l						+								1
Medial l	+													1
Initial r										+				1
Initial v												+		1
Medial v						+								1
Final v						+						+		2
I.F.M. f										+				1
Final ŋ								+						1
Medial ɣ	+		+											2
Final g							+							1
Final n									+					1

Continued....

TABLE 24. (Continued).

NOTE: In some cases the total errors deviate slightly from the Francis error score. This is due to the scoring technique used, which did not take into account multiple errors on individual words.

Legend: Phonetic Signs.

θ = th (unvoiced) as in "thumb".
$d\text{ʒ}$ = j as in "judge".
ʃ = sh as in "shine".
$t\text{ʃ}$ = ch as in "church".
η = ng as in "song".
δ = dth (voiced) as in "then".

TABLE 25.

THE MILL HILL VOCABULARY SCALE - RESULTS OF EXPERIMENTAL HFW AND CONTROL GROUPS BY RAW SCORES, PERCENTILE RANKS AND VOCABULARY AGES.

	HFW Group			Control Group		
Pair	Score	%ile	V.A.	Score	%ile	V.A.
A	11	< 5	6	20	5	9
B	37	75	14+	37	75	14+
C	28	25	$11\frac{1}{2}$	32	50	13
D	20	10	9	30	90	$12\frac{1}{2}$
E	25	25	$10\frac{1}{2}$	37	75	14+
F	17	< 5	8	36	50	14
G	13	< 5	$6\frac{1}{4}$	13	< 5	$6\frac{1}{4}$
H	9	< 5	$5\frac{1}{2}$	34	75	$13\frac{1}{2}$
I	18	5	$9\frac{1}{4}$	31	50	$12\frac{1}{2}$
J	7	< 5	5	20	5	9
K	19	5	$8\frac{1}{2}$	20	5	9
L	24	50	$10\frac{1}{4}$	25	75	$10\frac{1}{2}$
M	24	< 5	$10\frac{1}{4}$	32	c40	13
N	7	< 5	5	19	50	$8\frac{1}{2}$
O	16	< 5	$7\frac{1}{2}$	28	75	$11\frac{1}{2}$
P	18	10	$8\frac{1}{4}$	24	50	$10\frac{1}{4}$
Q	18	5	$8\frac{1}{4}$	30	c60	$12\frac{1}{2}$
R	4	< 5	< $4\frac{1}{2}$	20	25	9
S	36	75	14+	40	90	14+
T	11	< 5	6	24	5	$10\frac{1}{4}$

Statistic computed: $T = 0$

$p < .005$

TABLE 26.

WATTS' ENGLISH LANGUAGE SCALE - RESULTS OF EXPERIMENTAL HFW AND CONTROL GROUPS IN RAW SCORES AND LANGUAGE AGES.

	HFW Group		Control Group	
	Score	L.A.	Score	L.A.
Pair				
A	26	6-2	50	8-2
B	32	6-8	69	9-9
C	59	8-11	59	8-11
D	47	7-11	63	9-3
E	46	7-10	65	9-5
F	40	7-4	66	9-6
G	43	7-7	44	7-8
H	32	6-8	60	9-0
I	53	8-5	62	9-2
J	32	6-8	53	8-5
K	53	8-5	53	8-5
L	48	8-0	50	8-2
M	51	8-3	68	9-8
N	32	6-8	42	7-6
O	42	7-6	52	8-4
P	42	7-6	47	7-11
Q	21	5-9	50	8-2
R	34	6-10	45	7-9
S	58	8-10	66	9-6
T	24	6-0	52	8-4

Statistic computed: $T = 0$

$p < .005$

TABLE 27.

WRITTEN COMPOSITION - MEANS AND STANDARD DEVIATIONS OF NUMBERS OF WORDS WRITTEN BY SMALL REPRESENTATIVE SAMPLES OF LOCAL SCHOOLCHILDREN.

	Year Groups					
	8	9	10	11	12	13
N	12	12	10	12	20	20
BOYS. Mean	106	131	174	196	214	258
S.D.	45	42	37	48	59	118
N	10	10	10	12	10	10
GIRLS. Mean	105	167	216	184	218	272
S.D.	33	41	35	55	50	83

Total N = 148

Note: Appropriate means and S.D.s have been abstracted from the above results and presented in Table 30 for comparative purposes.

TABLE 28.

WRITTEN COMPOSITION - TOTAL NUMBERS OF WORDS WRITTEN BY EXPERIMENTAL HFW AND CONTROL GROUPS, COMPARED WITH SAMPLE "NORMS".

Pair.	HFW Group Number of Words.	X/S.D.	Sample Mean No. of words.	S.D.	Control Group Number of Words.	X/S.D.
A	Nil	-	214	59	95	- 2.0
B	49	- 2.7	214	59	216	(+) 0.0
C	170	- 0.7	258	118	123	- 1.1
D	118	- 1.5	174	37	110	- 1.7
E	74	- 2.3	214	59	82	- 2.2
F	191	- 0.5	258	118	235	- 0.1
G	65	- 2.7	196	48	119	- 1.6
H	23	- 3.2	214	59	138	- 1.2
I	26	- 3.5	196	48	87	- 2.2
J	44	- 3.4	218	50	98	- 2.4
K	111	- 1.3	184	55	102	- 1.4
L	134	- 2.3	216	35	212	- 0.0
M	133	- 1.6	272	83	232	- 0.4
N	67	- 1.1	105	33	160	(+) 1.6
O	50	- 4.7	216	35	49	- 4.7
P	73	- 4.0	216	35	126	- 2.5
Q	112	- 1.2	184	55	107	- 1.4
R	45	- 4.8	216	35	49	- 4.7
S	62	- 2.2	184	55	184	- 0.0
T	Nil	-	272	83	137	- 1.6

157.7 | 96.1

T = 21.5 $p < .005$

TABLE 29.

WRITTEN COMPOSITION - MEANS AND STANDARD DEVIATIONS OF SUBORDINATION INDICES OF COMPOSITIONS WRITTEN BY SMALL REPRESENTATIVE SAMPLES OF LOCAL SCHOOLCHILDREN.

		Year Groups					
		8	9	10	11	12	13
BOYS.	N	12	12	10	12	20	20
	Mean	15	19	24	24	25	30
	S.D.	11.1	10.5	12.6	12.6	9.8	9.9
GIRLS.	N	10	10	10	12	10	10
	Mean	17	21	23	25	26	26
	S.D.	10.9	10.3	5.8	8.4	8.9	8.3

Total N = 148

Note: Appropriate means and S.D.s have been abstracted from the above results and presented in Table 30 for comparative purposes.

TABLE 30.

WRITTEN COMPOSITION - SUBORDINATION INDICES OF EXPERIMENTAL HFW AND CONTROL GROUPS, COMPARED WITH SAMPLE "NORMS."

	HFW Group		Sample		Control Group	
Pair.	Subord'n. Index	X/S.D.	Mean S.I.	S.D.	Subord'n Index.	X/S.D.
A	N/A	-	25	9.8	22.0	- 0.3
B	0	-	25	9.8	33.0	(+) 0.8
C	11.7	- 1.8	30	9.9	18.7	- 1.2
D	33.3	(+) 0.9	24	10.9	11.1	- 1.3
E	0	-	25	9.8	23.0	- 0.2
F	13.7	- 1.6	30	9.9	29.0	- 0.1
G	N/A	-	24	12.6	14.0	- 0.8
H	N/A	-	25	9.8	16.0	- 1.1
I	N/A	-	24	12.6	12.5	- 0.9
J	9.0	- 1.9	26	8.9	18.0	- 0.9
K	0	-	25	8.4	6.2	- 2.3
L	12.0	- 1.8	23	5.8	20.0	- 0.4
M	0	-	26	8.3	24.0	- 0.2
N	13.6	- 0.3	17	10.9	17.0	- 0.0
O	28.5	(+) 0.9	23	5.8	44.4	(+) 3.5
P	13.6	- 1.6	23	5.8	21.0	- 0.3
Q	18.7	- 0.7	25	8.4	24.0	- 0.1
R	8.3	- 2.5	23	5.8	17.0	- 1.1
S	26.0	(+) 0.1	25	8.4	33.0	(+) 0.9
T	N/A	-	26	8.3	5.5	- 2.5

Statistic computed: $T = 12$ $p < .005$

TABLE 31.

SCHONELL'S TEST OF SENTENCE STRUCTURE - RESULTS OF EXPERIMENTAL HFW AND CONTROL GROUPS IN RAW SCORES AND ENGLISH AGES.

	HFW Group		Control Group	
Pair	Score	E.A.	Score	E.A.
A	0	-	2	-
B	25	13-11	8	10-0
C	7	9-9	9	10-3
D	4	8-6	5	9-0
E	0	-	3	8-0
F	3	8-0	6	9-6
G	4	8-6	4	8-6
H	0	-	4	8-6
I	0	-	3	8-0
J	0	-	1	-
K	4	8-6	2	-
L	5	9-0	7	9-9
M	4	8-6	11	10-8
N	0	-	4	8-6
O	3	8-0	8	10-0
P	2	-	4	8-6
Q	3	8-0	5	9-0
R	0	-	4	8-6
S	11	10-8	14	11-2
T	0	-	11	10-8

Statistic computed: $T = 25.5 \quad p < .005$

TABLE 32.

SCHONELL'S GRADED READING VOCABULARY TEST - RESULTS OF EXPERIMENTAL HFW AND CONTROL GROUPS IN RAW SCORES, READING AGES AND READING QUOTIENTS.

	HFW Group			Control Group		
Pair	Score	R.Age	R.Q.	Score	R.A.	R.Q.
A +	36	8.6	69	48	9.8	78
B	90	14.0	111	83	13.3	108
C +	77	12.7	96	73	12.3	92
D	63	11.3	104	71	12.1	113
E	72	12.2	101	73	12.3	105
F	46	9.6	71	73	12.3	91
G +	34	8.4	71	23	7.3	61
H +	21	7.1	58	69	11.9	97
I +	0	Nil.	c40	51	10.1	86
J	23	7.3	59	51	10.1	80
K	47	9.7	82	29	7.9	66
L	64	11.4	109	62	11.2	109
M +	72	12.2	90	76	12.6	93
N +	29	7.9	89	30	8.0	91
O +	53	10.3	97	50	10.0	96
P +	19	6.9	66	33	8.3	81
Q	61	11.1	95	45	9.5	83
R	29	7.9	75	26	7.6	72
S	83	13.3	113	80	13.3	113
T +	33	8.3	63	66	11.6	88

Statistic computed: T = 74.5

p = Not significant at the 0.05 level.

+ The HFW cases marked thus are those who had received extra remedial teaching in reading.

TABLE 33.

THE KELVIN MEASUREMENT OF READING ABILITY - RESULTS OF EXPERIMENTAL HFW AND CONTROL GROUPS BY RAW SCORES, PERCENTILE RANKS AND READING AGES.

	HFW Group			Control Group		
Pair	Score	%ile	R.A.	Score	%ile	R.A.
A	6	<5	8-3	13	30	11-0
B	14	40	11-6	20	95	14-6
C	14	25	11-6	14	25	11-6
D	14	60	11-6	15	75	12-0
E	13	30	11-0	16	70	12-6
F	15	30	12-0	16	40	12-6
G	11	20	10-3	10	10	10-0
H	0	<5	(<8-0)	16	70	12-6
I	0	<5	(<8-0)	14	40	11-6
J	3	<5	(<8-0)	11	10	10-3
K	13	30	11-0	12	25	10-6
L	18	95+	c13-6	14	80	11-6
M	13	5	11-0	18	60	c13-6
N	4	25	<8-0	12	80	10-6
O	10	40	10-0	15	80	12-0
P	0	<5	(<8-0)	12	50	10-6
Q	12	30	10-6	14	50	11-6
R	7	10	8-6	11	40	10-3
S	16	75	12-6	16	75	12-6
T	0	<5	(<8-0)	14	25	11-6

Statistic computed: $T = 12.5$

$p < .005$

TABLE 34.

SOME FORMS OF EXTRA HELP OR EXAMINATION FOR WHICH CHILDREN IN THE EXPERIMENTAL HFW GROUP HAD BEEN REFERRED DURING THEIR SCHOOL CAREERS.

	Referred to:								
Child	Head Teacher	Remove Class	L.E.A. Group	E.S.N. Exam'n.	S.H.S. (Hearing)	Speech Therapy	Psychol. Service	C.G.C.	Totals
A	+	+	+	+	+	+	+	+	8
Control		+							1
B					+			+	2
C					+	+		+	3
D					+				1
E									0
F					+	+		+	3
G	+	+					+	+	4
Control		+							1
H		+	+		+	+		+	5

TABLE 34 (CONTINUED).

Child	Referred to:- Head Teacher	Remove Class	L.E.A. Group	E.S.N. Exam'n.	S.H.S. (Hearing)	Speech Therapy	Psychol. Service	C.G.C.	Totals
I	+	+			+	+	+	+	6
Control								+	1
J		+		+	+				3
K			+					+	2
L									0
M	+						+	+	3
N	+						+	+	3
O	+				+	+			3
P								+	1
Q						+		+	2

TABLE 34 (CONTINUED).

Child	Referred to:- Head Teacher	Remove Class	L.E.A. Group	E.S.N. Exam'n.	S.H.S. (Hearing)	Speech Therapy	Psychol. Service	C.G.C.	Totals
R	+	+			+			+	4
S								+	1
T	+	+		+	+	+		+	6
Control				+					1
Totals: HFW	8	7	3	3	11	8	5	15	60
Controls	-	2	-	1	-	-	-	1	4

NOTE: Control cases are entered only when they had themselves been referred - i.e. in only four instances.
The figures in the 'E.S.N.' column include only three cases - those children who were tested on more than one occasion by school medical officers and actually ascertained as Educationally Subnormal. Cases A and J were registered as 'E.S.N. (O.S.)' - i.e. they were considered capable of benefitting from education in an ordinary school. Case T was registered as 'E.S.N. (S.S.)' and was admitted to a special day school for E.S.N. children.
Cases F, I, N, Q and R had also been referred for examination in the past, but on the evidence of their abilities and known I.Q.s the school medical officer had decided that further examination was not indicated.

TABLE 35.

AGES OF AND REASONS FOR FIRST REFERRAL OF HFW CHILDREN TO THE CHILD GUIDANCE CLINIC.

Child	Age at first referral	Reasons for Referral.
A	5	"Aphasic"
- B	11	Out of control at home - sullen, aggressive and destructive.
C	5	Stammer and enuresis.
- F	10	Enuresis.
- G	10	Enuretic, encopretic lethargy and bullying.
H	10	Reading retardation and immature speech.
I	11	Reading retardation and immature speech.
K	9	Enuresis.
M	12	"Hysteria." Immature behaviour.
- N	6	Infantile in behaviour and speech.
P	9	Tantrums and immature behaviour.
Q	9	Hysterical inability to walk.
R	9	Open masturbation in class.
- S	10	Pilfering and aggression.
- T	6	Out of control at school and home.

Aggressive	3	Enuresis	4	Reading	2
Immature	3	Hysteric	1	Aphasic	1
Mast'n.	1				

TABLE 36.

SOME FORMS OF EXTRA HELP OR EXAMINATION FOR WHICH HFW CHILDREN WERE REFERRED - ESTIMATED INCIDENCES OF THE RELEVANT REFERRAL CATEGORIES IN THE GENERAL SCHOOL POPULATION AND MEMBERS ACTUALLY REFERRED ANNUALLY IN THE LOCAL SCHOOL POPULATION.

	Estimated Incidence in General School Population	Mean Annual Referrals Locally (school pop. = 46,000)
L.E.A. Remedial Reading Group	-	180
Examination as possible E.S.N.	1%	160
Hard of Hearing	0.1 to 0.2%	27
Speech therapy	1.5 to 3.0%	140
School Psych. Service	-	200
C.G.C.	1.0%	200

Note:- The estimate incidences are taken from Ministry of Education Pamphlet No. 5 - "Special Educational Treatment" (1946).
The local referrals are rounded mean figures of children referred whether or not subsequently classified or treated.

APPENDIX E

Watts' English Language Scale - Examples of Responses by HFW and Control Children at each Age Stage.

APPENDIX E.

Watts' Stage One demands responses of which children of four to five years of age are capable. Each of the four pictures represents a single figure engaged in a simple action. Many children of four years of age will be able to name both the figure and the action, but will find difficulty in expressing both elements in a single statement without a good deal of prompting. It is not surprising that only one child tested made an incorrect response to one of the pictures at this stage. She was HFW case Q, aged eleven, who went on to make the lowest score of all, with a L.A. of 5-9. Her error was in response to picture number 4, which represents a girl dancing. Despite several promptings she insisted on describing this as "a ballerina".

Stage two is regarded as being appropriate for children of five to six years, full marks indicating a language development level of six. Each of the pictures represents a figure in action with another figure or object. Younger children would be expected to understand the idea of the pictures, but would find it very difficult to describe them neatly in a single sentence. Several of the HFW group were only successful at this level with prompting, and three of them failed on one or more items even on their third repetitions. Surprisingly, one of these three children was case B, one of the most intelligent children of the whole series. Their incorrect responses are given

below. In each case their matched controls had given acceptable responses at their first attempt, the required descriptions at this stage being:

"This is a picture of - "
" - a dog chasing a cat."
" - a girl hugging a doll."
" - a (black) girl carrying a basket (on her head)."
" - two boys shaking hands."

Examples:

Case B. C.A. 12-7. L.A. 6-8.

"A girl and a doll. A woman and a basket. (Rptd.)
Two boys. (Prompt) Two boys shaking hands."

Case: J. C.A. 12-4. L.A. 6-8.

"A cat and a dog running. (Rptd.)
A girl who is standing with her girl. (Rptd.)
A boy. Just a boy.
Two boys who is shaking hands."

Case: Q. C.A. 11-8. L.A. 5-9.

"A cat and a dog. With a girl and a gollywog.
A native woman."

An interesting point raised by Watts is that dull children seldom use a graphic present participle. For instance, in describing the girl and her doll they will seldom say 'hugging', 'loving' or squeezing'. Watts interprets this as an inability to think themselves into the situation shown. This was noticeable in the responses of the present HFW group who tended to use neutral words like 'holding' or 'carrying', whereas their controls commonly used 'hugging'.

Stage three is intended for children of six to seven years. A full description of these pictures requires the mention of three figures or objects in association with each other. A few representative

examples are given, followed in each case by the responses of the appropriate matched controls.

Sample acceptable descriptions:-

" - a boy giving a donkey a carrot.
- a girl lifting up a little boy to put a letter in the letter-box.
- a girl on a horse jumping over a gate.
- a policeman putting up his hand to stop the traffic."

Examples:

Case: A. C.A. 12-6. L.A. 6-2.

" - a girl carrying a baby. And the baby putting a letter in the post box.
- an 'orse jumping over some wood and a man on top of it."

Control A. C.A. 12-6. L.A. 8-2.

"-a girl lifting the little kid so it can put a letter in the post-box.
-a lady on horseback jumping over a fence."

Case: L. C.A. 10-6. L.A. 8-0.

" - a girl and her little brother posting a letter."

Control L. C.A. 10-3. L.A. 8-2.

" - a little girl holding a little boy up to put a letter in the post."

Case: R. C.A. 10-6. L.A. 6-10.

" - a horse and a man or a woman, I don't know, having a horseback.
- a policeman."

Control R. C.A. 10-7. L.A. 7-9.

" - a girl on her horse jumping a gate.
- a policeman signalling the traffic."

Case: T. C.A. 13-6. L.A. 6-0.

" - a lad and a horse.
- a girl holding a baby. It's posting a letter.
- a horse jumping with a lady on it."

Control T. C.A. 13-3. L.A. 8-4.

" - a boy feeding a horse with a carrot.
- a girl holding a baby up to post a letter.
- a girl on a pony jumping over a hedge."

Stage four is for children of seven to eight years. The pictures require the discernment of relations between actions, not merely between figures. Two of them require use of the word 'because'. Thus successful descriptions require the perception and expression of causal relationships.

Sample acceptable descriptions:

" - a cat who is angry because the dogs are drinking her milk.
- a girl lifting up her cat away from the dog.
- a man showing a boy how to hold a cricket bat.
- a boy crying because a dog has taken his shoe."

Examples:

Case: F. C.A. 13-8. L.A. 7-4.

" - a cricketer showing a boy to play cricket.
" - a boy and his dog pinched a shoe off him."

Control F. C.A. 13-11. L.A. 9-6.

" - a tutor showing a boy the correct way to play cricket.
" - a small child crying who has lost her slipper which the dog has got hold of."

Case: G. C.A. 11-11. L.A. 7-7.

" - a cat going to some little puppies that are drinking some milk in a dish."

Control G. C.A. 12-0. L.A. 7-8.

" - a cat spitting at the puppies because they are drinking its milk."

Case: H. C.A. 12-2. L.A. 6-8.

" - two pups drinking milk.
- the dog barking at the kitten.
- a boy playing cricket.
- a dog got the baby's shoe."

Control H. C.A. 12-3. L.A. 9-0.

All responses very close to acceptable examples above.

Case: K. C.A. 11-10. L.A. 8-5.

" - two dogs licking the milk and the cat coming close.
- a dog holding one of the baby's slippers and the baby is crying."

Control K. C.A. 12-0. L.A. 8-5.

" - two dogs eating the cat's food.
- a little boy crying because the dog has his slipper."

The responses of all the children whose L.A. was below 8 were characterized by an inability to express more than one set of actions in one sentence. Either they would offer one sentence describing one action as did H above, or they would proffer two sentences such as: "The dogs are drinking the milk. The cat is cross."

Stage five represents the level of language development achieved by children of eight to nine years of age. Here the key factor is that the pictures represent actions which have already taken place, a fact which the tester is required to bring out during the preliminary examples. This necessitates the use of relative pronouns. Before the age of eight children find it difficult to link up their statements in this way. They often go through another phase when they use the incorrect pronoun, in particular mixing the uses of 'who' and 'what'

or using 'that' in all cases. More than half the HFW group were quite unable to handle this and the subsequent stage, and the following examples are drawn from the responses of the relatively high-scoring children.

Sample acceptable descriptions:

" - a boy who has fallen into the water.
- a girl who has dropped her doll on the stairs.
- a boy who has fallen down and broken his jug.
- a boy who has just kicked a football."

Examples:

Case: D. C.A. 10-11. L.A. 7-11.

" - a girl going upstairs and she drops her doll.
- a boy who is kicking a football."

Control D. C.A. 10-8. L.A. 9-3.

" - a girl who has just dropped her golliwog which fell down the stairs."

Case: E. C.A. 12-0. L.A. 7-10.

" - a boy that's fallen in the water.
- a boy playing football."

Control E. C.A. 11-9. L.A. 9-5.

" - a little boy who has just fallen into the water.
- a little boy who has just kicked a football."

Case: I. C.A. 11-11. L.A. 8-5.

" - the girl what dropped a dolly on the stairs.
- a boy kicking a football."

Control I. C.A. 11-8. L.A. 9-2.

" - a little girl who has just dropped her golliwog downstairs by accident.
- a boy in a football match who has just kicked the ball to the right wing."

Case: M. C.A. 13-11. L.A. 8-3.

" - a little girl going up the stairs and
left a doll behind."

Control M. C.A. 13-9. L.A. 9-8.

" - a little girl who has just dropped
her doll on the steps."

Stage six is intended to discriminate at the nine to ten year level. Description of the pictures is rendered slightly more difficult than at the previous stage by the introduction of a double time element. Whereas at stage five the pictures represented actions which had just taken place, the stage six pictures involve a present action coupled with one that has already happened. To connect the two up in one sentence requires the use of a subordinate clause with the relative 'which'. As was noted in the discussion of previous literature on the development of written language, the ability to use subordinate clauses seems to provide an important index to the development of linguistic ability. Although these stage six pictures show children engaged in simple activity, their description in a sentence proved to be quite beyond the abilities of the HFW group. Only two of them, cases C and L managed to produce any correct responses, C to two of the pictures out of four, and L to one of them. Several other children achieved one or two correct responses, but only after promptings.

Sample acceptable descriptions:

" - a shopman putting potatoes into the basket which
a little girl is holding out to him.
- a boy looking at a bubble which he has just blown.
- a girl trying to catch her hat which has been
blown off by the wind.
- a cat jumping up at a fish which a boy has
thrown to her."

Examples:

Case: C. C.A. 13-4. L.A. 8-11.

" - a girl holding up a bag which the grocer is putting potatoes into it.
- a boy who is blowing bubbles out of his pipe and he is watching them."

Control C. C.A. 13-7. L.A. 8-11.

" - a young girl getting some potatoes from a man.
- a boy who is blowing bubbles."

Case: L. C.A. 10-6. L.A. 8-0.

" - a grocer and a little girl and the grocer is just putting potatoes in the little girl's bag.
- a cat jumping up in the air for the boy's fish."

Control L. C.A. 10-3. L.A. 8-2.

" - a little girl going to the shop and buying potatoes.
- a cat running after a fish the boy has thrown."

Case: E. C.A. 12-0. L.A. 7-10.

" - a shopkeeper giving a little girl potatoes in her bag.
- a boy training his cat to jump for fish."

Control E. C.A. 11-9. L.A. 9-5.

" - a little girl holding out a carrier to collect some eggs from a farmer.
- a little boy who has just tossed a fish in the air for his cat to catch."

Case: D. C.A. 10-11. L.A. 7-11.

" - a girl running to catch a hat.
- a cat jumping up to get a fish and a boy stands there."

Control D. C.A. 10-8. L.A. 9-3.

" - a girl whose hat has just blown away.
- a cat which is jumping up at a fish which the boy has just thrown up."

Case: M. C.A. 13-11. L.A. 8-3.

" - a little boy sat on a stool playing bubbles with a pipe.
- a little girl trying to catch her hat because it is blowing away in the wind."

Control M. C.A. 13-9. L.A. 9-8.

" - a little boy looking at a bubble he's just blown with his pipe.
- a girl running after her hat which the wind has caught."

Case: S. C.A. 11-10. L.A. 8-10.

" - a little boy. He has a bowl of soapy water and a pipe. He is blowing bubbles through the pipe.
- a little girl. The wind has just blown her hat off."

Control S. C.A. 11-9. L.A. 9-6.

" - a little boy admiring a big bubble which he has just blown.
- a little girl reaching for her hat which has blown off her head.

APPENDIX F

The Francis Phonetic Word List.

APPENDIX F.

THE FRANCIS PHONETIC WORD LIST.

Sound	Initial	Medial	Final
b	beat	baby	web
d	duck	ladder	mud
f	fish	toffee	cough
g	gun	tiger	egg
h	house	-	-
k	key	mickey	duck
p	penny	poppy	tap
s	sun	pencil	house
t	tap	letter	boat
v	van	seven	five
z	zebra	wizard	scissors
sh (ʃ)	shoe	washing	fish
ch (tʃ)	chair	teacher	match
zh (ʒ)	-	measure	-
j (dʒ)	jelly	pigeon	badge
th (θ)	thumb	panther	bath
th (ð)	them	mother	with
y	yellow	-	-
l	letter	pulley	ball
m	match	lemon	thumb
n	knife	penny	gun
r	red	hurry	-
w	wife	-	-
ng (ŋ)	-	singing	tang.

APPENDIX G

Children with High Frequency Weakness - Some Case Notes.

THE EXPERIMENTAL GROUP - CASE NOTES.

Case A - Joey. Age 12.

Joey was a slightly built boy, very poorly dressed and usually dirty. His hair was long and unkempt; on the few occasions it was cut it was usually done by his grandmother in 'pudding basin' style, so that a ragged fringe hung in front of his face, giving it a wistful, doggy appearance. This was heightened by Joey's expression, which was sad but eager. Given any encouragement, however, a great black-toothed smile would transform his features. His speech was always slurred and immature. Under the stress of excitement or anxiety it would become almost incomprehensible. In the same way Joey's co-ordination was not of the best; his movements were either sluggish or jerky. He would react to stress by rapid, ducking movements.

In general Joey was the only one of the experimental group who was immediately recognizable as a representative of what is becoming a rare group - the poverty-stricken, maltreated, under-nourished slum-dwelling urchin. This sort of child figured largely in studies written in the first decade of this century and again during the depression years. It has become almost non-existent since the advent of free milk, school meals and school welfare assistants. Joey was one of the half-dozen children to be seen by the writer during the school holidays running barefoot through the streets - a sight not uncommon thirty years ago, but sufficiently strange nowadays to draw startled attention from the local citizenry, followed by complaints to the police and to the N.S.P.C.C. inspector. There was, unfortunately, always the possibility

that Joey's woebegone manner and ragged apparel were as much the product of wit as of necessity. Joey was the regular and far from reluctant recipient of gifts of cash and cast-off clothing not only from the authorities but from tender-hearted persons of all ages and levels of society. On at least two occasions he arrived at the clinic stammering happily after some Christian trolley bus conductor had not only refused to accept his fare (given him by his headmaster) but had insisted on giving him a shilling or two "d' give d' memam." Furthermore Joey, with the same look of down-trodden suffering, was quite capable of filching any small portable possession whilst his benefactor was looking for something to give him. When caught in the act, as he often was, his redoubled wistfulness usually prevailed upon his benefactor-victim to treble his gift instead of calling in the police. The result was, that although often thrashed by his headmaster, Joey had never actually appeared before a juvenile court.

On the other hand his home background was indeed poor and sordid. Joey was one of six children, cared for by various adults of dubious marital status. His 'father' was an unskilled dock labourer, violent and irresponsible. The only consistent upbringing he seemed to have enjoyed was given him by his aged and dull grandmother and by an adult sister.

Joey first came to the writer's notice at the age of five and a half. He had been diagnosed by his G.P. and by a school medical officer as 'aphasic'. His I.Q. on the Terman Merrill was then 68. Six years later it was 70. There was a decided difference between his performance on the verbal items and on the non-verbal, his

performance on the latter being very low average. There was no evidence of organic lesion and the writer considered his speech problem to be dyslalia. Subsequently he attended the Speech Therapy Clinic irregularly, so that although improvement in his speech was noticeable it was not always maintained. Throughout his subsequent school career Joey was continually being referred to clinics of various types. Despite special attention in backward classes and remedial groups his reading ability remained negligible whilst his arithmetic ability was at a seven-year level. During his first year at the local secondary school (the school medical officer was never convinced that his intellectual ability was sufficiently low to justify his transfer to a special school) he presented such an obvious challenge that his new headmaster arranged intensive and often individual tuition in reading and arithmetic only. Joey responded by gaining mastery of the basic arithmetic simple processes and by displaying some effective familiarity with various word recognition tests. But his functioning reading ability on any other material remained non-existent. The headmaster, exasperated, deserted all conventional remedial techniques and ordered a new regime. He determined to instil some accomplishment into Joey even at the lowest level of learning, somewhat akin to that used by the trainers of circus animals. For a three-week period Joey was taken off all normal class activity, presented with a first reading primer (one which he had supposedly worked through twice before) and instructed to learn it by heart, reporting to the headmaster on the hour every hour

during school time. Any success was rewarded with sweets and brightly coloured pencils. Failure invoked automatic caning. Joey responded with alacrity. He was caned only once during the three week period and accumulated a great hoard of sweets and pencils. At the end of that time the headmaster sent him to see the writer, bearing a jubilant note containing a request for settlement of a small wager entered into between the headmaster and the writer at the commencement of the training regime. Joey happily recited a good proportion of the book. Unfortunately it transpired that not only could he give no account of what it was about, but could recognize none of the sentences out of context. The main positive result of this era was that Joey became a fervent admirer of the headmaster. On one occasion he staggered into his room bearing a gift in the form of a two foot cod. The head's bewilderment was rapidly resolved a few minutes later upon the arrival of the local fishmonger, from whose slab Joey had casually filched his monster offering on the way to school.

Throughout his school career Joey was regarded by his peers and mentors alike with a mixture of affection, exasperation and despair. This is not without interest, for it implies that he was generally considered to be not a typical mentally defective boy, but one with hidden potentiality which stubbornly refused to come to the surface. The conclusions reached about him by various responsible adults throughout his early years support this view:

At age 6.	Medical Officers:	"Aphasic."
	Headmistress:	"This little boy seems bright and active, but he has very poor speech and is making no progress."
	Psychologist:	"An E.S.N. level child hampered by verbal immaturity and dyslalia."
	Speech Therapist:	"Dyslalic."
At age 10.	Medical Officer:	"Borderline E.S.N. with uneven development."
	Headmaster:	"A behaviour problem with a very bad family background. He seems anxious to please but is always in trouble and does very odd things in answer to even the simplest of instructions. Has made no progress despite remedial help."
	Psychiatrist:	"Maladjusted. Dull hysteric."
	Speech Therapist:	"Language retardation and dyslalia."
At age 12.	Headmaster:	"More batty than daft, as the boys say. Eccentric and often delinquent, but not an ounce of evil in him. Appears stupid but has some taking ways and shrewd, street corner practical abilities. We are determined to teach him something. A pity his speech can't be improved."

Case B - Paul, Age 12.

Paul was a tall, well-built boy, clean and well dressed, usually in a school uniform. His speech was good apart from his slight lisp, and he spoke with a relatively refined accent. His voice was over-loud, but this was in accord with his general behaviour, which was over-confident, somewhat aggressive and often supercilious. Physically he was very active, and in interview situations he would soon become impatient and restless, even to the point of insolence, looking at his watch and ostentatiously shuffling his feet.

Paul came of a respectable middle class family. Both parents seemed to be well educated (his mother was a graduate). His father was a senior clerical officer in the civil service; he was many years older than his wife. There was one daughter, three years younger than Paul. The family lived in a middle class professional area of large Victorian houses, a circumscribed oasis of gentility bounded by a small park, two working class areas and a relatively new estate of large semi-detached residences occupied by rising young executives and prosperous tradesmen. Here was situated the primary school which served the two middle class areas, a fine modern building with spacious playing field. Although overcroweded it had exceptionally high academic standards and almost all its 'A' stream children and half the 'B' stream regularly won awards to the local grammar schools. The remainder attended a bilateral secondary modern/technical school of exceptionally high standard. (This was subsequently to become a tripartite campus school). In this

educational setting Paul was an average scholar in the middle stream of the primary school, and subsequently in a similar stream in the secondary school. He maintained this level however, largely by his results in subjects other than English. His work in the latter was patchy. Although a good mechanical reader, his compositions and creative work were poor. That this was not primarily due to intellectual limitations is indicated by the fact that his I.Q. on the Terman-Merrill was 121.

During his infant school time his relative slowness in reading, coupled with the fact that he sometimes missed or mis-heard the teacher unless he sat at the front of the class prompted the head-mistress to refer him to the school health service as possibly hard of hearing. After examination however, he was reported to be 'of normal hearing. Inattentive.' At the commencement of his junior school career his relative weakness in reading was again noted, but he subsequently improved sufficiently to avoid either demotion or remedial help. This was probably due to the fact that he received private tuition out of school hours. It may be noted that this, in another boy of his intelligence would normally have ensured his admission to a grammar school. In Paul's case it merely sufficed to keep him from being admitted to the 'remove' class as a backward reader.

Meanwhile Paul's junior school teachers had noted him down as "an aggressive show-off and a bully. He seems happy enough at school, but insists on having his own way and is unpopular with

the other children." When he was nine his headmaster suggested his referral to the Child Guidance Clinic, but the parents refused, denying that he presented a behaviour problem. Two years later, however, they requested referral themselves, and it transpired that he was out of control at home, being sullen, aggressive and destructive. His elderly father and rather ineffectual mother had turned a blind eye to this for some time, but were now anxious about the future. The psychiatrist's diagnosis was "Maladjusted. A boy of high intelligence who lacks firm control at home and is displaying some psychopathic traits."

In the event Paul made very few attendances at the Clinic, rapidly prevailing upon his parents to request his discharge.

He settled down reasonably well at the secondary school, the headmaster reporting "Paul has plenty of ability and has tackled new subjects with enthusiasm. He is very well informed and is making good progress. He can be sulky and awkward, but he lets off a lot of steam on the sports field and showed no sign of bullying after the first term. I am not quite happy about his personality, but feel that new interests and outlets will help him to find his feet. His verbal ability is patchy, although he can talk in an interesting manner on a number of topics."

Case C - Tony. Age 13.

Tony was a boy of average build, clean and decently dressed but untidy. He had a pale, puffy face, with a withdrawn and wary expression. His smile was fleeting and somewhat malicious. His speech was clear, but he suffered from a slight stammer which developed into gross blocking under stress. Furthermore, he showed a complete lack of spontaneity with adults, although this improved as he grew older. During interviews with adults he knew, he appeared physically relaxed, but his eyes would dart anxiously about. With other children he was boisterous and rough.

Tony's father was a male nurse. His mother was an intelligent woman, but anxious and in poor health. She was a devoted mother who read too many books on child psychology and was continually referring her children for various forms of specialist advice. The family consisted of a boy one year older than Tony who had been adopted by the parents after several years of childless marriage. As is often the case Tony was born the following year and a daughter two years later. When Tony was ten his mother gave birth to yet another son.

The family lived in a decent working class neighbourhood in a large terrace house. His mother, although usually suffering from some financial hardship, had middle class pretensions and sent her children to a modern primary school some distance away in a relatively prosperous suburb of small modern houses. Ironically enough, this 'snob' school had at that time attained an academic level which

was somewhat inferior to the neighbourhood school. During the next six years, however, the standard of the suburb school improved outstandingly, whilst those of the neighbourhood school deteriorated due to population shifts.

During his first year at the infant school Tony was referred to the speech therapy clinic for his stammer and some dyslalia, and then to the Child Guidance Clinic for his stammer and for enuresis. His headmistress had also referred him to the school health service as hard of hearing. The audiologist reported that his hearing "was within normal limits." The teachers however had noted that the child sometimes ignored or mishead instructions and would often reply to questions with irrelevant or peculiar replies. The speech therapist had discovered only slight dyslalia, the chief difficulty being with 'k' sounds. This was speedily remedied, and as the stammer was at that time not so gross he was discharged from the speech clinic, although in later years he had several further courses of treatment.

During his infant years Tony was shy but cheery. His I.Q. on the Terman-Merrill was 103, but on the non-verbal Drever-Collins Performance Scale his score was an I.Q. of 115. His reponses were often inconsistent, which reflected his general personality. He suffered from frequent mood swings and could be stubborn, tense and withdrawn. Perhaps under the stress of consistent school failure this side of his personality became more noticeable when he entered the junior school. Here he was regarded as "lazy, sly and unpredictable. He ignores instructions and can be aggressive and violent."

At the age of nine he was re-referred to the Child Guidance Clinic. His enuresis, which had improved considerably two years before, was now nightly again and his stammer was worse. It was found that he had made no progress whatsoever, and it was decided to concentrate on helping him with his schoolwork. Good progress was made, which incidently was maintained throughout his subsequent school career, so that during his secondary school years he was regarded as being of average attainment. He was discharged from the clinic when he was ten, only to be re-referred a year later after a series of episodes of pilfering and a bout of truancy. It was felt that this was a reaction to the birth of his baby brother. As is quite common in such cases he appeared devoted to this child and behaved towards it with tenderness and responsibility. Subsequently he settled down and proceeded to the secondary modern school where his career was unexceptional. The headmaster there reported "A decent enough lad, quite co-operative, who shows flashes of intelligence and is managing the work reasonably well. A pity he doesn't wear a hearing aid as I am sure he misses a lot of what goes on. He seems to get on all right with the other boys, although he can be very rough and irresponsible. But he is not a tough child, and can be shy with strangers, when his stammer is most embarrassing. His chief weakness is in expression and creation of any kind, but particularly in composition."

Case D - Bob. Age 10.

Bob was a stocky, amiable lad, clean and decently clad. He had a ready smile and although not talkative, showed no sign of shyness.

The family was poor, the father being a labourer. They lived in a near-slum area of squalid terraces and decaying tenements. Bob had two brothers, one older and one younger than himself. They all attended the local unreorganized boys' school, an old, overcrowded, grimy building adjoining the main railway line. Academic standards here were low, but the atmosphere was busy and cheerful.

Bob was regarded as quite a normal pupil. He maintained his position halfway up in the 'A' stream. This was not surprising, as his I.Q. on Terman-Merrill proved to be 113. He was relatively hampered by his progress in reading which was never up to the standard of his other work, although not retarded enough to justify remedial attention. He was regarded as being slightly hard of hearing by the staff, and whilst at the infant school had been referred to the school health service for the audiologist's opinion. The latter's report was that the boy was "of normal hearing, though with some slight upper tone loss."

Case E - Edgar. Age 12.

Edgar was a wiry boy of average height, clean and decently dressed. He had an alert, cheerful expression, was talkative and co-operative. His voice was hoarse and he produced a lateral 'hish' sound instead of 's'. In behaviour he was active and somewhat infantile. During testing he 'fussed' like a junior child, settling himself down busily and eagerly, laying out his pencils, re-arranging his chair, excitedly enquiring about the content of the tests. While he worked he screwed his face up in an ostentatious imitation of high endeavour. When faced with difficult material he sucked two fingers abstractedly.

Edgar's father was a shop assistant. The family lived in a pre-war housing estate near the outskirts of the twon. Many of the families were connected with the fishing industry and had no lack of material possessions. The local school was a modern building, the academic standards of which varied considerably as it drew children from a poorer area nearer the city centre. In many respects it was a very representative school; the proportion of its scholars who were awarded places at selective schools was exactly that of the city as a whole, and its scatter of results on educational surveys was very near that of the general school population. And in this representative community Edgar was an average individual. He was in the middle of the middle stream, showing no specific weaknesses, and shining only at physical education.

Edgar's home had apparently no particular problems, material or emotional. He had one sister, a year younger than himself. He mixed well with the other children. His head master reported, "Edgar is making reasonable progress, although he can be inconsistent and slip-shod. In some ways he is childish for his years and can be over-demanding of attention. Occasionally he reacts to difficulty quite hysterically."

Case F - Mark. Age 13.

Mark was a stocky boy with pale, tough features and a shock of fair hair. His speech was uncouth but clear except for a lisped 's' sound. With adults he was somewhat uneasy. His conversation lacked spontaneity. With other boys he was rough and predisposed to bullying.

Mark had one younger sister. His father was a skilled driller earning a good wage; the children's clothing and the condition of the home suggested that the income was not well managed. The family lived in a brand new and excellently equipped council house on a spacious model estate which adjoined the open country. The local schools were newly opened, light, airy and beautifully fitted out. Mark's family, like the majority of their neighbours had recently moved out from a slum area near the city centre, so that social standard and educational levels had not yet been established. In academic status it is not surprising that the secondary modern school attended by Mark was similar to the poor schools near the centre. Mark was towards the bottom of the 'C' stream, his attainment in English being particularly weak.

At his city junior school Mark had received extra help with reading. Because of periods of 'vacancy' in class he had been referred for audiological examination but had been reported by the specialist to have "hearing within normal limits." He had also attended the

speech therapist who had classed him as displaying "language retardation and stammer." The stammer was not in evidence at the time of testing and the school reported that it had been cleared up.

At the age of ten Mark had been referred to the Child Guidance Clinic for enuresis and uncontrolled behaviour. His headmistress had reported that he was "rough, sullen and vicious." His I.Q. on the Terman-Merrill was 79, the relative weakness of his performance on verbal items and the superiority on memory for designs being particularly noted.

Case M - Pam. Age 13.

Pam was almost fourteen, a big, well-developed girl but gangly and graceless. She was at the awkward stage, displaying a pathetic mixture of assumed sophistication and sexual awareness whilst being evidently insecure and immature. She had recently begun to use make-up, but invariably had untidy hair and a tide-mark round her neck. When in company with adults she would assume a brittle poise, flirting outrangeously with males of any age. This behaviour was rendered even more touching by the fact that she was an exceedingly plain girl with a very large nose, bad teeth, thick spectacles and plentiful (and often wet) acne all over her face. With other girls she was shrill, boisterous and bossy. With boys of her own age she was generally tongue-tied and scarlet. Her voice was poorly modulated and uncontrolled, its tone strident. She assumed an irritating mixture of over-emphasized local accent, and supposedly Transatlantic twang. Her conversation was plentifully sprinkled with coarse local slang and television advertisement jingles. She was garrulous, but her language was immature in form, repetitive and diffuse in content.

Pam was an only, and probably illegitimate, child who had been brought up by her elderly grandparents. They lived in a self-respecting working class area of old but well-maintained terrace houses. The girl attended the local girls' secondary modern school which, prior to the war had been a student teachers' "demonstration school" and still maintained a good deal of 'tone' coupled with

high academic standards. Pam was considered a very poor scholar although it is only fair to say that her deficiencies might not have been so apparent at a school of more average standard. Her backwardness was attributed by the headmistress more to her lack of application and emotional stability than to lack of intelligence. And in fact her I.Q. on the Terman-Merrill proved to be 92.

At the junior school Pam had been noted down immediately as "a hysteric type" and had had to receive extra help with her reading. But she was referred to the school psychological service later by the secondary modern school headmistress, not for help with her reading but for suggestions regarding her handwriting. This was so irregular and ill-formed as to be illegible, and had remained so despite years of extra help and exercises. The staff had become convinced that a child who could produce such attempted writing must be suffering from some neurological lesion which interfered with fine motor co-ordination. In fact the handwriting was yet another reflection of Pam's emotional instability and was somewhat improved by general adjustive counselling rather than by any form of remedial penmanship or physiotherapy. Subsequently the girl attended the Child Guidance Clinic for what the headmistress described as "hysteria", and because her grandmother was finding some difficulty in managing her. The psychiatrist diagnosed her as "Maladjusted. Hysterical symptoms in an adolescent girl."

Pam proved to be an essentially good-hearted, well-meaning girl, who was reactive to her social and emotional deficiencies without apparently having any insight. She had many of the traits associated with classical Charcot hysteria. She was highly suggestible, hypochondriacal and given to dramatic but superficial demonstrations of stress reponse. She would assume pallor and weakness, suffer from the 'vapours' and even swoon on to conventiently placed benches or carpets. She was sentimental and gushing. She was perpetually romantic, carrying large handbags stuffed with magazine portraits of 'pop singers' such as Cliff Richard or television western herioes such as Robert Horton. These she would kiss ecstatically or thrust into her blouse. Much of her time in school and out was occupied with the composition of slushy love letters to these heroes, some of which were actually despatched to impress her school friends. It was of some clinical significance, however, that at home she still played with her dolls and teddy bear. And on the one known occasion when a doubtless befuddled youth did attempt to kiss her on the way home from an evening meeting of her Sunday School Fellowship she neither responded, shrieked nor swooned. She swung her large handbag, heavy with its portraits of teen age idols and felled her assailant with one blow.

Case R - Martha. Age 10.

Martha was a small, neat, clean child who looked at least two years younger than her real age. She had long hair, wide eyes and a demure expression which accorded well with her clothes which were of good quality but of faintly Edwardian style. With both adults and other children she behaved with a sweet, old-fashioned courtesy. Her general demeanour was shy but friendly, her voice low and controlled, with a charming lisp. But both the form and content of her conversation was at a five or six-year level.

Martha was an only child. Her father was the manager of a public house in a squalid slum area, and the family lived on the premises. The street adjoined, but was not socially part of, the area inhabited by the families of trawlermen and fish-dock workers. It contained the same sort of tiny terrace houses, but these were the homes of coloured seamen and itinerant labourers, aged prostitutes and seedy down-and-outs. Martha's parents, however, seemed to shield their daughter from this environment fairly successfully. Much of her spare time was spent at the homes of relatives away from the area, and as a Roman Catholic child she did not attend the local school which was notorious for the toughness and intellectual impermeability of its pupils. Martha's school was some distance away. It was housed in a modern building and had good academic standards.

Martha had received extra tuition at school throughout her attendance there, and was currently in the remove class. Various members of the staff had noticed her fits of abstraction and her

liability to misunderstand instructions. It was noted that if the teacher was standing at the back of the class Martha did not appear to hear what was said. The reverend headmistress therefore referred her for audiological examination, but the report came back that, the child was "very vulnerable to middle ear infections her hearing was within normal limits."

At the age of nine the headmistress referred her to the Child Guidance Clinic on account of "sexual misdemeanour". It transpired that Martha had acquired the habit of openly masturbating in class. Her I.Q. on the Terman-Merrill turned out to be only 72, and it seemed likely that the behaviour complained of was a comfort mechanism which was resorted to under the stress of continual school failure. (As a matter of interest a female cousin of Martha had been referred to the clinic years before from a different school for the same behaviour and at the same age. It seems not improbable, in view of the extreme rareness of this type of referral that there was in this family some genetically determined predisposition.) After a period of play therapy during which no familial stresses were elicited, Martha was given help with her reading. But although her word recognition ability rapidly rose to the level of her estimated 'mental age' her comprehension and language ability remained retarded.

Case N - Elizabeth. Age 8.

Elizabeth was a thin, active child with a plump pale face. She continually suffered with catarrh, so that her mouth was usually open and each nostril appended by a 'candlestick'. The general effect was to some extent countered by her very large and attractive china blue eyes. With both adults and children Elizabeth's initial shyness rapidly gave way to friendly, excited chatter. Her voice was strong but rather hoarse. Her articulation was clear but her intonation rather infantile, whilst both form and content of her conversation was at a six-year level.

Elizabeth had two baby brothers. Her parents were young, amiable and rather simple. The family lived in the same squalid area as did Bob, and Elizabeth attended the local unreorganized girls' school. Although the family was poor Elizabeth never seemed to want for any necessity. Her clothes were often cast-offs, but they were always ample, warm and clean.

The child soon drew attention to herself in the infant school. Her expression was vacant, she was inattentive and she made no progress. But when the headmistress referred her to the school psychological service the main complaint was that Elizabeth was "a grossly immature child with very bad speech." Elizabeth was six when first seen by the writer. She was sitting limp and inanimate at a large table where her class-mates were busily cutting out patterns in coloured paper. When approached she immediately burst into anguished tears and had to be led by the headmistress into

her room. Within a few minutes however, she had kissed the writer wetly upon his nose and insisted upon sitting upon his knee. Her speech was babyish and included some jargon. She was quite inattentive to the speech of others, but alert and interested when presented with test apparatus. Her I.Q. on the Terman-Merrill was 86. At that age she had no attainment in the basic skills whatsoever. Socially she was very immature. She would salivate down the front of her jumper, pick her nose or be flatulent with blissful disregard for the presence of others, whether children or adults.

Subsequently the child was seen at the Child Guidance Clinic at the mother's request. The behavioural problems diminished during the course of the next year and during the next few months an attempt was made to help her to listen to language and to discriminate sounds. Her articulation improved remarkably, to the extent that no dyslalia or jargon was still in evidence. Similarly, her mechanical reading ability was brought almost up to her mental age level. But as in the case of Martha her comprehension and language remained retarded.

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