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Perceptual Processing Abilities and Academic Skills:
Intensive Case Studies of Audio-Psycho-Phonological
Remedial Training with Five Dyslexic Boys

Robert Thomas Roy

Thesis submitted to the School of Graduate Studies
of the University of Ottawa as partial fulfillment
of the requirements for the degree of Doctor of
Philosophy in Psychology.

Ottawa, Canada, 1980



Robert Thomas Roy, Ottawa, Canada, 1981.

TABLE OF CONTENTS

Chapter	Page
ACKNOWLEDGEMENTS	vi
CURRICULUM STUORIUM	vii
ABSTRACT	viii
LIST OF TABLES	x
LIST OF FIGURES	xii
INTRODUCTION	xv
 I REVIEW OF THE LITERATURE	 1
The Concept of Dyslexia	2
Phase One: Description and Identification (1860-1917)	 2
Phase Two: Analysis and Discus- sion (1917-1960)	 5
Phase Three: Development and Dis- array (1960 to Date)	 15
The Definition of Dyslexia	25
Research Models in Dyslexia	30
The Remediation of Dyslexia	33
Tomatis' Audio-Psycho-Phonological Approach to Dyslexia	 40
Tomatis' Concept of Dyslexia	42
The Ear, Listening, Language and Dyslexia	 43
The APP Training Program for Dyslexia.	56
Critical Considerations	58
The Research Status of APP Training	62

Chapter	Page
Perceptual Processing Abilities and Academic skills	67
Perceptual Processing Abilities	67
Academic Skills	79
Summary, Research Proposal and Expectations	82
II EXPERIMENTAL DESIGN	89
Single Subject Research	89
Selection of Subjects	92
Measurement Devices	118
Academic Achievement Tests	118
Tests of Perceptual Processing Abilities	122
Research Procedures	135
Presentation and Analysis of Data	151
III DIAGNOSIS AND REMEDIAL TRAINING PROGRAM	153
Case #1: Andrew	154
Diagnosis	154
The APP Remedial Training Program	158
Case #2: Brian	167
Diagnosis	167
The APP Remedial Training Program	172
Case #3: Charles	181
Diagnosis	181
The APP Remedial Training Program	185

Chapter	Page
Case #4: Darryl	193
Diagnosis	193
The APP Remedial Training Program	197
Case #5: Ernest	206
Diagnosis	206
The APP Remedial Training Program	211
IV PRESENTATION OF THE RESULTS	221
Case #1: Andrew	221
Perceptual Processing (ITPA) Results	221
Academic Achievement Test Results	230
Additional Pre and Posttraining Data Comparisons	234
Case #2: Brian	238
Perceptual Processing (ITPA) Results	238
Academic Achievement Test Results	245
Additional Pre and Posttraining Data Comparisons	251
Case #3: Charles	253
Perceptual Processing (ITPA) Results	253
Academic Achievement Test Results	259
Additional Pre and Posttraining Data Comparisons	265
Case #4: Darryl	267
Perceptual Processing (ITPA) Results	267
Academic Achievement Test Results	274

Chapter	Page
Additional Pre and Posttraining Data Comparisons	279
Case #5: Ernest	282
Perceptual Processing (ITPA) Results . .	282
Academic Achievement Test Results . . .	291
Additional Pre and Posttraining Data Comparisons	297
V DISCUSSION OF RESULTS	300
Discussion of Research Expectations	300
General Research Expectation	300
Specific Research Expectations	302
Further Findings Related to APP Training . .	322
Strengths and Weaknesses of the Present Research Project	329
Future Research Directions	333
REFERENCES	339
APPENDICES	
A The Three Integrators	363
B The Approximate Mean Age-Grade Table Stated in Years and Months	372
C Procedures for the Evaluation of the Dominant Ear - Audiometerometry . . .	374

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CURRICULUM STUDIORUM

Robert Thomas Roy was born August 18, 1944, in Saint Boniface, Manitoba. He received his Bachelor of Arts degree in Latin Philosophy from the University of Manitoba in 1965. He was granted a Master of Arts degree in Psychology by the University of Ottawa in 1971. The title of his thesis was: Extent of psychological differentiation as related to verbal skills.

ABSTRACT

Perceptual Processing Abilities and Academic Skills: Case Studies of Audio-Psycho-Phonological Remedial Training with Five Dyslexic Boys.

Although dyslexia was formally recognized over 75 years ago, the understanding and correction of this condition leaves much to be desired. The heterogeneity of symptoms, the lack of clear-cut diagnostic criteria and the diversity of remedial approaches are among the critical problems faced by the researcher and clinical practitioner alike. A. A. Tomatis has recently advanced the Audio-Psycho-Phonological (APP) approach to the remediation of dyslexia. This approach presents a theoretical frame of reference that may help put the complexity of this condition into proper perspective. It offers new diagnostic techniques which throw light on primary causative factors in terms of listening deficiencies. The remedial program emphasizes the reeducation or reconditioning of inadequate listening and language skills rather than academic skills as such. The present study investigated the nature of changes in perceptual processing abilities and academic achievement in five dyslexic boys as they pursued their individual APP remedial training programs. Four of the five boys progressed considerably in both areas assessed. In general, gains in perceptual processing preceded gains in academic achievement, and gains in reading ability followed a developmental pattern in keeping with normal process of acquiring reading proficiency. Intriguing changes were also noted in

the areas of attentional behavior, the self-regulating role of speech and language, and personal-social behavior. The research findings were discussed in terms of Tomatis' theoretical postulates and in terms of relevant literature on the nature of listening and language as they pertain to human development and learning. Overall the results of this study suggest that APP remedial ~~training may enhance important pre-~~requisite skills to the benefit of academic achievement.

Since the present investigation, exploratory in its intent, did not provide for a control group, some caution is indicated in interpreting the results. Some critical considerations of Tomatis' theory and technique are also advanced.

LIST OF TABLES

Table		Page
1	Andrew's ITPA Scaled Scores for Eight Testing Sessions	222
2	Andrew's Achievement Test Grade Ratings for Eight Testing Sessions	231
3	Comparison of Andrew's Achievement Test Results at the Onset of APP Training and at the Close of the Follow-Up Period . . .	236
4	Pre and Posttraining Data Comparison for Andrew	239
5	Brian's ITPA Scaled Score for Eight Testing Sessions	240
6	Brian's Achievement Test Grade Ratings for Eight Testing Sessions	247
7	Comparison of Brian's Achievement Test Results at the Onset of APP Training and at the Close of the Follow-Up Period . . .	252
8	Pre and Posttraining Data Comparison for Brian	254
9	Charles' ITPA Scaled Scores for Eight Testing Sessions	255
10	Charles' Achievement Test Grade Ratings for Eight Testing Sessions	261
11	Comparison of Charles' Achievement Test Results at the Onset of APP Training and at the Close of the Follow-Up Period . . .	266
12	Pre and Posttraining Data Comparisons for Charles	268
13	Darryl's ITPA Scaled Scores for Eight Testing Sessions	269
14	Darryl's Achievement Test Grade Ratings for Eight Testing Sessions	276

Table		Page
15	Comparison of Darryl's Achievement Test Results at the Onset of APP Training and at the Close of the Follow-Up Period . .	281
16	Pre and Posttraining Data Comparisons for Darryl	283
17	Ernest's ITPA Scaled Scores for Eight Testing Sessions	284
18	Ernest's Achievement Test Grade Ratings for Eight Testing Sessions	292
19	Comparison of Ernest's Achievement Test Results at the Onset of APP Training and at the Close of the Follow-Up Period . .	296
20	Pre and Posttraining Data Comparisons for Ernest	299
A	The Approximate Mean Age-Grade Table Stated in Years and Months	373

LIST OF FIGURES

Figure		Page
1	Audiometric curve for the musical ear	48
2	Audiometric representation of prenatal sounds frequency range	48
3	The ideal listening curve	102
4	Various non-listening attitudes	105
5	Additional non-listening attitudes	107
6	Spatialization difficulties	109
7	Partially closed selectivity	111
8	Clinical model of the ITPA	125
9	The Electronic Ear	139
10	Frequency modification curve for Channel C1 of the Electronic Ear	142
11	Pre and post APP remedial training results on the Tomatis Listening Test and Audiometerometry for Andrew	166
12	Pre and post APP remedial training results on the Tomatis Listening Test and Audiometerometry for Brian	180
13	Pre and post APP remedial training results on the Tomatis Listening Test and Audiometerometry for Charles	192
14	Pre and post APP remedial training results on the Tomatis Listening Test and Audiometerometry for Darryl	205
15	Pre and post APP remedial training results on the Tomatis Listening Test and Audiometerometry for Ernest	218
16	Comparison of time spent by each child on various subphases of the APP remedial training program	219

Figure		Page
17	Andrew's ITPA patterned scaled scores before and after APP training	228
18	Andrew's mean ITPA scaled scores during baseline, APP training and follow-up periods	229
19	Andrew's academic achievement index during baseline, APP training and follow-up periods	235
20	Brian's ITPA patterned scaled scores before and after APP training	243
21	Brian's mean ITPA scaled scores during baseline, APP training and follow-up periods	246
22	Brian's academic achievement index during baseline, APP training and follow-up periods	250
23	Charles' ITPA patterned scaled scores before and after APP training	258
24	Charles' mean ITPA scaled scores during baseline, APP training and follow-up periods	260
25	Charles' academic achievement index during baseline, APP training and follow-up periods	264
26	Darryl's ITPA patterned scaled scores before and after APP training	273
27	Darryl's mean ITPA scaled scores during baseline, APP training and follow-up periods	275
28	Darryl's academic achievement index during baseline, APP training and follow-up periods	280
29	Ernest's ITPA patterned scaled scores before and after APP training	288

Figure		Page
30	Ernest's mean ITPA scaled scores during baseline, APP training and follow-up periods	290
31	Ernest's academic achievement index during baseline, APP training and follow-up periods	295
A	The vestibular (or somatic) integrator	369
B	The visual (or spatial) integrator	370
C	The cochlear (or linguistic) integrator	371
D	Illustration of Audiolaterometer	381
E	Setup for administration of the Audiolaterometry test in conjunction with the Electronic Ear	382
F	Audiolaterometry results for left ear dominance of 3.0 in the control of speech	385
G	Audiolaterometry results for right ear dominance of 2.0 in the control of speech	387

INTRODUCTION

The attainment of literacy marks a unique achievement in human evolution as well as a proud accomplishment in a young person's striving to learn, relate and progress in modern society. Yet up to 30% or more of school children may suffer from an inability to read properly and from related academic underachievement (Eisenberg, 1966). Such problems represent a common mode of expression for several antecedent disruptions in learning such as sensory handicaps, brain injury, emotional disorders, and a lack of cultural or educational opportunity. In a world where adaptation and happiness are becoming increasingly dependent upon higher education and the skills of literacy, such a situation constitutes a major educational and social crisis.

Within this population of underachievers, one can delineate a smaller group of children with specific learning disabilities. These children manifest a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written language. The disorder is not primarily due to sensory or motor handicaps, mental deficiency, emotional disturbance or environmental disadvantage. A learning disability may affect 10 to 15% of otherwise able school children (Gaddes, 1976). It is recognized as the greatest single reason for school dropout and as a characteristic of 75% of youths found in juvenile detention centers (Yahraes and Prestwich, 1976).

Within the learning disability population, one can find an intriguing yet poorly understood subgroup of children afflicted with dyslexia, a condition sometimes referred to as developmental or specific dyslexia, or again as specific reading disability. Dyslexic children experience difficulty in reading, spelling and writing to a level commensurate with their innate potential despite adequate instruction and socio-cultural opportunity, and in the absence of primary emotional problems or a neurological disorder. It is said to be dependent upon perceptual or cognitive disabilities often associated with delays in speech and language development, and frequently of genetic or constitutional origin (cf. Critchley, 1970; Orton, 1937; Thompson, 1966). This dyslexic subgroup represents 5 to 10% of the school population (Thompson, 1966). It is the dyslexic child that is the concern of the present investigation, although it is acknowledged that the distinction between dyslexia and learning disabilities is not always nor easily made.

Formal recognition of dyslexia dates back to the turn of the century. Considerable research and treatment efforts have been directed towards it over the last 50 and especially the last 15 years. However dyslexia remains somewhat of a mystery (Young, 1975), its study plagued with problems of definition and diagnosis, of treatment choice and research strategy (Applebee, 1971; Benton; 1978; Money, 1962).

As a clinical entity, dyslexia has generally been defined

in negative terms by process of exclusion. The dyslexic child has often been described as one whose measured reading achievement falls 1 to 2 or more grades below level of expectancy (often derived on the basis of an IQ test), the discrepancy not being attributable to sensory, neurological or emotional disorders, nor to a lack of cultural or educational opportunity (Eisenberg, 1966; Rabinovitch, 1968). This definition leaves much to be desired from both a pragmatic and a theoretical standpoint (Benton, 1978). Although over the years many symptoms and correlates of dyslexia have been adduced, no one sign or combination of signs has yet proven to be unequivocally diagnostic.

Aetiological considerations and remedial approaches have been numerous and diverse, with few if any providing any clear evidence of their validity (Botel, 1968; Johnson, 1978; Myers and Hammill, 1969). This situation has left parents and remedial specialists alike frustrated in terms of assisting the dyslexic child.

Most of the tens of thousands of research articles dealing with reading disability have been inconclusive, contradictory or sadly incomplete (Kirk, 1977; Rourke, 1975). The heterogeneity of dyslexia and the lack of a clear-cut definition have contributed to this state of affairs. It is also clear that the simplistic single-cause and single-effect research model is inadequate: dyslexia is a multifaceted problem with developmental features that may change

over time (Applebee, 1971; Satz et al., 1975; Wiener and Cromer, 1967). More appropriate research models are needed to deal with the complex nature of dyslexia.

Recent research has focussed on the normal acquisition of reading skills in an effort to better understand the nature of reading disability and its correction (Bannatyne, 1971, 1973; Gibson and Levin, 1975; Wiener and Cromer, 1967). This has led to the recommendation of using more than one measure or level of reading achievement in investigating dyslexia (Doehring, 1978; Torgeson, 1975). Evaluation of other aspects of academic achievement such as spelling and arithmetic is also encouraged (Gaddes, 1976). Another important area of research has focussed on deficits in perceptual processing that may underlie reading problems: factors which seem relevant to the understanding of dyslexia are the ability to pay attention, difficulty with complex tasks and with tasks which make heavy demands on language skills and information organization (Bryan, 1974).

Alfred A. Tomatis (1972a, 1979), a French oto-rhino-laryngologist, has recently advanced the Audio-Psycho-Phonological (APP) approach to the understanding, diagnosis and remediation of dyslexia. Tomatis conceives the disorder as a language-communication problem rooted in primary listening difficulties. He states that the condition is of preschool origin, and that reading and other academic difficulties are but late indicators of the disorder. He adds that dyslexia

is mainly socio-affective or socio-familial in nature rather than genetic. In essence Tomatis postulates that painful encounters and experiences can bring a child to adopt deficient or distorted listening skills, and that these in turn negatively affect speech, language, academic achievement, bodily awareness and cortical arousal as well as perceptual and cognitive functioning.

Tomatis has developed new methods for assessing listening and language skills, methods which he considers more relevant to the diagnosis of dyslexia and the monitoring of its treatment. He has also refined a remedial program for dyslexia which enhances or reconditions listening and language skills following a developmental sequence of auditory-vocal exercises. These exercises are carried out through a cybernetic device called the Electronic Ear (EE). The overall approach is called Audio-Psycho-Phonological in the benefit that improvements in one's listening skills (Audio) can bring about lasting improvement in one's speech (Phono) and related language skills, as well as positive changes in one's general disposition and psychological functioning (Psycho). No specific academic tutoring is undertaken although improvements in academic achievement are expected once the proper listening and language foundations have been acquired.

Tomatis' definition of dyslexia is broader than that generally entertained yet he does offer specific diagnostic

tools and criteria that purportedly focus on pertinent causative factors rather than on accessory symptoms. His emphasis on listening and language factors in a developmental scheme may provide a timely frame of reference to place the confusing complexity of dyslexia in proper perspective. However despite the fact that the APP approach to the remediation of dyslexia is presently used in dozens of centers in Europe, little solid research evidence of its effectiveness has yet to come forth. This may be due in part to the very individualized nature of the remedial program, in keeping with the heterogeneous nature of dyslexia.

As a first step in investigating the merits of Tomatis' APP approach, the present study will focus on the areas of perceptual processing and academic achievement during the remedial training of five dyslexic boys. The research design employed is that of the intensive single case study, each boy being used as his own control. Although no research hypotheses are set forth, a number of research expectations are formulated in terms of the nature and degree of possible changes that might occur in perceptual processing abilities and basic academic skills in relation to the APP remedial training program and its different phases.

The first chapter of this thesis reviews the history of the concept of dyslexia, giving some attention to problems of definition, research models and remedial approaches. The second chapter describes the research design used to carry

out the present investigation. The third chapter gives a detailed account of the diagnostic findings and APP remedial training program for each of the five dyslexic boys. The fourth chapter presents the results of the treatment program in terms of changes in perceptual processing abilities and academic achievement. The fifth and final chapter discusses these results in terms of the research expectations and future research directions.

CHAPTER I

REVIEW OF THE LITERATURE

Although children suffering from dyslexia were first described over 75 years ago, the disorder remains somewhat of an enigma. Its study has been plagued with problems of definition and diagnosis, with a diversity of orientations as to etiology and remediation, and with research findings of frequently inconclusive or conflicting nature.

A. A. Tomatis (1972a, 1972b, 1974) has proposed his Audio-Psycho-Phonological Approach (APP) for the understanding, diagnosis and treatment of dyslexia. This approach might in theory provide answers to some of the major obstacles encountered thus far in dealing with this disorder. However Tomatis' definition of dyslexia is broader than that generally entertained, and little solid research evidence has been advanced to date in support of his claims of successful treatment of thousands of afflicted youngsters. Beyond anecdotal reports, little is known about what changes actually occur during and after an APP training program. Further, it is not clear how this program might be evaluated without violating its individualized nature.

The present study proposes to investigate the extent and nature of changes in the perceptual processing abilities and basic academic skills of five dyslexic boys participating in

a 10-month APP remedial training program. This first chapter presents the issues relevant to this study in five sections. The first section outlines the historical background of the concept of dyslexia with particular attention to the recent emergence of the field of learning disabilities. Special emphasis will be placed upon the definition of dyslexia and upon research models in dyslexia. A second section will focus on the remediation of the disorder. Tomatis' concept and remediation of dyslexia will be elaborated upon in a third section. The fourth section contains a review of research findings and directions in the areas of basic academic skills and perceptual processing abilities as they relate to dyslexia: these areas may be relevant to the study of the effects of APP training. The fifth and final section deals with the research problems, the research proposal and the research expectations.

The Concept of Dyslexia

Three general phases can be delineated in the history of the concept of dyslexia: an initial period of description and identification (1860-1917), a period of analysis and discussion (1917 to about 1960), and a period of rapid development and disarray from the early 1960's to date.

Phase One: Description and Identification (1860-1917)

The disorder called dyslexia was gradually identified during this period although at first it was not yet differ-

entiated from aphasic disturbances. According to Thompson (1966) and Critchley (1970), medical men made the greatest contribution during this phase. Initially European neurologists studied the loss of previously acquired language and literacy skills in adults as a result of brain trauma. Later, around the turn of the century and with the advent of progressive education, ophthalmologists were called upon to examine children experiencing difficulty in learning to read.

In the 1860's, as a result of his study of aphasic patients, Broca localized a speech zone in the frontal area of the left temporal cortex (Schuell et al., 1964). In the 1870's, similar studies led Bastian and Wernicke to state that reading and writing depend upon the coordination of many cortical centres, that Broca's speech area is vital to these functions, and that verbal ability in turn depends upon an intact auditory centre for its inception (Penfield and Roberts, 1959). Kussmaul, in 1877, first described an aphasic loss of reading ability in the presence of intact vision, speech and intellect: he referred to this as "word-blindness" (Thompson, 1966). In 1877, Charcot described a similar pure condition as "alexia" while Berlin, again in 1877, offered the term "dyslexia" for cases of slow and hesitant reading rather than total loss (Critchley, 1970; Tomatis, 1972a). Other aphasiologists such as Trousseau, Ogle and Finkelnburg resisted notions of localization of functions or purity of symptoms: they were struck by the complexity of language functions, by the aphasic's impairments in memory and symbolic

activity, and by the appearance of uninhibited behaviors (Tomatis, 1972a).

The English ophthalmologist Morgan (1896) was the first to describe as "congenital word-blindness" the condition of a teenage boy of good health and intelligence, normal vision and without sign of brain damage, yet unable to learn to read despite his and his teacher's vigorous efforts. By 1909, over forty similar reports had surfaced in Europe, North and South America, according to McCready (1910).

The Scotch ophthalmologist Hinshelwood (1896, 1900, 1912, 1917) studied many such children closely over a period of two decades. In addition to reading difficulties, he noted visual memory problems in spelling such as improper sequence or omission of letters. In his landmark monograph entitled Congenital Word-blindness, (1917), he attributed the disorder to an agenesis of the angular gyrus of the left hemisphere, reserving the term dyslexia for less severe cases. Hinshelwood believed that many intelligent youngsters were being dismissed as imbeciles because of dyslexic problems.

The contributions of two psychologists, Edmund B. Huey and Augusta Bronner, deserve mention here as they foretold of important areas of future study. Huey, an early investigator of the normal process of attaining reading proficiency, stated that:

... to completely analyze what we do when we read would almost be the acme of the psychologist's achievements, for it would be to describe very many of the most intricate workings of the human mind,

as well as to unravel the tangled story of the most remarkable specific performance that civilization has learned in all its history. (1908, p.6).

Bronner (1917), studied the nature of perceptual processing in the reading behavior of seven boys with language disabilities. She concluded that their reading problems stemmed from a lack of synthesis of visual, auditory and motor functions at perceptual, conceptual, symbolic and memory levels.

Hinshelwood's monograph (1917) and Bronner's study (1917) bring to a close the first phase of the history of dyslexia by shifting emphasis from the identification to the analysis of the disorder.

Phase Two: Analysis and Discussion (1917-1960)

This second phase occurred largely in the U.S.A. and Scandinavian countries. At the risk of oversimplification, one can delineate three main orientations: the bio-medical, the psychoanalytic and the psycho-educational.

The bio-medical orientation. The psychiatrist and neuropathologist Samuel T. Orton championed the bio-medical tradition from the mid 1920's to his death in 1948. In his intensive case studies of dyslexic children he could find no evidence for organic pathology although he found the similarity of symptoms to those of true aphasics instructive. Orton was intrigued by the dyslexic's visual problems: the tendency to reverse the order of letters in words and words in sentences, and the unstable recognition or recall of the orientation of letters. He called such confused perceptual

modes "strephosymbolia" (Orton, 1928a), which means "twisted symbols", in the belief that they were a key factor in reading and spelling problems. Orton was also impressed by the frequency of left or incomplete handedness, mixed dominance of hand, eye and foot, as well as speech and motor problems in dyslexic children. A high familial incidence of delayed speech, stuttering, left-handedness, abnormal clumsiness and weak academic skills was also noted.

Orton (1928b) postulated a physiological defect to account for such problems. He proposed three levels in the evolution of the cortical areas of the brain: the sensory, elaborative and associative. He stated that at the highest associative level, the left master hemisphere should normally come to control the right minor hemisphere in matters of coordinated action such as speech, reading, spelling and writing. He felt that a specific reading problem called strephosymbolia occurs when mirror images of letters and words, located in the non-dominant hemisphere, are not adequately suppressed over time because of slow or incomplete attainment of cerebral dominance. For Orton, such a condition impedes easy associative linkage with meaningful auditory engrams of the left hemisphere. It also creates orientation problems and inconsistent lateral preferences.

Orton (1937) attributed this physiological failure to a developmental lag. He added that genetic influences were at play and that emotional problems, although important, were

always secondary to the learning problems. Optimistic that such a lag could be overcome by proper remedial techniques, Orton contributed to the development of the well known Gillingham-Stillman (1936) multisensory teaching approach. Orton (1937) cautioned however that each case of strephosymbolia entails an individual problem requiring thorough diagnosis and personalized remediation. He warned that the search for simplified universal formulas and blanket prescriptions would lead to error.

Strephosymbolia eventually came to represent not just visual perceptual problems but a language-related syndrome of many manifestations, several or all of which might be present in any one case. (Orton, J. L., 1957). Among the most frequent characteristics are: poor oral reading, fundamentally poor spelling, errors in the orientation or order of letters, delays or defects in speech and language, delayed or incomplete establishment of unilateral cerebral dominance, the absence of neurological or primary emotional factors, and a familial incidence of language as well as laterality problems. Interestingly, Orton (1942) later added that another index of laterality more closely related to speech and reading would be more revealing of confused dominance than problems of eye, hand and foot laterality.

Over the years Orton's concept of strephosymbolia has been frequently dismissed because the error patterns in reading, spelling and writing are not adequately explained in

terms of competing mirror images. Furthermore, some neurological propositions such as the suppression of the minor hemisphere have only recently found some support (Masland, 1975). He is credited with broadening the concept of dyslexia or word-blindness to that of a specific language disability involving incomplete unilateral cerebral dominance. He also related this to a correctable form of physiological delay.

Many other clinicians and researchers have maintained Orton's tradition with their own personal emphasis or modifications.

Bender (1951, 1956, 1957, 1975), an early associate of Orton's, uses the terms dyslexia, specific reading disability and specific language disability interchangeably. She attributes these conditions to a maturational lag restricted to recently evolved and poorly stabilized areas of the brain affecting language, dominant cerebral control of manual and ocular functions, and spatial orientation. Such a maturational lag is characterized by a plasticity of neurological functions that allows for a wide variety of symptoms that often defy classification but permit different investigators to emphasize those factors best suited to their theories. Bender adds that such non-fixated plasticity leaves dyslexic youngsters with a capacity for accelerated growth if a holistic treatment approach is used, an approach emphasizing proper remedial exercises within a motivating teacher-pupil relationship. Bender has however deviated significantly from Orton's views in maintaining that many of the dyslexic's emotional

problems such as impulsivity, immaturity and vulnerability to stress, are part and parcel of the maturational lag rather than secondary reactions. She also suggested that dyslexic problems could be diagnosed prior to school entrance.

Schilder (1944) also considered dyslexia as due to a maturational lag, and he too was struck by frequent visual reversal problems. He chose to emphasize a lack of differentiation and integration of both visual and auditory cerebral structures which renders attempts at symbol-sound decoding and encoding very difficult.

Silver and Hagin (1960) found that dyslexic children, as described by Bender, did not outgrow their difficulties if left unassisted. They were mainly impressed by the pervasive temporal and spatial disorientation these youngsters manifested: poor visual figure-ground stability, vague body image, immature posture and reflexes, unclear notions of right and left, and unclear grasp of time concepts. Such symptoms were attributed to a lack of clear-cut cerebral dominance for language.

De Hirsch (1954) interpreted the many symptoms of the dyslexic's organismic immaturity within a gestalt framework: pre-reading skills of visual, auditory and kinaesthetic nature were deemed insufficiently developed and integrated into a gestalt experience to provide the proper basis for reading. She maintains that perceptual and cognitive growth are due to the attainment of gestalten rather than to the

addition of new skills. De Hirsch also found that dyslexic problems could be predicted before school, especially in a large percentage of three to five-year-olds with speech delays.

Hallgren (1950) carried out an in-depth study of the families of Swedish children affected with congenital word-blindness. He found a very high incidence of speech and reading problems, concluding that the condition is inherited and genetic in nature.

The Danish neurologist Hermann (1959), in describing congenital word-blind children, confirmed some of Orton's findings in regards to confused dominance and hereditary influences. He was however more impressed by the directional confusion resulting from inadequately developed left hemisphere dominance. Afflicted youngsters manifested an inability to orient themselves in space and unclear body image; their poor concepts of direction and sequence affected all symbol systems such as reading, spelling, arithmetic and musical signs. Hermann specified that diagnosis of the disorder did not depend on any simple pathognomic sign but on the appraisal of a whole configuration of findings together with the history.

In France, Launay (1960) also agreed with many Ortonian concepts. He recognized a familial factor but hesitated in accepting genetic transmission as a cause. Instead he opted for cultural transmission from a linguistic base.

In general, the aforementioned clinicians analyzed and

discussed a distinct subgroup of children: those unable to acquire normal reading and spelling skills despite adequate intelligence, educational and cultural opportunity, while free from gross sensory, neurological or primary emotional handicaps. Such children have been described in different countries and under various labels. Despite lack of agreement as to the importance of various symptoms, the disorder has been described often enough to warrant recognition as a language-related syndrome sometimes called dyslexia. It is often believed to be of hereditary nature and to manifest itself as a maturational lag.

The psychoanalytic orientation. Psychoanalysts, during this second historical phase of the concept of dyslexia (1917 to about 1960) maintained that emotional inhibitions were at the root of reading problems. Two main forms of impediments have been described. First, a psychogenic inhibition of visual recognition because the organ of sight had been misused for shameful sensual or aggressive purposes that aroused too much anxiety (Strachey, 1930; Klein, 1931; Sylvester and Kunst, 1943). Secondly, a fixation at a pre-school level of personality development because of unhealthy parent-child interactions such as maternal overprotection or dominance, and paternal rejection or absence (Klein, 1949; Jarvis, 1958). Learning impotence thus reflected a safe and noncommittal life stance.

Chassagny (1962) and Ajuriaguerra (1957) abandoned the

traditional psychoanalytic approach in favor of the ego psychological perspective. Ego psychology stresses that personal individuation and adjustment depends on the pre-adaptiveness of ego givens within a facilitating socio-emotional milieu. Chassagny views dyslexia as a problem of communication and self-expression that affects not just reading but also one's ego givens and integration into the milieu as a whole. According to Ajuriaguerra, dyslexia refers to a disharmony of functional maturation, and he points to the contribution of environmental impacts on the maturational process. These clinicians stress that language involves more than just words and grammar, that it interacts subtly with ego givens and affective experiences. The distinction between primary and secondary emotional factors in reading-disabled children may not be as easy to make nor as accurate as has been suggested.

The psycho-educational orientation. From 1917 to about 1960, many teachers and psychologists resisted recognizing dyslexia as a distinct syndrome. This was perhaps due to the mistaken notion of dyslexia as an irremediable disease entity with a fixed symptomatology. During this period, attempts were made to estimate the size and nature of reading backwardness, listing such possible causes as absenteeism, malnutrition, brain damage, emotional problems and parental attitudes (Monroe, 1932; Burt, 1937; Harris, 1961).

Studies of children suffering from various types of non-progressive brain damage strongly influenced trends in the

understanding of learning problems. The pioneering studies of Strauss and Werner (1942), Strauss and Lehtinen (1947), Strauss and Kephart (1955) and Cruikshank et al. (1957) revealed in such brain-damaged children specific disabilities in perception, thinking, memory, concept formation, body awareness and attentional mechanisms, disabilities which impaired performance in academic skills. This led to the development of diagnostic tests, classroom strategies and teaching procedures to help these children strengthen and integrate subskills required for higher level learning such as reading and writing. Since both brain-damaged and non-brain-damaged children with school learning problems often display similar symptoms, the above methods came to be applied to all forms of learning difficulties.

On the basis of work with aphasia and hearing disorders, Osgood (1957), Myklebust (1960) and Wepman et al. (1960) formulated theoretical models of the language-communication process which later found application in understanding related reading and writing problems. Osgood's model for example led to the development of the widely used Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk and McCarthy, 1961) which permits a more refined diagnosis of a child's learning problems.

Although some of the above clinicians distinguished between structural deficiencies and other causes of learning disorders such as developmental immaturity, the conviction

grew that most learning problems were rooted in some form of brain damage, whether demonstrable or not. The term "minimal brain dysfunction" (Clements, 1966) eventually reflected this trend.

Rabinovitch's (1959) timely attempt to classify the many forms of reading retardation provides a convenient marker for the end of this period of analysis and discussion in the history of dyslexia. He suggested three major categories of children with reading problems:

- 1) Capacity to learn to read is intact but is utilized insufficiently for a child to achieve a reading level appropriate to his intelligence. The causative factor is exogenous, the child having a normal reading potential that has been impaired by negativism, anxiety, depression, emotional blocking, psychosis, limited school opportunity or other external influence. They are diagnosed as secondary reading retardation.
- 2) Capacity to learn is impaired by frank brain damage manifested by clear-cut neurological deficits. The picture is similar to the early described adult dyslexic syndrome. Other definite aphasic difficulties are generally present. History usually reveals the cause of brain injury, common agents being prenatal toxicity, birth trauma or anoxia, encephalitis and head injury. These cases are diagnosed as brain injury with reading retardation.
3. Capacity to learn to read is impaired without definite brain damage suggested in the history or neurological examination. The defect is in the ability to deal with letters and words as symbols, with resultant diminished ability to interpret the meaningfulness of the written material. The problem appears to reflect a basic disturbed pattern of neurological organization. Because the cause is biological or endogenous, these cases are diagnosed as primary reading retardation. (p. 865)

Rabinovitch equates his primary reading retardation category with dyslexia. Despite the neatness of his classification system, he later confessed that in practice a diagnosis of "secondary retardation with a touch of primary disability" (1962, p. 76) was not infrequent.

Phase Three: Development and Disarray (1960 to Date)

This third period can be described as one of rapid development, with a diversity of research findings and treatment directions, and with some degree of disarray. On the one hand a greater coordination of ideas and efforts can be discerned among disciplines involved in the study of learning problems. On the other hand a confounding of issues and territorial wars among some professionals can be noted. Only the main trends can be dealt with here, however two conferences in the early 1960's deserve special comment.

The John Hopkins conference on Research Needs and Prospects in Dyslexia and Related Aphasic Disorders, held in Baltimore in 1961, brought together professionals from several fields who no longer questioned the existence of dyslexia but stressed the need for a clearer definition and for means of differential diagnosis. The variability of symptoms from one case of dyslexia to another was considered characteristic of a syndromatic condition, and the possible existence of subtypes was put forward. Participants indicated promising research directions such as the area of intersensory integration and the complex issue of cerebral dominance. Since

syndromes of disease in medicine had not been identified by large scale surveying, correlating and factor analyzing of symptoms or other data, the final recommendation called for investigative experimental and detailed clinical studies.

The proceedings of this conference were published in Reading Disability: Progress and Research Needs in Dyslexia (Money, 1962), which set the tone for other future conferences and publications of similar collaborative design (Bakker and Satz, 1970; Knights and Bakker, 1976; Benton and Pearl, 1978).

In 1963, at another conference sponsored by the Fund for Perceptually Handicapped Children, Dr. Samuel A. Kirk told several parent groups that he favored more humane and diagnostically useful terms such as "learning disabilities" to describe children previously referred to as perceptually handicapped, hyperactive, strephosymbolic, brain damaged, or "minimal brain dysfunction". He excluded from this group children with gross sensory handicaps such as blindness or deafness, with generalized mental retardation, and with emotionally or culturally induced problems. In keeping with the psycho-educational tradition, such a group of children goes beyond dyslexia to encompass both of Rabinovitch's (1959) "primary reading retardation" and "secondary to brain damage" categories. Neurologically based perceptual or cognitive problems form the common factor here. Kirk had offered the phrase "learning disabilities" as a planning guideline, not as a new category. However the attending parents seized

this easily misinterpreted term to create the Association for Children with Learning Disabilities (ACLD), which spread quickly throughout North America with staggering effects both positive and negative.

On the positive, the ACLD became a powerful lobbying force in gaining recognition for the plight of learning disabled children. It secured vast funding for research and task reports on the identification and educational management of such children (Clements, 1966; Haring and Miller, 1969; Chalfant and Scheffelin, 1969). It promoted special teacher training programs, and obtained laws to insure that services for LD children will be provided. Pressure from concerned parents also led to a Canadian report on the needs of children with emotional and learning disorders entitled One Million Children (CELDIC, 1970).

On the less desirable side, the term learning disability was overextended to include conditions such as mental retardation or severe emotional disorders, thereby creating strain and confusion in many areas. Kirk (1977) stated that the lack of conceptual clarity had become more acute than in the late 1950's. He enumerated several problem areas e.g., a "dumping ground" practice had sent many non-LD children into special LD classrooms; a panacea of new diagnostic and remedial aids of questionable validity were being used by unsuspecting parents and teachers; territorial wars had arisen between professionals eager to claim their right to work with

the LD child; and special teacher training programs had been prematurely and inadequately set up, leaving their graduates ill-prepared to meet expectations. Finally, according to Kirk, the literature was being flooded with "pseudo-research", studies using the wrong subjects and asking the wrong questions about the wrong factors at the wrong age, thereby drawing confusing or contradictory results. Kirk (1977), Cruikshank (1977) and Ames (1977) have all recently felt the need to clarify issues and attend to the disunion created by the overly rapid expansion in the learning disabilities field.

Among other trends apparent since 1960, attempts to link dyslexia and learning disabilities to personality maladjustment have diminished. However Van Meehl et al. (1970) proposed a broad unifying concept of learning problems that takes personality dynamics into account. They noted that children with learning difficulties have a distinct cognitive style characterized by the need for "immediate preparedness for action". This style, laden with anxiety and insecurity, involves a narrowing of awareness or a "foreshortening of temporal perspective": it interferes with long-range planning, complex discrimination and the maturation of verbal-symbolic behavior.

Within the psycho-educational field, non-academic learning disabilities have been recognized. Afflicted children have difficulty understanding various aspects of social and self-perception such as the relevance of time, gestures and

facial expressions (Johnson and Myklebust, 1967; Bryan and Bryan, 1978).

Proponents of the psycho-educational and bio-medical approach have concentrated on questions concerning perceptual processing dysfunctions that may underlie learning problems. Research thus far indicates that problems of attention, difficulty with complex tasks or tasks that make heavy demands on language skills are significant disabling factors (Bryan, 1974).

The specialized field of neuropsychology, which studies brain-behavior relationships, has promoted the development of tests that more accurately assess cortical functions. This may allow a more in-depth investigation of such pertinent issues as brain maturation, cerebral dominance and information processing (Rourke, 1975, 1978; Knights, 1978; Knights and Bakker, 1976).

A noteworthy trend since the 1960's has seen several investigators trying to analyze the normal process of acquiring competence in reading, relating this to language development as well as to learning disabilities (Fries, 1962; Luria, 1966; Wiener and Cromer, 1967; Bannatyne, 1971, 1973; Goodman, 1972; Gibson and Levin, 1975). These analyses indicate at least two main steps in the mastery of the reading process: an early stage of basic skills dealing more with perceptual phenomena, and a second stage of comprehension that depends more on conceptual and language abilities. In the first stage,

visual symbols (letters) are encoded into the sounds they represent, and these sounds are then decoded into meaning. This requires attention and some visual discrimination. It also leans heavily on good auditory and articulatory skills, and on phonetic strategies to organize sounds into syllables and words. Further, a good vocabulary facilitates the task through a quicker identification of words. In time these basic skills should become automatic. The second stage of comprehension involves quick extraction of meaning from strings of words on the basis of one's linguistic ability, communication skills and experiential background. Anticipation or guessing from minimal cues is important here (Kolers, 1972). Once this second stage becomes fluently automatic, reading itself becomes a living language.

While all investigators of the reading process recognize good language ability as a prerequisite to the comprehension stage, many add that a good language-communication base is also indispensable at the basic skills stage. Goodman (1972) makes the point that overemphasis on the teaching of decoding skills in the absence of a proper language base may actually hinder progress in reading. Research by Shankweiler and Liberman (1972, 1976) confirms the relevance of speech and language in understanding reading and reading problems.

Another trend concerns efforts to deal with the heterogeneity of dyslexia. Money (1962) and Klassen (1972) both consider dyslexia as a syndrome of many possible manifesta-

tions, none of which in itself is diagnostically unequivocal. Both authors alluded to possible subtypes of the disorder. Johnson and Myklebust (1967) and Boder (1971) have described two groups of disabled readers: one deficient in visual-spatial skills and the other in audiophonic or linguistic skills. Mattis et al. (1975) describe a third group deficient in sequential analysis and grapho-motor skills. Kinsbourne and Warrington (1963) have isolated a carefully defined subgroup of retarded readers on the basis of a characteristic pattern of performance of the WISC, a spelling test and finger differentiation tasks: the subgroup has been labelled the developmental Gerstmann syndrome. Such a search for subtypes may help attain definitional clarity and clinical homogeneity.

The heterogeneity of dyslexia may also reflect a developmental phenomenon, the symptomatic picture changing with the developmental age of the child. Benton (1962), Birch and Belmont (1965), de Hirsch et al. (1966) and Reed (1967) have indicated that younger children (5 to 8-year-olds) with reading problems show a higher incidence of simple non-language deficits e.g., in form perception, visual-motor performance and manual laterality. Older children (9 to 12 years of age) tend to show greater impairment on higher level conceptual and interpretive tasks, particularly on language skills and right-left discrimination (spatial representation).

- This developmental perspective can be extended downward

to preschool years. Jansky and de Hirsch (1972) demonstrated that reading failure could be predicted from select test data at a kindergarten level. De Hirsch (1954) had indicated, earlier that dyslexia could be predicted at three to five years on the basis of motor speech delay, developmental word-deafness and severe dyslalia. Condon's (1975) research suggests that future reading problems are indicated in some neonates on the basis of subtle disturbances of bodily movements in response to sounds. De Quiros (1976) holds that similar predictions can be made with neonates, infants and toddlers on the basis of vestibular and postural disorders.

Shankweiler (1964) underscored the need for some form of theoretical framework that could account for the many correlates of dyslexia while focussing on pertinent key factors, thereby giving some direction to research and practice. Satz et al. (1975) have proposed such a framework. They postulate that reading disability reflects a lag in the maturation of the brain, especially in its left hemisphere. This maturational lag differentially delays those skills which are in primary ascendancy at different chronological years. In early school years, visual perceptual and cross-modal sensory integration skills necessary for beginning reading would be delayed. In later school years, conceptual and linguistic skills necessary for reading at a comprehension level would be delayed as earlier sensory-perceptual skills would be catching up. This theory is presently being

researched in a complex longitudinal study (Satz et al., 1978).

Mucchielli and Bourcier (1964) offer an existential frame of reference. They propose that the dyslexic's world is unstable and full of double meanings. In the normal child, body schema and laterality, time and space concepts as well as value systems help stabilize one's grasp of the universe. In the dyslexic child however, these stabilizing agents are seen as defective or underdeveloped, leaving him with a confused and syncretic perception not only of letters and words but also of other people, of one's own being and of one's life-space as a whole. Consequently the dyslexic child is condemned to an ambivalent and unstable existence that does not allow access to a normal analytic and symbolic level of cognition. In essence, dyslexia is not restricted to school learning: it hinders social relationships, ego and self development. Mucchielli and Bourcier suggest many possible causes of this disturbing instability, ranging from mild hearing loss and vague body image to intrafamilial communication problems and modern society's shifting value systems. They add that proper treatment of dyslexia involves a good fit between the personalities of the child and the remedial teacher, considerable drill and "overlearning" in academic work, and a restructuring of the child's familial-social relationships to support academic progress.

In the same vein, Sapir and Nitzburg (1973) submit that

the study of learning problems has become too specialized and divorced from the affected child's everyday life and being. They opt for a developmental-~~interactional~~ approach to assessment and research, and for a holistic approach to treatment.

In terminating this historical review, it is evident that the concept of dyslexia remains complex and difficult to grasp. Although few facts about the disorder can be stated with certainty, some guiding notions can be advanced.

1. A special type of reading problem, often called dyslexia, has been referred to when a significant discrepancy between a child's reading achievement and potential ability cannot be attributed to sensory defects, brain damage, primary emotional problems, socio-cultural disadvantage or lack of educational opportunity.

2. Dyslexia manifests a wide variety of symptoms, none of which is diagnostically unequivocal. It is often considered as a syndrome, and different subtypes of the syndrome may exist.

3. In the majority of cases, dyslexia seems to be a language-related phenomenon.

4. The disorder may be developmental in nature, its symptoms changing over time. Research indicates that it can be predicted before the reading task is faced in school.

5. A genetic or constitutional basis has frequently been postulated. Familial patterns present themselves.

6. Conservative estimates of the incidence of dyslexia vary between 5 and 10% of the school population (Thompson, 1966, 1. XII-XVI).

7. Male dyslexics definitely outnumber female dyslexics. According to Bannatyne (1971), this is in the order of 4 to 1 in moderate cases, and 10 to 1 in severe cases.

The Definition of Dyslexia

Research findings on dyslexia have often been inconclusive or contradictory, in part due to poor case selection or inadequate definition of the population. This has been particularly evident from 1963 on as the broader learning disabilities category became overextended in a confusing manner.

To overcome this problem, Applebee (1971) and Torgeson (1975) suggest Eisenberg's (1966) definition of a specific reading disability. Eisenberg (1962, 1966) uses this term interchangeably with dyslexia.

Specific reading disability may be defined as a failure to learn to read with normal proficiency despite conventional instruction, a culturally adequate home, proper motivation, intact senses, normal intelligence and freedom from neurological defect. (1966, p. 360).

Unfortunately this definition, like many others, is arrived at by process of exclusion: specific reading disability refers to the unexplainable leftover population of reading problems after a host of possible causes has been eliminated. As clear as this definition may seem, its criteria may not

always be easily applied. While sensory disorders are more readily evaluated, a neurological examination of a child with reading problems may be inconclusive as a result of the presence of soft neurological signs or mild EEG variations. The presence or absence of emotional problems, and the degree to which they represent a cause or an effect of a reading disorder, is equally difficult to distinguish in many cases. Such distinctions may not always be relevant: Wepman (1962) and Rutter et al. (1970) suggest that specific reading disability and antisocial behavior may have something in common rather than one being an effect of the other. The presence or absence of cultural, domestic or educational disadvantage is hard to evaluate without some notion of what might or might not be acceptable. The criteria of normal or adequate intelligence, conventional instruction and proper motivation are open to interpretation. For example, an IQ of 90 or more has often been employed as an indicator of normal intelligence while some hold that the psychometrically dull or borderline children have adequate intelligence and can be dyslexic at that level. Overall Eisenberg's definition serves as a general guideline but leaves much to be desired in its application to individual cases.

In addition to exclusion criteria, a special education criterion and a discrepancy criterion may be used to define dyslexia.

The special education criterion refers to the fact that

the poor reader could not profit from a regular class program despite adequate attendance and motivation, and that special remedial techniques are required. The difficult question of what constitutes a regular program or its proper delivery is often given insufficient consideration here.

The discrepancy criterion is the one most frequently employed, and it too remains problematic. A discrepancy of two or more years behind expected grade level in reading has often been used to define a significant reading problem. Unfortunately this procedure produces psychometric incongruities: using data provided in the 1965 edition of the manual to the Gates-MacGinitie Reading Tests, a two-year lag would be found in 2% of third graders and in 30% of ninth graders. This problem can be partly solved by using variable cut-off markers depending on the age of the child. Rabinovitch (1959) has suggested a minimum of a one-year delay in achievement for the 10-year-old and under group, 1½ to 2 years delay for older children. But even this remains inadequate in identifying bright dyslexic children able to compensate in their reading.

An alternate discrepancy method uses a deviation score, with perhaps the lowest 10% of any group on a reading achievement test being considered dyslexic. While this overcomes difficulties inherent in the previous formulas, it raises other confounding issues such as differences in quality of instruction or socio-economic status between student groups.

Myklebust (1968) proposed a more sensitive discrepancy criterion using a Learning Quotient, a measured relation between learning potential and achievement.

In reading, a child's Learning Quotient = $\frac{\text{Reading Age}}{\text{Expectancy Age}}$

Expectancy age is derived from the average of a child's mental age, life age and grade age. To calculate mental age, the higher of either the Verbal or Performance IQ of the WISC is employed, a procedure considered more equitable since dyslexics are often impaired in their intellectual abilities, especially so in verbal skills. Life age, or chronological age, is incorporated because it reflects physiological maturity. Grade age provides a measure of a child's school learning experience. After calculating this formula, Myklebust recommends a Learning Quotient of .90 as a cut-off point: a quotient of .89 or less constitutes the basis for classification as a learning disability. This method improves considerably upon the previous formulas although Gaddes (1976) cautions that it is most useful with children in the middle IQ range.

Rutter et al. (1970) have employed a multiple regression equation, using IQ and reading scores, to obtain an even more accurate estimate of true learning deficit. This approach may be more suitable for children across all IQ ranges although it does not take account of large differences between Verbal and Performance IQ ratings.

Weiner and Cromer (1967), Torgeson (1975) and Doehring

(1978) point out that in applying discrepancy formulas, a single measure of reading is inadequate. Reading is a complex process and its evaluation should tap not only simple word recognition but also word meaning and passage comprehension. Gaddes (1976) questions whether other academic skills should not also be assessed. Walker and Cole (1965) and Myklebust (1971) found spelling performance to be a better indicator of learning problems than reading behavior. Rabinovitch (1968) adds that dyslexia affects arithmetic skills although not to the degree that it affects reading.

It seems to the writer that in diagnosing dyslexia, the above-mentioned issues should be taken into account. A comprehensive operational definition, making the best use of the previously described criteria and keeping in mind the evolution of the concept of dyslexia, seems desirable.

As a step in this direction the writer proposes the following composite definition of dyslexia whereby Kirk's (1977) description of a learning disability has been slightly reworded to include Eisenberg's (1966) concept of specific reading disability and Rabinovitch's (1959) concept of primary reading retardation. This composite definition defines dyslexia as a psychological and/or neurological impediment to perceptual and/or communicative behavior which manifests itself in significant discrepancies among specific behaviors or between estimated potential and academic achievement (discrepancy criterion); which is not primarily due to severe

mental deficiency, sensory handicaps, brain damage, emotional problems, socio-cultural disadvantage or lack of opportunity to learn (exclusion criterion); and which requires remedial procedures over and above the teaching offered in a regular classroom setting (special education criterion).

This operational definition retains most of Kirk's ideas while adding brain damage to the excluded conditions. Eisenberg's and Rabinovitch's concepts are more clearly elaborated upon, while adding the special education criterion. The discrepancy criterion can involve one or more measures of academic achievement or other non-academic measures as employed in preschool evaluations. Such a definition should contribute to better research endeavors.

Research Models in Dyslexia

The heterogeneity of dyslexia constitutes a major problem in the investigation of this disorder. Thus far, traditional research approaches such as the population comparison strategy and the specific deficit analysis strategy have been of limited usefulness in understanding and helping disabled learners (cf. Torgeson, 1975; Miechenbaum, 1976; Doehring, 1976). Three alternate approaches have been suggested: the search for subtypes, the use of more complex research models, and the use of the intensive single case study.

In the search for more homogeneous subtypes of dyslexia, investigators have identified two relatively broad groups: one deficient in visual-spatial skills and the other in audio-

phonic or linguistic abilities (Myklebust and Johnson, 1965; Boder, 1971; Mattis et al., 1975). Some evidence has been found for a third group with problems in sequential analysis and graphomotor skills (Ingram, 1969; Mattis et al., 1975). According to Masland (1979) children with auditory and language difficulties account for approximately 60 percent of the cases in the above studies. A much rarer subtype called the developmental Gerstmann syndrome has also been delineated: affected children manifest problems mainly in finger agnosia, right-left orientation and arithmetic (Kinsbourne and Warrington, 1963). The use of such subgroups in research may lead to more conclusive and helpful results.

Wiener and Cromer (1967) and Applebee (1971) each outline six models for conceptualizing reading problems, ranging from a simple model where reading disability is a unitary disorder derived from a single causative factor to models involving more than one type of reading disability with more than one contributing agent and with complex interactions between both dimensions. They both urge the abandonment of the most simple models and propose that the complex nature of dyslexia is best approached through the more complex models. Applebee cautions that the statistical method must fit the conceptual model invoked: more complex models may require considerable statistical sophistication. Satz's (1975, 1978) maturational lag research program attests to the heuristic value of using complex models.

Guthrie (1973) proposed two research models: an assembly model whereby reading requires a group of subskills that develop independently, and a system model which contends that reading develops from a system of interdependent subskills. His own research found that the system model was appropriate to normal readers and the assembly model was more appropriate for reading-disabled youngsters. He concluded that a lack of interfacilitation among subskills may be one source of reading difficulty.

Money (1962), Torgeson (1975) and Meichenbaum (1976) all recommend the intensive single case study as an alternate research approach to dyslexia. Despite methodological problems, case studies have in the past led to important insights useful for treatment purposes, for theory building and for the generation of larger scale research hypotheses.

Money (1962) reports the consensus of several professionals that the syndrome-like features of dyslexia would not likely yield to large group research. A preference for investigative experimental and detailed clinical studies was stated.

Torgeson (1975) indicates that group approaches and data often hide significant variables by averaging them out or again grant them too much importance. Though replicable, such results may offer little direction for remediation. In encouraging the use of single case research, Torgeson adds that:

Because they start with the child himself, clinical observations may point to problems of central importance which are missed by more rigid research approaches that operate within a specific theoretical or methodological bias. (p. 340)

Torgeson also favors a greater emphasis on process-oriented evaluation whereby how a youngster performs or obtains a test score is given as much importance as the test score itself. The case study approach is well suited to such an emphasis.

In the same view, Meichenbaum (1976) favors a case study approach to learning problems, using the child as his own control, analyzing the tasks faced by the child, and determining how the child manages to fail or succeed on the task as well as how his cognitions (i.e. self-statements and images) influence performance. Meichenbaum refers to this as a cognitive-functional approach.

In short, group research using subtypes or more complex models of the disorder as well as the intensive single case design may both have merit in dealing with the complexity of dyslexia. In addition, Bannatyne (1975) encourages research reviewers to take a slightly more tolerant attitude towards basic exploratory studies.

The Remediation of Dyslexia

Remedial approaches to dyslexia are as varied and numerous as the conceptual orientations presented earlier. However the majority of remedial methods available consists of teaching strategies that help the dyslexic child cope with the

reading, spelling and writing demands of the classroom. Some of these approaches provide temporary crutches to ease the child's plight, others lean heavily on rigid structure and lengthy drill. Some methods favor an auditory-phonetic emphasis while others favor a visual-perceptual bias. Certain approaches are taught analytically, others synthetically. Whereas one system may stress explicit learning of basic decoding or syllabication, another allows the child to learn them implicitly. While all these methods claim some degree of success, reviewers (Botel, 1968; Myers and Hammill, 1969; Harris, 1970) underline the dearth of well designed supportive research.

Johnson (1978) appropriately points out that in view of the heterogeneity of dyslexia, researchers and clinicians should analyze the characteristics of each child for whom a particular remedial teaching approach may be suitable. The pinpointing of distinct subtypes of dyslexia should facilitate this endeavor.

Tarnopol and Tarnopol (1976), on the basis of their worldwide review of reading and learning problems, indicate that two frequently used approaches, the Fernald (1943) method and the Gillingham-Stillman (1960) method, have provided generally satisfactory results. Despite this claim, these reviewers provide no statistical data or quantitative evidence. Both methods are multisensory in nature but each has a different style and focus.

The Fernald method emphasizes the tracing and writing of words rather than their phonetic analysis. In a very flexible and motivating format, the child chooses the words to learn from his or her experience. According to Kline and Kline (1975), Fernald reported in 1957 that 62 cases of non-readers from 8 to 17 years of age all achieved normal or superior performance in reading, after being taught by this method. Myers and Hammill (1969) suggest however that this approach may be more suitable for dyslexic children with visual-perceptual or memory deficits.

3 The Orton-Gillingham method emphasizes visual, auditory and kinaesthetic reinforcement of sound-symbol associations. Following a highly structured program, reading and spelling are taught simultaneously by focussing on auditory patterning and the phonetic dissection of words. Rawson (1968), in a longitudinal study of children she taught by this method, found that as adults they had advanced academically and professionally to a degree at least equal to their non-dyslexic peers. Kline and Kline (1975), in a follow-up study of 216 severely dyslexic children, reported that nearly 96 percent of the 140 cases taught by the Orton-Gillingham method made impressive gains, whereas only 51 percent of the remaining children showed similar gains when taught by other methods or left unassisted. At least one reviewer (Guthrie, 1978) seriously questions the impartiality of this recent study. Johnson (1978), in describing this remedial method as multi-

sensory, synthetic and alphabetic, points out that it may therefore be better suited to children with auditory problems at the decoding rather than comprehension level.

Proponents of the psychological information processing position call for the diagnosis of specific deficits in such areas as psycholinguistic abilities (Kirk and McCarthy, 1961, 1968), visual-motor (Frostig et al., 1961) and perceptual-motor skills (Kephart, 1960), in an effort to locate underlying sources of school learning problems. Remedial programs involve the isolated training of weak skills or their enhancement through association with stronger skills, in the hope of improving academic performance. Although these methods may have some diagnostic validity, serious doubts have been raised about the efficacy of their remedial interventions (Hammill, 1972; Hammill and Larsen, 1974; Mann and Goodman, 1976). Nevertheless advocates of process training stand firm in their commitment to this orientation (Minskoff, 1975; Lund et al., 1978).

A promising research program by Ayres (1969, 1972) has delineated, using a large battery of tests, five subtypes of sensori-motor or language deficits in learning disabled children. This has permitted a more specialized application of remedial exercises. One subgroup of children characterized by a vestibular dysfunction showed gains in language and academic skills following certain forms of sensory integrative training (Ayres, 1978).

An alternative approach which does not look for causes within the child, has been labelled, tongue in cheek, dys-pedagogia (Cohen, 1971). It attributes learning problems to deficits in the education the child has been exposed to. Intervention procedures involve applied behavior analysis techniques (Hobbs and Lakey, 1977) and direct instruction (Englemann, 1967). The academic areas in which the child is weak are identified and task analyzed. A systematic teaching program is designed to lead the child through various task substeps towards a clearly defined goal. The child's progress is closely monitored; rewards and reinforcement are given for specific gains. Proponents of this approach claim good success although in view of their anti-diagnostic bias, one cannot say whether they are dealing with dyslexia or with a more manageable form of underachievement. Nevertheless systematic programs with built in rewards comfort and assist discouraged disabled learners (Tarnopol and Tarnopol, 1976). Task analyses have often underscored the necessity of dealing with crucial problems in attention span (Ross, 1976, 1977).

Kirk (1977) suggests that the behavioral task analysis approach is preferable for minor learning problems such as those due to poor teaching or lack of schooling. He adds that perceptual or abilities training seems justified when training a process for its own sake, especially at the pre-school level, and not in the hope of automatic transfer to

academic skills. For severely disabled learners, Kirk recommends a combined process training and task analysis approach geared to a academic material rather than preschool skills. In this instance a student's perceptual characteristics and learning weaknesses are analyzed and matched to the merits of one or more specialized teaching programs (cf. Johnson and Myklebust, 1967; de Hirsch et al., 1966; Bannatyne, 1971).

Psychotherapy is rarely recommended for dyslexic children as their emotional problems are generally considered secondary to their learning difficulties. On occasion, secondary reactions such as anger, guilt and sense of defeat may require some counselling in addition to remedial work (Eisenberg, 1975; de Hirsch, 1975). Even when such counselling is not required, good rapport with the remedial teacher is highly desirable to remotivate the child (Bender, 1975; Jansky and de Hirsch, 1972). Organizing support systems for the child in the home, school and community should not be overlooked in the overall treatment of dyslexia (Johnson, 1978; Mucchielli and Bourcier, 1964).

A number of medically oriented treatment approaches to dyslexia and learning disabilities have emerged in recent years. Such factors as avitaminosis, allergic reactions, and neurologically based hyperactivity have been singled out as sources of learning problems. Intervention has taken the form of massive doses of vitamins, special diets, and drugs with stimulant, tranquilizer or anticonvulsant properties.

The arguments and evidence for and against these controversial approaches are rather complicated, and further research is awaited. Although increased behavioral stability and attention span have been attributed to these methods, the nature of their effect on academic performance remains unclear (The New Therapies, 1977).

Overall, a combined process training and task analysis approach to the treatment of dyslexia seems the most justifiable. This involves matching the perceptual characteristics and learning needs of a child to a specialized teaching method such as the Fernald or Gillingham-Stillman method. The emotional needs of the child must also be considered for successful intervention.

A few longitudinal studies (Rawson, 1968; Kline and Kline, 1975) and clinical reports (Critchley, 1973; Johnson, 1980) indicate that dyslexics who have made marked progress after lengthy remediation continue to struggle with many residual deficiencies. They often experience difficulty reading rapidly or spelling conventionally. They write in a brief monotonous style with inadequate use of punctuation. They admit to a latent aversion to reading. It is conceivable that these methods may be helping the dyslexic compensate as well as possible for their difficulties rather than provide a cure for them.

Despite the importance of the many clinical progress reports found in the literature, the writer agrees with Botel

(1968) and Johnson (1978) that there is little reliable evidence regarding the success of various remedial procedures. Well designed research is urgently required. The populations studied need to be more homogeneous. Longitudinal investigations are particularly indicated: Bannatyne (1975) and Johnson (1978) both suggest that a valid test of current methods should involve at least two years of intervention. Johnson also encourages the use of detailed "N of 1" studies of remedial approaches that require a more individualized application.

Overall, the present status of dyslexia and of its remediation underlines the need for a comprehensive conceptual framework capable of putting the many correlates of the disorder into proper perspective, of focussing attention on key factors and of giving direction to remedial as well as research endeavors. An effort in this direction has been made by Tomatis (1972a), who has proposed his audio-psycho-phonological approach to the understanding and remediation of dyslexia.

Tomatis' Audio-Psycho-Phonological Approach to Dyslexia

Introduction

Alfred A. Tomatis (1977) is a French medical doctor specializing in disorders of the ears, nose and throat, and in disorders of the voice. His research endeavors and clinical practice over the last thirty-five years have led him to

propose major laws governing the relationship between hearing and speech. He has elaborated upon generally unknown or poorly understood functions of human audition and their effect upon speech, language, academic skills, and upon one's physical as well as psychological well-being. Tomatis developed methods of assessing listening and language problems, as well as a remedial approach to these problems using a cybernetic machine called the Electronic Ear (EE). These developments have been framed within a body of knowledge called Audio-Psycho-Phonology (APP) (Tomatis, 1963, 1972a, 1972b, 1974).

The EE is the main tool used in APP remedial programs. It assists in the training or re-education of deficient auditory-vocal behavior. APP is defined as the study of the interrelationship between a human being's listening skills (Audio), psychological disposition (Psycho) and control of speech (Phonology). In essence, APP proposes that the enhancement of listening skills can improve one's speech, language, school performance, mood tone and interpersonal relationships.

APP training has found one of its major applications in the remediation of dyslexia. Tomatis (1972a) claims to have treated over 12,000 dyslexics in the dozens of European centres using his approach. He maintains that a better understanding of the role the ear plays in human adaptation can put the many confusing symptoms of dyslexia into proper focus.

He asserts that one can thereby envisage an actual cure for the disorder.

Tomatis' Concept of Dyslexia

Tomatis (1972a, 1979) considers the dyslexic's academic difficulties as late indicators of language problems rooted in primary listening deficiencies. He indicates that these listening deficiencies generally appear before the child goes to school or attempts to read. He believes that they are mainly triggered by emotional factors of sometimes subtle nature. These same listening deficiencies are said to affect the youngster's brain such that it is insufficiently prepared to make proper sense out of schooling as well as every day living. In short, Tomatis affirms that dyslexia is essentially auditory in nature, of preschool socio-affective origins, and with psychoneurological ramifications.

Tomatis (1972a, 1974) believes that the listening function, an intentionally directed ability he distinguishes from the involuntary ability called hearing, can be diminished or distorted at will. He proposes that a wide variety of painful experiences in early years or even within the womb may cause a child to recoil from its desire to relate by turning off the listening function in one way or another. Disturbing or insufficient interaction with parents, siblings or other significant persons may bring a child to habitually "tune out" to the point where even though hearing remains intact, listening ability has been lost or reduced. Severe ear infections

or allergic reactions may have a similar effect. Or again a youngster may innocently acquire poor listening (and language) habits through exposure to or imitation of persons with the same deficiencies: a dyslexic listening style may be acquired much like one acquires a distinctive ethnic accent from one's parents or cultural setting. Tomatis (1972a, 1972b) firmly believes that dyslexia runs in families because of sociolinguistic shaping influences rather than genetic factors.

Once listening ability has been reduced or distorted for any length of time, it loses its adaptive flexibility and becomes ineffective. Speech, language and school performance suffer in the process as do posture, body image, lateral dominance and perceptual-cognitive functioning (Tomatis, 1972a, 1974). The listening deficient child becomes dyslexic, i.e. disorganized in bodily behavior, in thought and language, as well as in his relationship to self and others (Tomatis, 1972a). The dyslexic child's total universe becomes "dyslexified" (Madaule, 1978). These far-ranging effects, all of which play a part in dyslexia, can be best understood and attended to, according to Tomatis, through revised notions of what human audition and language entails.

The Ear, Listening, Language and Dyslexia

In arriving at his conceptualization of dyslexia, Tomatis formulated three laws of auditory-vocal behavior and elaborated upon four functions of the human ear as well as upon the nature of human language.

Tomatis' first law. While examining airplane factory workers who had sustained some degree of higher frequency hearing loss after prolonged exposure to industrial noise, Tomatis noted changes in their voice quality and energy level. On the spectrograms of the workers' verbalizations, he repeatedly found that the frequencies no longer perceived by their ears were absent in their vocal spectrum. This led Tomatis (1954) to state his first law: "The voice contains only what the ear hears" (p. 264). Husson (1957) confirmed this law at the Sorbonne University, calling it the Tomatis Effect, and rephrasing it more scientifically: "The larynx emits only the harmonics that the ear can hear":

Tomatis also observed that these workers could, upon retesting, somewhat unconsciously alter their hearing threshold up to thirty decibels for the better or the worse. This depended upon whether they feared job dismissal or anticipated compensation as a result of their hearing loss. This alerted Tomatis to the psychology of hearing, or to the effect of listening attitudes on audition.

Tomatis' second law. Consulted by opera singers who had lost control of their voice in the higher frequency range, Tomatis discovered a hearing loss on their audiograms similar to that of the airplane factory workers. He hypothesized that these singers may have damaged their own hearing since they were the first to feel the full impact of their voice, rated at more than a hundred decibels in volume at a distance of

one metre. He further hypothesized that the hearing function could perhaps shut itself down in a self-protective manner.

Tomatis developed a sound amplification and filtering system that electronically restored the lost frequencies in a disabled singer's voice before feeding it back via ear-phones: the voice immediately corrected itself. This led Tomatis to formulate a second law: "If a defective ear is given the capability of hearing the lost or impaired frequencies correctly, they are instantly and unconsciously restored to the vocal emission" (LeGall, 1961, p. 8-9).

Husson (1957) considers this second law as a phonatory physiological consequence of the Tomatis effect. He underlines an excito-tonic effect of proper auditory stimulation in the 2500 - 3000 frequency range, enabling a subject to recover a normal vocal pattern.

The auditory-vocal counter-reactions implied here have been explained in three ways: cybernetically, i.e. as a self-monitoring feedback system; neurologically, inasmuch as the organs of hearing and speech are interconnected by a number of cranial nerves; and cytoarchitectonically, inasmuch as various parts of the hearing and speech mechanisms have evolved from the same basic cellular structures (Tomatis, 1963, 1974).

Tomatis' third law. The restoration effect just described would however vanish the moment corrective auditory feedback was discontinued. Tomatis then developed an appa-

ratus called the Electronic Ear. It allowed a person to hear, via modified feedback and in alternating succession, in either a desirable or defective manner. A person could thus be gradually conditioned to acquire and retain the desirable mode of hearing with corresponding improvements in speech and mood tone. This led Tomatis to state his third law: "Auditory stimulation maintained for a determined period modifies, by the retention phenomenon, the self-listening faculty of the subject and consequently his phonation" (Le Gall, 1961, p. 9).

This retention effect could not be adequately explained by recognized notions of auditory physiology. Tomatis (1973, 1974) later proposed a new theory of human audition to account for this phenomenon. It emphasizes the adaptive potential of the muscle of the hammer in tensing or relaxing the tympanus to incoming sounds, and of the muscle of the stirrup on the oval window in regulating inner ear fluid pressure for purposes of reception. Such muscle play is said to be centrally controlled. Furthermore, according to this theory, sound reaches the cochlear and vestibular system via cranial bone vibration rather than through the middle ear ossicles.

The musical ear. Tomatis discovered that good singers displayed a distinct hearing curve on their audiogram. Named the "musical ear", this curve is illustrated in Figure I.

It ascends by at least 6 and up to 12/18 decibels per octave from the 500 to 2000 hertz range, with a dome in the 2000 to 4000 hertz range and a slight inflection from 4000 hertz to 6000 hertz. The musical ear is said to favor a rich voice as well as smooth and accurate singing. EE training programs for persons with auditory-vocal problems can be set up to aim towards the musical ear pattern.

Prenatal sounds. Tomatis also discovered that music or a human voice modified so as to filter out frequencies below 8000 hertz, as shown in Figure 2, approximates the kinds of sounds heard by human foetus before birth. The foetus can apparently hear from 4½ months on (Eisenberg, 1976). The sounds it perceives, i.e. the mother's internal organs and especially her voice, are modified in passing through the protective amniotic fluid in such a way that only the highest frequencies penetrate within. A mother's words are not discernible but her speech rhythm and intonation pattern come through. Listening to music or to a mother's voice filtered in prenatal fashion is said to have a calming yet alerting effect while instilling the desire to relate (Tomatis, 1963, 1972a). It is postulated that the desire to communicate finds its inception prior to birth through an intrauterine dialogue with maternal sounds (Tomatis, 1963, 1972b). Such prenatal sounds are frequently used in the initial stage of EE training programs because of their ascribed salutary effects.

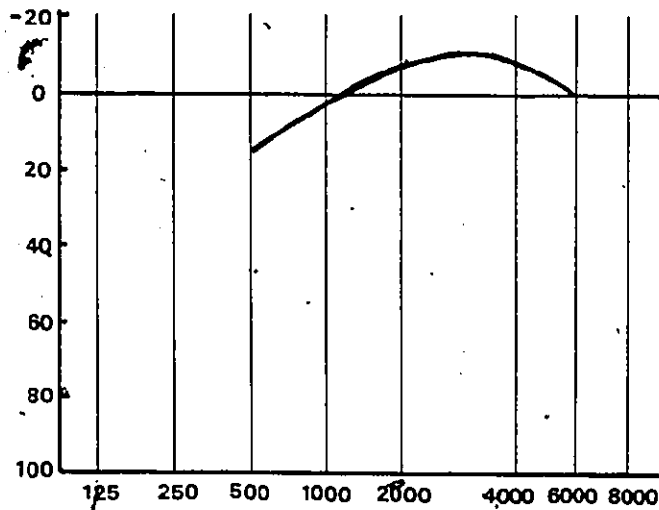


Figure 1. Audiometric curve for the musical ear.

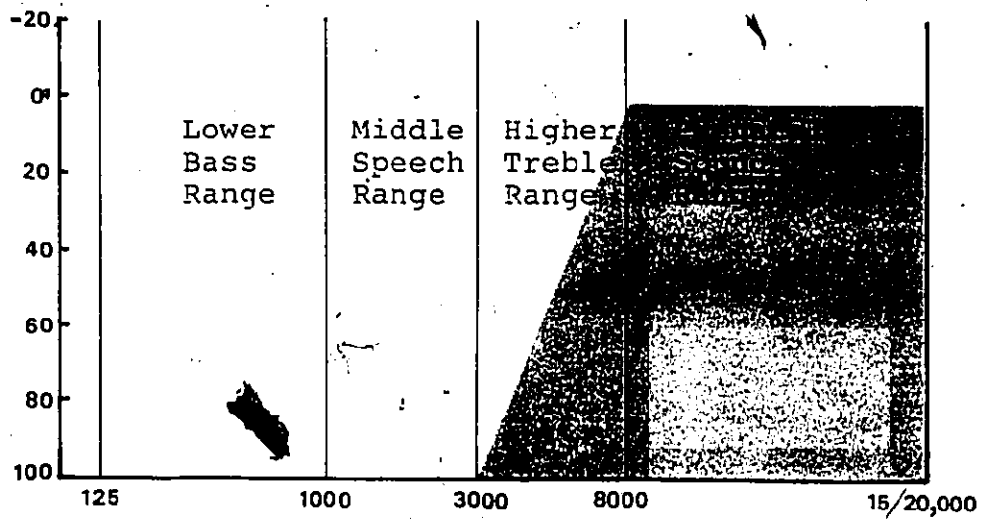


Figure 2. Audiometric representation of prenatal sounds frequency range.

The directing ear. A series of experiments brought Tomatis to realize that the right ear has an advantage in controlling speech and even some aspects of bodily expression. This is attributed to the fact that the right ear has shorter and quicker neural connections with the larynx and with the motor speech centre of the left hemisphere (Tomatis, 1953, 1963). When the right ear takes the lead in self-listening, i.e. in monitoring one's vocal expression, the voice is described as richer, speech as more fluent and articulated. In addition, facial expressions and hand movements are reportedly better synchronized with vocal emphases (Tomatis, 1963, 1972a). In view of these advantages, the right ear has been named the "directing ear" (Tomatis, 1953). EE programs are set up to train towards the acquisition of the right directing ear.

Auditory selectivity. Although a person does not reproduce sounds he cannot hear, he does not, by the same token reproduce all those sounds he can hear. Tomatis (1954) proposed that good sound reproduction depends upon a listening ability called auditory selectivity. This is a refined form of auditory discrimination capable of perceiving small frequency variations within the sound spectrum and of discerning the direction of these variations. The relevance of auditory selectivity is well illustrated in different ethnic languages, each with its characteristic pace and accent that the non-indigenous find difficult to reproduce. Tomatis

(1963) indicates that different "ethnic ears" form the basis of well recognized ethnic tongues. A particular ethnic ear shows a characteristic audiometric curve as well as one or more specific zones of auditory selectivity. These distinctive features act upon the neuromusculature of the vocal organs to produce distinct ethnic tongues or accents. Specific EE exercises are said to facilitate second language learning through the training of the appropriate auditory patterns.

The functions of the ear. The EE treatment of children and adults with auditory-vocal problems brought about unexpected gains in energy level and attention span, bodily awareness and coordination, laterality of eyes and limbs, as well as in academic achievement and socialization. The understanding of these results led Tomatis (1972a, 1972b, 1974, 1978) to elaborate more clearly upon the four main functions of the ear.

The first function of the ear is an energizing function. The ear transforms sensory stimulation into neural energy to keep the cortex alert and active (Tomatis, 1974). The human ear supplies 60 to 90% of the required cortical excitation via its cochlear and vestibular systems (Tomatis, personal communication, 1977). APP programs train the ear to be particularly receptive to the higher frequencies above the speech zone of the sound spectrum. The sensory cells of the cochlea corresponding to these higher frequencies are

very numerous, thereby providing more neural energy (Tomatis, 1974).

Dyslexic children often manifest poor listening skills in the higher frequency range: their voice is often lacking in timbre or richness, their concentration generally falters quickly.

The second function of the ear is one of equilibrium. Tomatis considers the cochlear and vestibular systems as a functional unit, a view supported by the evolution of these systems throughout various species (Tomatis, 1974). In properly training the ear, one also exercises its vestibular system, thereby enhancing posture, muscle tone, equilibrium, bodily awareness and mental alertness. The vestibular system in itself is said to provide up to 60% of the ear's energizing potential (Tomatis, personal communication, 1977).

According to Tomatis (1972a) poor posture or verticality, vague body image, disorganized body schemata and low level of arousal are frequent symptoms of dyslexia. Improvements in these areas are among the first gains to be noted during APP training.

The cochlear-vestibular team also exercises an integrative action upon various sensory-motor systems, including the visual-motor system. Tomatis (1978) has recently pointed out the existence of three neurointegrative systems that are developed through healthy listening habits or through APP training as a preparation for language behavior. They are

described in detail in Appendix A. Summarily, an initial vestibular integrative system, centred on bodily experience, unites itself to a visual integrative system focussed on outer experience. These are both in turn completed by a cochlear interpretative system that permits the integration of inner and outer experience through sound and through personalized listening and language functions. Tomatis (1972a) refers to this overall schema as "audio-gyration". He adds that certain dyslexic children have not attained sufficient integration within and between these three systems.

A third and more recent function of the ear is listening, the active seeking of sounds. APP training focusses on developing listening skills rather than hearing ability. The dyslexic child has good hearing but is often unable to listen or persist in listening, especially in regards to sounds pertinent to speech (middle range frequencies) and energizing potential (upper range frequencies).

A fourth function of the ear involves its being a major vector or directing force in establishing lateralized behavior. Tomatis has indicated that the right "leading ear" is the most effective for the purpose of self-listening and self-expression. Proper right-eared control of speech reportedly favors fluent verbalization, rich in rhythm and intonation, and well articulated from the front of the mouth. In addition, movements of the hands, head and eyes are better synchronized with the vocal patterns, and the face itself comes alive with

expression. Left-eared control of speech, often found in dyslexics, reveals itself by a flat monotone voice, poorly enunciated from the back of the mouth, and by a broken or hesitant rhythm. A lifeless facial expression and disordinated bodily movements are frequently noted. According to Tomatis, the lack of a clearly established right "directing ear" contributes to the mixed or unsettled laterality frequently encountered in dyslexia.

The four functions of the ear can be promoted or thwarted by a child's socio-emotional experiences (Tomatis, 1963, 1972a, 1972b). The relationship with the mother, even before the child is born, is considered crucial in instilling the desire to relate, listen and communicate. Her continued love and encouragement during the first three or four years of life provide the child with a base of trust in life and people. Afterwards, the child should gradually move beyond dependency on mother into the wider social arena under the patronage and tutorage of the father or a worthy substitute. A more articulated form of speech and a clearer expression of one's thoughts are then required and attained, according to Tomatis, through right-eared self-listening habits. Hence a developmental task affects psychoneurological strategies. A positive relationship with the father will facilitate this process whereas a negative or non-existing relationship may block it. In the latter case, the child may be fixated at an earlier and less articulate level of dialogue, stuck on

mother's lap so to speak, as is frequently the case in dyslexia (Tomatis, 1972b). Psychoneurological preparedness for higher level language functions such as reading is also held back.

That socio-affective experience may influence auditory functions to such a degree is partly due to the fact that the tenth cranial or vagus nerve receives sensations from the auricle, thereby linking this outer surface to thoracic and abdominal viscera. This creates a psychosomatic loop that allows for conditioned responses to sounds and voices, depending on their affective coloring (1972a, p. 76-77).

Language. In APP, language is conceived of as more than just words, grammar or a verbal tool. It is a secretion that reflects man's total adaptation (Tomatis, 1980). Its understanding requires notions of psycholinguistics, sociolinguistics, neurolinguistics, psychophysiology, and developmental psychology. Language involves listening, self-listening, the quality of one's communication with one's self and with others, the degree of receptivity to others and to the environment, and the mastery of one's bodily instrument. This latter aspect can illustrate this marvellous complexity further. Language, affirms Tomatis, has no particular organ of expression. It entails the orchestration of several organs and bodily functions such as vertical posture, lateral preferences, body schemata, the mouth, the larynx, the lungs, the ears, the eyes and the hands. Comfortably established language acts

as a catalyst or inductor that brings all of the above together in a coordinated fashion, creating a form of bodily logic or syntax that carries over into one's movements, thoughts and verbalizations. Tomatis refers to this as the "structuring dynamics" of language (1972b).

Inadequately established language, typical of dyslexia, betrays itself by some degree of disorganization in the afflicted person's movements, verbalized thoughts, self-perception and social participation (Tomatis, 1972a; Madaule, 1978).

Reading. Tomatis insists that we read primarily with our ears. Letters and words represent sounds encoded in conventional visual signs that await decoding via a "reauditing" process, silently or aloud (Tomatis, 1972a). Whereas visual perception is only required to pick up the visual cues, the achievement of a sign-sound match depends upon good auditory discrimination and clear articulation of the sounds of one's idiom. Smooth reading at a comprehension level requires a well integrated language base, properly established by good listening and self-listening habits.

Vision thus serves an ancillary purpose in reading. A "reauditing" process has to be achieved simultaneously. The required eye-ear synchronization reflects the integrative action of the vestibular system. Visual reversal errors, classical signs of dyslexia, are attributed to poor auditory discrimination and articulatory grasp of phonetically similar

sounding letters such as "p" and "b". Such errors may also reflect inadequate laterality and body schemata that do not allow the dyslexic person to impose a personal sense of direction upon visual signs. Slow and hesitant reading reflects insufficient cortical excitation and psychoneurological preparedness for higher level language processes. All of these deficiencies can be understood and corrected through APP theory and training. The secret of reading may be found in language but, according to Tomatis (1972a), the ear is the royal road to language.

The APP Training Program for Dyslexia

Tomatis has developed a remedial training program for dyslexia focussed entirely on the dynamics of listening as a basis for achieving proper speech and language. He stresses that APP training does not teach a child to compensate for poor academic skills: it aims at bringing about a cure of underlying listening and language deficiencies. Auditory and auditory-vocal exercises are employed rather than remedial reading, spelling and writing exercises.

The APP training program consists of three basic evaluation procedures and a two-phase program of exercises. The evaluation procedures involve a listening test, i.e. a modified hearing test designed to reveal listening and non-listening dispositions; a test of auditory laterality carried out as the client speaks; and a personal interview designed to assess, on an observational basis, the client's posture,

listening skills, voice qualities and bodily comportment while speaking, and ease or discomfort in relating. These procedures are employed for initial diagnosis and for monitoring progress in the training program.

The APP training program aims at recapitulating, in abbreviated and simulated fashion, the normal stages of listening and language development, as understood by Tomatis, from their prenatal beginnings to the level of articulate and well adjusted youngster capable of meeting the demands of schooling. The first main phase of training entails passive listening exercises using specially prepared tapes of music and "prenatal sounds" presented via the EE apparatus. This phase is designed to awaken or enhance the desire to relate, while simultaneously energizing and relaxing the client. Symbolically this phase represents the "encounter with mother". The second main phase of training requires active listening to and repeating of words and phrases, via the EE, as presented on special tape recordings. A gradual strengthening of the right "leading ear" is also undertaken. This phase symbolically represents the "encounter with father" and an "encounter with self". It prepares the client for the more socialized interaction and articulate self-expression that normally emerges around 4 years of age (Tomatis, 1972a, 1972b).

The two main phases of training each involve two or more subphases. The general direction of the program is identical for all dyslexic clients but the rate of progression through

the subphases is highly individualized and closely monitored by a Program Consultant in keeping with each client's needs. APP training for dyslexia may last from three to twelve months at the rate of two half-hour training sessions per school day. A typical program may involve about 200 sessions over a five-month period.

According to Tomatis (1972a), a greater energy level and involvement in everyday activities, a keener desire to relate and communicate, and a more hopeful attitude towards schooling are often reported during the first phase of training. Improved self-expression and gains in academic performance are generally noted during and after the second phase. In some cases, tutoring may be recommended after APP training to help a child catch up more quickly in school related learning.

The support and involvement of the dyslexic child's parents and siblings are considered important. If certain family members show seriously deficient listening and language skills, they too may be taken into APP training so as to eventually provide a healthy communicative milieu.

Critical Considerations

The writer has thus far endeavored to provide a clear and systematic account of Tomatis' concept of dyslexia and of the APP remedial approach to this disorder. Such an account was culled from many sources, some of which have yet to be translated into English, and from personal

communication with Tomatis himself. The writer must however underline at this point the fact that Tomatis writes in a somewhat cursive and unsystematic style that often prompts skepticism on the part of the critical reader or the professional community. As he describes a listening or language difficulty, he may delve into psychoanalysis, philosophy and spirituality, thereby lending his APP approach a cosmogonic flavor. He tends to make broad statements that are sometimes too general or unverified. Moreover some of his assertions and theorizing deviate from existing knowledge in psychophysiology, thereby creating resistance to if not outright rejection of his ideas. The writer wishes to draw attention here to a few of Tomatis' more controversial notions and to a few critical considerations regarding the APP remedial program.

In his writings Tomatis (1963, 1972a) asserts that only the left hemisphere can mediate speech and that right ear control of speech should be favored because of its more direct anatomical connections with the left hemisphere. However a growing body of evidence underscores the fact that some individuals have bilateral or right hemisphere speech representation (Penfield and Roberts, 1959; Zangwill, 1962; Branch et al., 1964) and that the right hemisphere can mediate the comprehension of certain aspects of spoken or written language (Sperry and Gazzaniga, 1967; Gazzaniga and Hillyard, 1971). In view of these findings, Tomatis' statements seem

oversimplified. One can only wonder if APP training towards right ear dominance in persons with bilateral or right hemisphere representation of speech would improve their neuropsychological organization or create an imbalance therein.

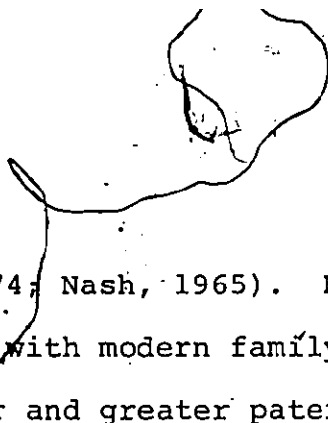
Tomatis (1972a, 1972b) has further stated that the two hemispheres of the brain are anatomically symmetrical and that certain visceral aspects of the organism actually impose assymetry or laterality upon the individual. More specifically, the vagus nerve, shorter in its right-sided connection between the auricle and its recurrent laryngeal branch, is said to favor a better auditory control of phonation preferential to the right ear and left hemisphere. This assymetry of the vagus nerve is also said to promote functional hemispheric differentiation as well as laterality that is right dominant. Such a proposition seems questionable in view of evidence provided by Geschwind and Levitsky (1968, 1970) that in infants as well as in adults clear anatomical differences exist in the auditory cortex of the two hemispheres and that in the majority of cases the left hemisphere auditory cortex is much larger than the right. This evidence points to a structural advantage in the left hemisphere for matters related to the organization of language and laterality.

Tomatis (1963, 1972a, 1977) has over the years insisted that right ear self-listening is necessary for proper control of speech, musical expression and certain bodily movements. Sussman (1971) and Dionne (1974) have provided some research

support for a right ear advantage in the control of phonation. Kimura (1973a, 1973b) found a right-sided predominance of free hand movements in right ear dominant persons, as established by the dichotic digits technique, during spontaneous speech. However several reports (Bryden, 1963; Kimura, 1964; Kinsbourne, 1971; Milner, 1962; and Spellacy, 1970) have all indicated left ear dominance and right hemisphere superiority in matters related to the perception of melodies and musical stimuli. Such evidence stands in stark contradiction to Tomatis' position on musical expression. A more recent study (Bever and Chiarello, 1974) did however report a right ear superiority for musically experienced listeners involved in frequent playing or singing as opposed to a left ear superiority for musically naive subjects.

Tomatis bases much of his APP training upon the belief that two of the ear's main functions relate to the provision of cortical energy and corporal equilibrium. As interesting and viable as these basic notions may seem, Tomatis provides little research evidence to support such fundamental aspects of APP theory.

In regards to Tomatis' (1972b) theorizing on the psychology of language development, primary importance is given to the humanizing role of the mother in a child's first years, and to the role of the father in the socialization process from four years of age on. Such a formulation parallels some traditional psychoanalytic, psychological and sociological concepts (cf.



Mahler et al., 1974; Nash, 1965). However this formulation seems out of tune with modern family life patterns characterized by an earlier and greater paternal participation in infant care as well as by the mother's gradual liberation from a narrow and home-bound child-rearing vocation.

In this writer's opinion, Tomatis' (1972a, 1972b) attribution of dyslexic listening and language difficulties to communication or relationship problems within the family unit requires some caution as well as experimental confirmation to avoid placing unnecessary blame or guilt on family members.

In terms of the technical or practical aspects of the APP approach to the diagnosis and remediation of dyslexia, the use of a listening test in favor of traditional audiometrics is certainly innovative but again requires supportive research evidence as to the usefulness of this bias. As will be indicated later, the Tomatis Listening Test (TLT) and Audiometerometry Test (ALM), both of which form an integral part of the initial diagnosis of dyslexia and of the monitoring of ongoing remediation, are intriguing instruments which however require statistical proof of their reliability and validity.

Keeping these problematic theoretical and technical issues in mind, the following section reviews some research endeavors related to APP theory and training.

The Research Status of APP Training

Tomatis has developed his theory and techniques on the

basis of laboratory investigations and everyday clinical experience over a thirty-year period. APP training is currently employed in the remediation of such problems as stuttering, delayed language development, difficult second language learning and dyslexia. It is also used in the treatment of such disorders as autism, neurosis, depression and certain forms of epilepsy. However proof of the effectiveness of APP training has come mainly in the form of anecdotal and clinical reports (Tomatis, 1972a; Le Monnier, 1974; Spirig, 1974; Gardey, 1975; Derrien, 1975; Hannard, 1978). Tomatis' insights and innovative methods call for more rigorous experimental validation.

Tomatis (1963) has recognized the need for more stringent research. He cautions that one should not lose sight of the individualized nature of APP training (personal communication, 1974). He has facilitated research endeavors by systematizing APP diagnostic and training procedures, and by pointing out the probable physiological, neurological and psychological underpinnings of APP methods.

Some research findings deserve comment. In South Africa, Van Jaarsveld (1973, 1976) studied the effect of APP training on a group of thirty young adult stutterers. At the end of APP training, he found significantly better hearing acuity, especially in the middle frequencies or speech range. A spectral analysis of oral reading samples also showed a significant gain in the group's vocal output, and most promi-

nently in the speech-related frequencies. A significant reduction in severity of stuttering and in number of speech dysfluencies, along with a significantly faster rate of speech and reading were also recorded following APP training. Scores on the Iowa Scale of Attitudes Toward Stuttering (Johnson et al., 1963) indicated a significantly better attitude towards stuttering and a greater degree of self-acceptance by the close of the program.

In Belgium, Schenkel et al., (1978) studied the usefulness of APP training in helping a group of sixteen French secondary school students learn a difficult second language, i.e. Oxford-style English. Although a control group was used, statistical tests of significance were not employed. Following a special APP program, the experimental group showed considerably better gains than the control group in listening ability within the high frequency range, and in the repetition of sibilant and diphthongal sounds. Such gains are congruent with the English ethnic ear's unusual sensitivity to the high frequency sounds. The experimental group also attained, in comparison to the control group, greater mastery of Oxford English as to its characteristic articulation, intonation and pitch.

In Canada, more circumscribed aspects of Tomatis' work have been investigated. Dionne (1974), on the basis of longitudinal performance on the dichotic digits test, classified subjects into either stable or unstable right or left ear

dominance. Interference with the ear's speech monitoring function was obtained using monaural delayed feedback. The results indicated that the right dominant "leading ear" is related to the control of speech output in its articulatory and temporal aspects. The latter dimension was evaluated in terms of phonation time and error-free mean syllabation time. The results were somewhat ambiguous inasmuch as all groups were affected by the interference procedure in terms of error free syllabation time. The use of a measure of ear laterality more directly linked to speech and language, as employed by Tomatis, might have provided clearer results. The validity of the dichotic digits test as a measure of laterality has been seriously questioned (Colbourn, 1978).

Schnitzer (1974) submitted 20 dyslexic children to an Electronic Ear training program, comparing the results obtained to those from a matched control group. No statistically significant differences were found, after training, on tests of laterality and reading (word recognition). Unfortunately a perusal of the research procedures underlines that although the Electronic Ear apparatus was employed, the program followed only faintly resembles Tomatis' APP remedial program. Hence this investigation does not provide a true test of the Tomatis method as purported. Schnitzer's report does however contain some well formulated criticisms of certain theoretical and methodological aspects of APP remedial training.

Gillis and Sidlauskas (1976, 1978) found that ten dyslexic children, given APP training one hour each school day over a four-month period, advanced from an average of grade 1.88 to 2.43 on the combined Vocabulary and Comprehension scores of the Gates-MacGinitie Reading Tests (1965). They also found a significant improvement in oral reading rate when feedback was given mainly to the right ear instead of both ears. However the quality of reading performance was not evaluated for this aspect of the investigation. It should be noted that this study did not individualize the training programs which in themselves were possibly too brief. Moreover, the procedure used to define dyslexia is questionable.

Overall, no systematic investigation of the effectiveness of the APP training program for dyslexia has yet been carried out. Many aspects of the APP approach, such as the emphasis on developmental language problems, are in keeping with current trends in the study of dyslexia. In addition, APP theory offers a framework that may lend some direction and order to research efforts. Tomatis stresses that APP training aims at enhancing underlying listening, perceptual-motor processing and language skills. Eventually it improves academic performance. It seems to the writer that a first question to be answered is whether or not the APP approach to the remediation of dyslexia does affect perceptual processing ability and academic performance, and if so, in what way.

The following section reviews the literature in the areas of perceptual processing abilities and academic skills as related to dyslexia, in an effort to set the stage for the research proposal.

Perceptual Processing Abilities and Academic Skills

The nature of perceptual processing in dyslexic children has taken up the attention of many researchers on the assumption that academic learning problems may be related to underlying perceptual deficits. Academic performance, especially reading behavior, has been the standard reference point in defining dyslexia.

Perceptual Processing Abilities

The search for underlying perceptual problems has been shared by proponents of the bio-medical tradition concerned with dyslexia and by proponents of the psycho-educational orientation concerned with learning disabilities. Both groups feel that learning problems are based in some form of neuropsychological dysfunction perhaps due to a developmental lag (bio-medical tradition) or to a minimal degree of brain damage (psycho-educational orientation). Perception in this context refers to the full exploitation of incoming sensory stimulation and involves central nervous system mechanisms.

In a broad definition, Cruikshank (1978) states that:

Perception is an inherent function of the neurology of the organism. Perception is not something separate and apart from the organism, but

is the direct reflection of the capacity of the neurological system to receive stimuli, to transform them into neuro-electrical energy, to transport this energy to appropriate portions of the central nervous system, to provide a mechanism or mechanisms whereby experience, judgment, symbolization, the organization of symbols in linguistic structures, intelligence and other forms of higher intellectual function can be related to the energizing forces, and ultimately to activate efferent nerves (output) so that appropriate motor responses in the form of movement, speech, listening, viewing or feeling can be experienced. Perception is a process through which the steps we have just delineated are accomplished and by which the individual accommodates or adjusts to its environment. Socially acceptable responses are those which are perceived and processed within the standards recognized by society. Reading, writing, acquisition of number concepts, as well as overt forms of more gross behavior, constitute such responses. (p. 5-6).

A perceptual processing dysfunction is said to involve a weakness or impediment in one or more of the previous steps such that reading, spelling and other desirable responses are disturbed. Such deficits or dysfunctions have been explored under the title of perceptual skills, perceptual-motor handicaps, sensory integration, temporal and spatial abilities, psycholinguistic abilities, attentional mechanisms, etc. This has produced a fairly large body of findings which have been amply reviewed elsewhere (cf. Hallahan, 1975; Morgeson, 1975; Vellutino, 1978). Only main trends derived from this approach are presented here.

Visual and visual-motor processing. Studies of visual processing mechanisms such as visual discrimination, visuo-spatial skills, visual memory and visual-motor functioning,

were historically the first to be explored and have received the greatest research emphasis. However the results were often confusing, contradictory or inconclusive.

Benton (1962) shed some light on this situation by indicating that nearly all the positive correlations and predictive ability between visual or visual-motor deficits and reading retardation were related to young children below eight or nine years of age, while negative findings were found in older groups where conceptual and language factors are more pertinent.

Upon closer examination, the early predictive usefulness of the Bender Gestalt or the Draw-A-Man Test may depend more on the complexity and cognitive demands of these tasks than on simple visual-motor coordination. (Jansky and de Hirsch, 1972; Torgeson, 1975). Furthermore, visual perceptual tasks of verbal nature, such as the naming of numbers or letters, have been found to be better predictors of reading failure than visual non-verbal tasks such as pattern copying. (Jansky and de Hirsch, 1972).

Letter reversal and orientation problems traditionally thought of as compelling evidence of visual perceptual deficits, are now considered as markers of delayed maturation since even normal readers manifest and outgrow these confusions. Money (1962) and Kephart (1960) have related such visual problems to more basic difficulties of body image and body schemata. Bannatyne and Wichiarajote (1969a, 1969b)

suggest that a child properly sensitized to phonemic and articulatory differences in graphically similar letters or words has a variety of linguistic cues to program the correct orientation and sequencing of visually equivocal configurations, thereby overcoming reversal and order problems.

Several studies by Shankweiler and Liberman (1972, 1976, 1978) indicate these supposed visual perceptual disorders are overrated in most poor readers, including dyslexics. Such children made the largest proportion of oral reading errors on vowels (43 percent) and consonants (32 percent) whereas orientation errors and sequence reversals accounted for 10 and 15 percent respectively. The authors conclude that all of these errors may reflect inadequate phonetic coding processes rather than simply poor memory span or temporal order perception. Following a series of well designed studies, Vellutino (1978) affirms that the apparent visual perceptual problems of discrimination, memory, orientation and sequencing found in dyslexic children are essentially manifestations of poor verbal encoding (labelling) or weak verbal mediation skills.

In regards to many of these visual perceptual problems associated with dyslexia, Torgeson (1975) suggests that poor performance rather than poor ability may be at play; difficulties of attention or poor scanning may be interfering.

In short, visual and visual-motor deficits may have some early predictive usefulness but their importance may have been overrated. Mounting evidence suggests that problems

in verbal coding, verbal mediation, body image, speech behavior, and attention may be the more basic issues involved.

Auditory and auditory-vocal processing. Orton (1937) wrote about the importance of the relationship between auditory perceptual abilities, speech and language development, and the specific reading disability we call dyslexia. Yet this area was slow in being researched. Rabinovitch (1959) reported that 60% of children with primary reading disability had a large verbal-performance discrepancy on IQ tests in favor of the latter. This was later confirmed by Huelsman (1970). Slow receptive and expressive language development in 3 to 5-year-olds was reported by de Hirsch (1954) as highly predictive of dyslexic problems in school. Wepman et al. (1960) pointed out that poor auditory discrimination of speech sounds led to delay in the onset of speech, slowness in acquiring speech accuracy, and problems in phonetic-phonemic visual integration necessary for reading.

Wepman's seminal article triggered a long series of studies of verbal and non-verbal auditory perceptual skills in relation to reading, the results of which are highly questionable because, contrary to Wepman's investigation, intelligence had not been controlled for (Hammill and Larsen, 1974). A noteworthy exception is the longitudinal study by Chall et al. (1963) which found auditory blending, i.e. reproducing a word or syllable by synthesizing its component sounds, when assessed in the first grade, to be highly

predictive of reading achievement in the third grade.

More recent research indicates that complex auditory discrimination tasks related to speech and language, sound blending or phonological processing tasks for example, do discriminate good from poor readers at a level of significance (Bannatyne, 1971). Shankweiler and Liberman (1972) propose that poor readers have not become sufficiently sensitized to the phonetic structure of words they can hear and do repeat, that they have difficulties in phonemic segmentation, and that this in turn impairs the ability to establish clear sound-symbol relationships.

Several investigators (Sticht et al., 1974) have found "auding" ability, the process of listening directed towards speech and language behavior, to be a good forecaster of reading achievement. Moe (1957) reported that a single measure of "auding" ability derived from children's understanding of stories predicted reading performance as well or better than either of two readiness tests or any of a series of psychometric tests used as alternative predictors. Friedlander and de Lara (1973) have found language-oriented measures of selective listening ability significantly correlated to reading dysfunction. Luria's (1966) hypothesis that auditory portions of the cortex function as selective analyzers seems relevant here. He suggests that for language, the auditory cortex can extract the linguistic meaning from an incoming message while ignoring those portions which do not

add to the meaning.

In terms of verbal processing skills, recent studies seem to indicate that poor readers may be deficient in semantic and syntactic abilities. In terms of semantic dimension, Vellutino's (1978) critical review of the literature indicates that some poor readers are not proficient in extracting meaning from what they hear, or in retaining details of what they have read; that they are slower in finding their words or in naming familiar objects; and that they are weaker in expressing themselves clearly or succinctly. In terms of the syntactical dimension, investigators have tried to relate linguistic rules and structures to reading ability or disability. Psycholinguistic research has established the order of development of such rules and structures, and this can be used as a measure of language readiness or delay in children. Such rules and structures can be used to generate hypotheses about meaning in an effort to read more quickly at a comprehension level. Studies by Fry (1967), Schulte (1967), and Vogel (1975) on primary grade children found that poor readers have less command of syntactical and morphological rules, and that this taxes their verbal comprehension, their self-expression and their reading. Such deficiencies appeared early enough to contribute to rather than result from dyslexia.

In short, it is becoming increasingly clear that speech and language-related deficiencies of auditory and auditory-

vocal processing are most pertinent to the study of reading problems.

Cross-modal integration. Reading is a complex process involving auditory, visual and kinaesthetic functions. Bronner (1917) was the first to suggest that some form of integration between these modalities may be at the root of reading problems. Dysfunction of late-maturing areas of the brain such as the left inferior parietal lobe (angular gyrus region), which mediates inputs from visual, auditory and somatosensory association cortices of both hemispheres, has been implicated in dyslexia (Geschwind, 1965). The fact that multisensory linkage approaches to remedial reading have attained some success also points in this direction.

Birch and Belmont (1964, 1965) found disabled readers to be deficient in auditory-visual integration tasks. Blank and Bridger (1966) related such an integration deficit to verbal mediation problems: they found learning-disabled children less competent than controls in applying verbal labels or verbal mnemonics even within the same modality to thereby facilitate association or recall. Research by Senf and his colleagues (Senf, 1969; Senf and Freundl, 1971; Vande Voort and Senf, 1973) suggests that auditory-visual integration deficits may reflect more basic weaknesses in attention, memory, and especially serial order recall.

Zigmond (1966) provided evidence that intramodal failure of auditory processing could well account for intersensory

integration as well as reading deficits. McGrady and Olson (1970), and Vellutino et al. (1975) added a further distinction in finding that verbal rather than non-verbal aspects of intramodal auditory processing were at issue in intersensory integration problems of dyslexic youth. The fact that the latter study controlled for the effect of attention and short-term memory adds further weight to this hypothesis.

In an innovative research approach, Guthrie (1973) administered tests of phoneme-grapheme association skills to disabled readers, normal readers similar to the disabled in age and IQ, and normal readers similar to the disabled in reading level and IQ. The strength of subskills in the disabled group was virtually identical to the comparable subskills in normals of similar reading level. Both groups were inferior to normals matched on age who had completely mastered each of the subskills. Intercorrelations among subskills were highly positive for the normals and largely insignificant for the disabled. This suggested that interfacilitation among these subskills is necessary for normal reading. Guthrie also concludes that one source of disability for poor readers is a lack of integration among subskills.

The empirical evidence thus far points primarily to an intramodal auditory disorder of verbal nature and secondarily to an intersensory deficit as critical factors in disabled readers.

Memory and attentional mechanisms. Many early investi-

gators reported consistent large group perceptual-cognitive deficits in poor readers as shown by low scores on WISC subtests such as Information, Arithmetic, Digit Span and Coding (Huelsman, 1970). However since these subtests do not tap distinct areas of psychological functioning, many possible interpretations can be or have been made, most notably in terms of short-term memory deficits, attentional problems, sequencing difficulties, anxiety factors, etc. (Hallahan, 1975).

Memory, as a construct, is quite complex, as emphasized by Flavell (1970), Belmont and Butterfield (1971), and Meacham (1972). It can be considered as a epiphenomenon of various cognitive activities such as rehearsal strategies, labeling and mnemonics. Its efficiency is highly susceptible to the influence of anxiety, curiosity, attention and motivation.

Senf and Freundl (1972) found that the memory deficiencies of poor readers increases with length of task, and may be due to quick fatigue or lack of staying power. Doehring (1968) as well as Zurif and Carson (1970) provided evidence that poor readers are not as effective as normal readers in processing serial order information (serial order recall) of both auditory and visual nature. Bakker (1972) suggests that it is temporal order memory of verbal nature that is particularly deficient in disturbed reading. He relates this to an underdevelopment of the left hemisphere which supports temporal sequencing of verbal stimuli. Blank et al. (1968) attributed

short-term recall deficits of poor readers to inability to employ verbal mnemonics as do normal readers. Finally, Eakin and Douglas (1971) have found poor readers to be particularly weak in "automatization", a cognitive style whereby certain behaviors have become so highly practiced as to occur rapidly with a minimum of conscious effort or energy expenditure. Such "automatization" would come into play on the WISC Coding or Digit Span subtests as well as in the initial decoding skills of the reading process.

The possibility that attentional mechanisms may be at issue in dyslexia has attracted considerable research efforts recently (Douglas, 1976). Yet attention, like memory, is a psychological construct in need of further refinement to be useful, as hinted at by findings that can be grouped under this broad heading. Noland and Schuldt (1971) detected that vigilance, or the ability to sustain attention, is deficient in reading-disabled children. Bryan and Wheeler (1972), on the basis of classroom observation, found that LD children spent less time on behavior that could be classified as task-oriented, and tended to engage more often in non-task-oriented behavior. Santostefano et al. (1965) report that good readers are not affected by distracting stimuli to the degree to which poor readers are affected. Hunter et al. (1972), on the basis of physiological tests, were able to show that disabled readers may lack the degree of arousal necessary to support sustained attention and learning.

Memory and attentional mechanisms clearly warrant further investigation for the understanding of reading disorders. One should not however expect these functions to be the sole factors involved in a disorder such as dyslexia. Hueismann (1970) pointed out that in regards to the WISC subtest pattern of low Information, Arithmetic, Digit Span and Coding, none of the individual disabled readers he studied manifested this pattern in full, and that many were not significantly deficient in any of those areas. Doehring's (1968) thorough research, which found reading disability most highly correlated with sequential memory deficits of both auditory and visual nature, underlined that dyslexics as a group were also significantly weaker on half of the 72 non-reading measures employed, a global deficit far more extensive than anticipated.

All in all, the study of perceptual processing dysfunctions has shed some light on the nature of reading problems of the dyslexic variety. Factors which seem relevant are memory, especially serial order recall, ability to pay attention, and language-related auditory-vocal skills. However future progress in the investigation of these areas requires that the global constructs of memory, attention and language be refined into their components and attributes. According to Torgeson (1975), a major step in this direction has been taken in the development of the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk et al., 1968; Kirk and Kirk, 1971). This test assesses language-related perceptual pro-

cessing functions. It differentiates three dimensions: (a) channels of communication, or the sensori-motor route through which communication flows such as the auditory-vocal and visual-motor channels; (b) the process dimension, which considers the receptive, associative and expressive aspects of communicative behavior, and (c) a level of organization dimension which distinguishes between "automatic" level responses related to integrated habits chains, and "representational" level responses requiring higher order cognitive functioning. Retarded readers as a group are reported to experience particular difficulty on tests at the "automatic" level while individual weaknesses at the "representational" level are also apparent (cf. Kirk and Kirk, 1971). Such a test illustrates the usefulness of more precisely defined areas of perceptual processing in evaluating reading disabled youngsters.

Academic Skills

Reading behavior. Considering the central importance of reading behavior in definitions of dyslexia using a discrepancy criterion, it is surprising that much of the research on the disorder has generally made use of a single measure of reading. This has often taken the form of a simple oral word recognition task such as the reading subtest of the Wide Range Achievement Test (WRAT) (Jastak and Jastak, 1965).

A number of investigators recently took a closer look at the nature of the normal reading process, indicating

therein two or more distinct levels with component skills involved at each level (Fries, 1962; Luria, 1966; Wiener and Cromer, 1967; Bannatyne, 1971, 1973; Goodman, 1972; Gibson and Lewin, 1975). Accordingly, reviewers of research on dyslexia now recommend the use of more than one type or level of reading measure in operationally defining reading disability. Such an approach may reveal the presence of discrete classes or subtypes of reading difficulty, or of a developmental pattern of deficits over time.

The writer's experience with learning disabled youth has indicated that word recognition tests often overrate the reading competence of older children and of some younger children who compensate through smart guessing. The additional use of tests of word understanding (vocabulary) and passage comprehension would do more justice to the perceptual and conceptual levels of the reading process described previously.

Spelling behavior. According to Rawson (1968), Rabinovitch (1968) and Myklebust (1971), spelling may be a better indicator of dyslexia. It makes heavier demands on reproduction rather than on recognition skills. There is less room for guessing from external cues as in the case of reading. Written spelling in particular can give clear indication of reversals, omissions, substitutions, sequencing errors, mastery of phonics and spelling rules, knowledge of irregularly spelled words, and of penmanship.

Childs and Childs (1971) draw attention to the complexity of spelling by delineating three groups of words encountered in the English language. A first group involves words that are phonetically accurate and can be spelled as they sound. A second group requires knowledge of basic rules and principles to be spelled correctly. A third group consists of words with irregular sound-letter connections about which no generalizations can be made and which must be memorized individually. Such a frame of reference allows for a more in-depth analysis of spelling behavior.

Arithmetic. Arithmetic skills are frequently below expectation in dyslexia although generally stronger than reading and spelling skills. Ansara (1973) points out that the manipulation of mathematical symbols, like letters and words, involves perception, memory and sequencing within a spatial organization and in association with concepts. Dyslexics may therefore manifest reversals of numbers; difficulty in writing a sequence of numbers from dictation or an inability to memorize times tables to the detriment of higher level calculation. Rabinovitch (1968) views dyslexia as a problem of symbolization and feels that arithmetic is inevitably affected. This can take the form of being unable to grasp mathematical concepts even when directional, spatial and memory problems have been corrected.

It seems clear to the writer that the proper diagnosis of dyslexia and the evaluation of remedial techniques should

be done through tests of spelling and arithmetic skills as well as through a selection of reading tasks. Dyslexia may involve a basic deficiency that differentially affects all academic skills calling for perceptual and cognitive ability. Or again such an approach might point to different subtypes of the disorder. For instance, Kinsbourne and Warrington (1963), in delineating the developmental Gerstmann syndrome, found characteristic types of spelling errors in these children as well as strikingly profound arithmetical difficulties that were more severe than the reading problems.

Summary, Research Proposal and Expectations

At this stage, it may be helpful to recapitulate the major points brought forward in the previous sections.

Over the years a particular form of reading disability called dyslexia has often been conceived as distinct from other forms of reading difficulty inasmuch as it cannot be attributed to sensory handicaps, neurological damage or primary emotional disturbance, and inasmuch as it occurs despite adequate intelligence, educational and socio-cultural opportunity. This disorder is often considered dependent upon perceptual-cognitive disabilities which may reflect a maturational lag of hereditary nature. Dyslexia however remains enigmatic, its study plagued by problems of definition and diagnosis, treatment choice and research design. The lack of unequivocal diagnostic indicators and the heterogeneity of the disorder have been particularly problematic although

some suggestions have been made to deal more effectively with these issues.

Tomatis (1972a) has advanced the APP approach for the understanding, diagnosis and treatment of dyslexia. It focuses on listening deficiencies believed to lead to difficulties in speech, language functions and academic skills, as well as to other far-ranging difficulties in mental alertness, cognitive efficiency and interpersonal relationships. Tomatis conceives of dyslexia as essentially auditory in nature, often originating in early socio-emotional problems. His diagnosis of dyslexia relies predominantly on tests of listening and language behavior. APP remedial training aims at enhancing the dyslexic person's listening skills in an effort to positively influence other behaviors indicated above. Although APP training does not involve remedial academic exercises as such, it reportedly improves school performance.

Tomatis' APP approach may provide answers to some of the problems encountered thus far in the study of dyslexia. It offers specific diagnostic criteria, a comprehensive definition of dyslexia, and a developmentally oriented remedial program. Its emphasis on listening and language skills and their energizing as well as integrative action seems consistent with current research findings that point to attentional mechanisms, intersensory integration and language-related perceptual processing as pertinent to the understanding of dyslexia. Moreover, APP seems to offer a timely conceptual

frame of reference that may help to place the complexity of dyslexia into a more workable perspective.

Tomatis' concept of dyslexia is broader than that generally accepted. However reference to pre-school and socio-emotional contributing factors is not without precedent according to the literature review.

Thus far no systematic or controlled study has been carried out on the effectiveness of APP training for dyslexia. In view of the heterogeneity of dyslexia, in view of the individualized nature of APP training and the uncertainty as to its effects, the writer proposes to investigate the merits of this program by means of an intensive single case study design.

Given the lack of consensus as to the definition and diagnosis of dyslexia, and given Tomatis' Broad definition and unique diagnostic criteria, the writer proposes that dyslexic children be selected according to the comprehensive operational definition advanced previously and according to APP criteria.

Research has shown the areas of academic achievement and perceptual processing ability to be pertinent to the understanding of dyslexia. If APP training does enhance language-related auditory-vocal behavior, cortical excitation and psychoneurological integration, one might expect changes to occur on a battery of tests of academic achievement and language-related perceptual processing abilities.

Language-related perceptual processing ability could be assessed on the basis of the previously mentioned ITPA. This test provides a battery of twelve subtests designed to tap various stages of auditory-vocal and visual-motor functions, at both automatic and representational levels of functioning. Academic achievement could be evaluated through a test of basic spelling and arithmetic skills, and through tests of reading ability geared to the perceptual decoding level as well as to the conceptual level of word understanding and passage comprehension. Within the intensive single case study design, these tests could be administered at fixed intervals during baseline, intervention and follow-up periods, using a time-series strategy. This might reveal important patterns of change over time. In addition, emphasis could be placed not only on the test results per se but also on the manner in which they were obtained. This, as well as behavioral reports gathered during the research project, might be helpful in discussing the test results and research findings.

It seems logical, in view of the APP program's emphasis on providing the dyslexic child with prerequisite listening and language skills, that gains in language-related perceptual processing should generally occur before gains in academic achievement. Since APP training focuses mainly on audio-phonatory exercises rather than on verbal discourse, it also seems logical that gains in perceptual processing should occur

primarily in auditory-vocal functions, and at the level of automatic sensori-motor habits rather than at the representational or symbolic level. However since APP training purportedly brings about an excitatory and integrative action on many cortical and neurological functions, one might expect some gains in visual-motor processing. Moreover, in view of this apparent integrative effect, it seems reasonable that the post-training profile of language-related perceptual processing abilities should be more evenly balanced than its corresponding pre-training profile.

In terms of academic achievement, given Tomatis' emphasis on developing normal listening, language and academic skills within an educational or re-educational perspective, it seems reasonable that gains on the reading tests might follow a developmental pattern. One might expect initial improvement at the perceptual level of decoding skills and later gains at the conceptual level involving the meaningful understanding of words and phrases. In view of APP training's focus on listening and phonation exercises, gains in spelling should logically occur mainly on words that follow the regular and phonetically accurate sounds of the English language rather than on words requiring knowledge of special rules or individual memorization. It also seems reasonable to expect that reversals of words, letters and numerals should disappear during the course of APP training as it emphasizes clear articulation of words via right-eared self-listening and moni-

toring of speech. The review of the literature suggests that better listening and speech habits as well as more clearly defined laterality may help impose a proper sense of direction on visual symbols in academic skills.

While the proposed approach prohibits the formulation of experimental hypotheses, certain research expectations may be advanced. A general research expectation derived from APP theory and from the review of the literature can be stated as follows: language-related perceptual processing abilities and basic academic skills will improve during an individualized APP remedial training program.

This general expectation can be subdivided into several specific expectations to determine the interdependence between the phases of APP training, perceptual processing abilities and academic skills. These specific research expectations can be formulated as follows:

1. Gains in language-related perceptual processing ability should generally precede gains in academic achievement.
2. Gains in perceptual processing should occur in auditory-vocal functions, and primarily at the level of automatic sensory-motor habits rather than at the representational or symbolic level.
3. Gains in perceptual processing of a visual or visual-motor nature can be expected.
4. The posttraining profile of perceptual processing abilities should be more evenly balanced than the correspond-

ing pretraining profile.

5. Gains in reading should follow a developmental pattern, with initial improvement at the perceptual level of basic decoding skills, and later improvement at the conceptual level involving the meaningful understanding of words and passages.

6. Gains in spelling should occur mainly on words that follow the regular and phonetically accurate sounds of English rather than on words requiring knowledge of special rules or individual memorization.

7. Reversals of letters, words and numerals should disappear during the second phase APP training as it emphasizes auditory-vocal laterality and clear articulation of words.

The next chapter provides a detailed description of the manner in which the research proposal was carried out.

CHAPTER II

EXPERIMENTAL DESIGN

Introduction

This chapter presents the methods and procedures adopted to implement the single case studies proposed in the previous chapter as an initial step to evaluate the effectiveness of Tomatis' APP approach to the remediation of dyslexia. These methods and procedures will be discussed under the following headings: Single Subject Research; Selection of Subjects; Measurement Devices, Research Procedures; and the Presentation and Analysis of the Data.

Single Subject Research

Intensive case studies of dyslexic children, using a time-series strategy, were used to investigate the effects of APP training in terms of perceptual processing abilities and academic skills, as well as the merits of the APP training program. This approach was chosen in view of the heterogeneity of dyslexia as well as in view of the individualized and relatively unknown nature of the APP program.

Historically, single subject research has made important and even pivotal contributions to the field of psychology (Dukes, 1965). Its usage decreased in the forties and fifties when group research and statistical methods were considered more scientific and informative. In recent years however,

ideographic research has increased in popularity and sophistication despite inherent limitations (Sidman, 1960; Gottman, 1973; Hersen and Barlow, 1976; Kratochwill, 1978). The usefulness of the intensive case study in monitoring and evaluating therapeutic interventions has been emphasized by Shapiro (1961, 1966), Chassan (1967), and Bergin and Strupp (1970, 1972).

The acceptability of results and conclusions derived from single subject research depends to a large degree upon the logic behind the investigation itself. A number of situations and requirements can constitute a legitimate rationale for N of 1 studies, some of which are particularly relevant to the present research. In applied research, it seems important to ascertain not only whether a technique works but also who it works for and under what conditions. This applies to psychotherapy research in general (Bergin, 1966) and also to the specific remediation of dyslexia (Johnson, 1978). The case study approach is well suited to answering these questions (Bergin and Strupp, 1972). Furthermore, most therapeutic interventions, including the individualized application of APP training, involve ongoing decisions related to the modification of the intervention on the basis of reports, observations and test data. The single subject design lends itself well to the monitoring and evaluation of such interventions (Gottman, 1973; Hersen and Barlow, 1976). Finally, in evaluating therapeutic or remedial techniques,

process variables may be as important as the outcome itself (Chassan, 1967; Bergin and Strupp, 1972; Torgeson, 1975; Meichenbaum, 1976). Again the single subject design seems appropriate to such an orientation. In the field of psychotherapy, Shapiro (1966) has demonstrated how repeated testing and data gathering throughout treatment can fruitfully relate process to outcome in single subject research. Staats (1975, 1977) has employed a somewhat similar approach in the remediation of dyslexia.

Single subject research is often exploratory and heuristic in nature. Rather than evaluate hypotheses, its aim is to clarify questions, define variables, generate hypotheses or point out directions that may afterwards be pursued more systematically (Dukes, 1965; Lazarus and Davidson, 1971; Shine, 1975). Such an orientation seems indicated in investigating the relatively unknown nature and effects of APP training.

Campbell and Stanley (1966) as well as Kratochwill and Levin (1978) have underlined the advantages of the time-series strategy which uses repeated measures or observations at fixed intervals during baseline, intervention and follow-up phases of an investigation. This strategy allows one to look at the pattern of change over time. This feature is considered important in the present research since the separate phases of APP training may have a differential effect on perceptual processing abilities and academic skills. The time-series strat-

egy is also better suited to deal with possible "evolutionary changes": a child's performance may worsen before it improves as old habits are unlearned before acquiring new ones, a fact anecdotally reported by remedial reading teachers (Gottman, 1973). Within practical limits, measures and observations were gathered at regular intervals during baseline, intervention and follow-up periods of the present research project, as will be described later in this chapter.

Campbell and Stanley (1966) as well as Kratochwill and Levin (1978) also indicate that the acceptability of results from time-series investigations must be judged in terms of important questions of internal and external validity. Of major concern are threats to internal validity coming from such confounding influences as historical events, maturation, changes in testing procedures, poor reliability of measurement devices, multiple treatment interference, and experiment effects such as the Hawthorne effect. The basic question of internal validity is whether the experiment will yield similar results when repeated. Replication is the most desirable way of answering this question. The main concern of external validity is the problem of generalizability of results due to such factors as small samples or restricted selection procedures. These concerns were taken into account in the present investigation.

Selection of Subjects

It was decided to submit a number of children considered

dyslexic to the criteria of a comprehensive definition of dyslexia and also to Tomatis' diagnostic methods. Only those youngsters who fitted all criteria were retained for the present study. This procedure was chosen in view of the lack of consensus among professionals as to the diagnosis and definition of dyslexia, as well as in view of Tomatis' (1972a) broad definition of dyslexia and unique diagnostic criteria.

Eight possible candidates, all male, were evaluated using the composite operational definition of dyslexia proposed in Chapter I. This definition states that dyslexia is a psychological and/or neurological impediment to perceptual and/or communicative behavior which manifests itself in significant discrepancies among specific behaviors or between estimated potential and academic achievement (discrepancy criterion); which is not primarily due to severe mental deficiency, sensory handicaps, brain damage, emotional problems, socio-cultural disadvantage or lack of opportunity to learn (exclusion criterion); and which requires remedial procedures over and above the teaching offered in a regular classroom setting (special education criterion). All eight boys were also assessed by Dr. Tomatis according to APP criteria. This involved a listening test, an assessment of auditory-vocal laterality, and a structured interview. Of the eight possible candidates five proved acceptable according to all criteria.

The Discrepancy Criterion

The discrepancy criterion was calculated according to Myklebust's (1968) Learning Quotient method. This approach was presented in Chapter I as a more sensitive indicator of the true discrepancy between achievement and expectancy.

The Myklebust formula may be stated as follows:

$$\text{Learning Quotient} = \frac{\text{Achievement Age}}{\text{Expectancy Age}}$$

where

$$\text{Expectancy Age} = \frac{\text{Mental Age} + \text{Life Age} + \text{Grade Age}}{3}$$

Achievement age was arrived at by first averaging the combined grade scores from the subtests of the Wide Range Achievement Test (WRAT) (Jastak and Jastak, 1965) and the Gates-MacGinitie Reading Tests (Gates and MacGinitie, 1965). Overall Achievement was thus derived from three measures of reading at different levels, one measure of spelling and one measure of arithmetic ability: this was recommended in Chapter I rather than the use of a single measure of reading performance. The resulting achievement grade rating was then converted into an achievement age rating on the basis of an Ottawa Separate School System (1967) conversion table. This table is reproduced in Appendix B: it presents the mean age/grade by year and month of children in that school system. The WRAT and Gates-MacGinitie Reading Tests will be described in greater detail in a later section since they were also used for ongoing evaluation of APP training.

Expectancy Age reflects Myklebust's position that a child's learning potential involves the combined results of intellectual ability, physiological maturity and learning opportunity. Mental Age was calculated on the basis of the higher of the Verbal or Performance IQ from the Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). This procedure is deemed more equitable since dyslexics are often significantly impaired in intellectual skills, and especially so in verbal skills. The chosen intelligence quotient is converted into Mental Age (MA) using the formula

$$\text{MA} = \frac{\text{IQ} \times \text{CA}}{100}$$

where CA stands for chronological age in months. Life Age, or chronological age, is incorporated because it reflects physiological maturity. Grade Age provides a quantitative index of the child's experience in terms of school learning opportunity.

Once the overall formula has been calculated, Myklebust suggests that a Learning Quotient below 90 be considered an indication of a learning disability.

Of the five children retained for the research project, two had a significantly large depression in their Verbal IQ rating, hence the Myklebust Learning Quotient seemed particularly appropriate in their case.

The WISC-R. This test is considered the instrument of choice for determining a dyslexic child's intellectual skills because it provides both verbal and non-verbal IQ ratings as

well as a helpful profile of differential intellectual abilities. Certain subtest patterns have been linked to perceptual-cognitive deficits in dyslexic children (Heulsman, 1970).

The revised form of the WISC has been improved considerably over its predecessor through replacement or updating of test items, through improved administration procedures that establish the proper mental set for each subtest, and through quicker test giving approaches (Wechsler, 1974). The standardization, reliability and validity data of this well-known test are acceptable.

The Pupil Rating Scale. The results of the Pupil Rating Scale (PRS) (Myklebust, 1971) were also employed in applying the discrepancy criterion because it takes into account factors other than academic achievement. The PRS is a five-point rating scale designed to provide evaluations of five independent categories of classroom behavior: Auditory Comprehension, Spoken Language, Motor Coordination, Orientation to Time and Space, and Personal-Social Behavior.

As to the validity of the PRS, Myklebust stresses that the scale was designed as a quick, economical and effective screening device, and not for diagnosis of individual problem areas. He maintains that significantly low scores on the PRS should be followed up by more in-depth assessments. Myklebust found, by process of discriminant analysis, that teacher ratings on the PRS were more effective in discriminating between groups of normal and learning-disabled children than 48 out

of 49 other test variables employed (1971, p. 14-15). Bryan and McGrady (1972) factor analyzed the PRS and found evidence for four of the five proposed independent categories of behavior. In a second part of their study, they found the PRS as a whole to be an economical and efficient screening device for learning disabilities in general. They added that a low rating on the Auditory Comprehension category may be particularly valuable in detecting a specific language or specific reading disability. Proger (1973) as well as Reeves and Perkins (1976) were favorably impressed with the PRS when used, as intended, as a quick and meaningful screening device.

Reliability studies are mentioned but not specified in the PRS manual. This weakness has been underlined by Proger (1973). Forness and Esveldt (1975), using another rating scale to evaluate learning-disabled children's classroom behavior on five different categories, found interobserver reliabilities ranging from .87 to .97 during a reading period, and from .86 to .93 during a mathematics period. Bryan and Wheeler (1972), in another study of teachers' systematic observation of learning-disabled children, found 80% agreement amongst two raters. While these studies may not be directly comparable to the PRS, they do suggest that teachers are consistent in their rating of student behaviors.

The PRS rating scale was completed on all of the children proposed for this study. The ratings were done by three teachers and staff members closely involved with the children

on an everyday basis. The scale for each child was completed by mutual agreement of the three raters in an effort to obtain more accurate results. This procedure forced the raters to weigh their response options carefully.

Myklebust offers no specific cut-off scores in the PRS manual. The writer chose a cut-off score of 70 to select the dyslexic subjects. This figure approximates the mid-point between the mean total score for learning-disabled groups in grades 3 and 4 as described in the manual, and the mean total score for the control groups (Myklebust, 1971, p. 34). A score of 69 or less indicates potential learning problems.

Of the eight original candidates, one child was eliminated from the study because he failed to meet the discrepancy criterion as defined by the Learning Quotient formula.

The Exclusion Criterion

All eight original candidates had attended classes at the University of Ottawa's Child Study Centre for a minimum of six months to over two years. Their adjustment difficulties and testpsychological characteristics were well documented. A carefully detailed developmental history, including academic and socio-familial background, was available on each child. From such information, one could check out the possibility of major sensory handicaps, emotional problems of primary nature, cultural disadvantage or lack of opportunity to learn. On the basis of these criteria, a second child was excluded from the research project because of emotional problems that most likely

antedated his academic difficulties.

All eight original candidates were given a battery of neuropsychological tests. The results, along with developmental histories and other psychological test data, were reviewed by Dr. Ronald Trites, Director of the Royal Ottawa Hospital's Neuropsychology Laboratory. On the basis of Dr. Trites' analysis, a third child was excluded from the project because of suspected left hemisphere damage.

Special Education Criterion

The developmental histories and daily experience with the children at the Child Study Centre clearly indicated that all eight had been unable to learn and read up to expectancy despite considerable exposure to regular classroom procedures. In some cases, remedial tutoring had been undertaken with little noticeable gain.

In short, after applying the three criteria from the composite operational definition of dyslexia, three of the eight boys had been eliminated from the project.

Dr. Tomatis himself assessed each of the eight initial candidates according to his three criteria: 1) the Tomatis Listening Test, 2) Audiolaterometry and 3) a personal interview technique. These criteria will be discussed in detail because of their unfamiliar and original nature.

The Tomatis Listening Test (TLT)

The TLT constitutes the most important of Tomatis' diag-

nostic procedures. A brief and modified form of hearing test, it can be administered with a standard audiometer although an instrument specifically devised for this purpose is now available. The TLT evaluates the adaptive perceptual dimension called listening rather than the passive sensory experience called hearing.

Using an audiometer as a generator of pure sounds, certain aspects of a subject's audition are assessed for each ear, by way of air conduction as sounds are sent via earphones to the external ear, and by way of bone conduction as sounds are transmitted through a vibrator placed on the mastoid bone behind the external ear. For the air conduction test, pure tones are given octave by octave from 8000 Hertz (Hz) down to 125 Hz, by way of 6000, 4000, 3000, 2000, 1500, 1000, 750, 500 and 250 Hz. At each frequency level, the intensity can be varied by five decibels (db) from the faintest -20 db to the loudest 100 db. For the bone conduction test, pure tones are given only from 4000 Hz down to 250 Hz, and very loud sounds cannot be given on the lower frequency levels.

Using an audiometer as described, the TLT is conducted in a manner to provide an evaluation of listening thresholds, an evaluation of auditory spatialization and an evaluation of auditory selectivity.

Threshold evaluation. Starting with the right ear in air conduction at 8000 Hz, the subject is asked to lift his hand as soon as he hears the faintest sound. Pure sounds

are sent in a single direction only, from the faintest -20 db upward, increasing intensity by 5 db at a time, until the subject clearly indicates that the sound has been perceived. Once this minimal threshold has been established, testing is immediately discontinued at that frequency. The same procedure is followed at the next lowest frequency level, 6000 Hz, and so on downward to 125 Hz. Again, only the subject's earliest perceptual readiness to acknowledge sound at each level is sought out and recorded. The same procedure is followed in testing the left ear in air conduction from 8000 Hz down to 125 Hz. Afterwards, similar threshold evaluations are carried out in bone conduction for each ear from 4000 to 250 Hz. The results of this evaluation are presented on an audiometric grid that shows air conduction thresholds in solid lines and bone conduction thresholds in dotted lines. The right ear results are presented first to the left of the grid, and the left ear results are charted on the right hand side. This is shown in Figure 3 which illustrates an optimal TLT profile. The frequencies are presented horizontally or in abscissa from 125 to 8000 Hz, while intensity is presented vertically or in ordinate from -20 to 100 db.

According to Tomatis, years of research have revealed that ideal listening habits or dispositions should yield gradually ascending air conduction curves with a slope of 6 to 18 db/octave from 500 Hz up, peaking at 3000 or 4000 Hz. The bone conduction curves should follow the same profile, but

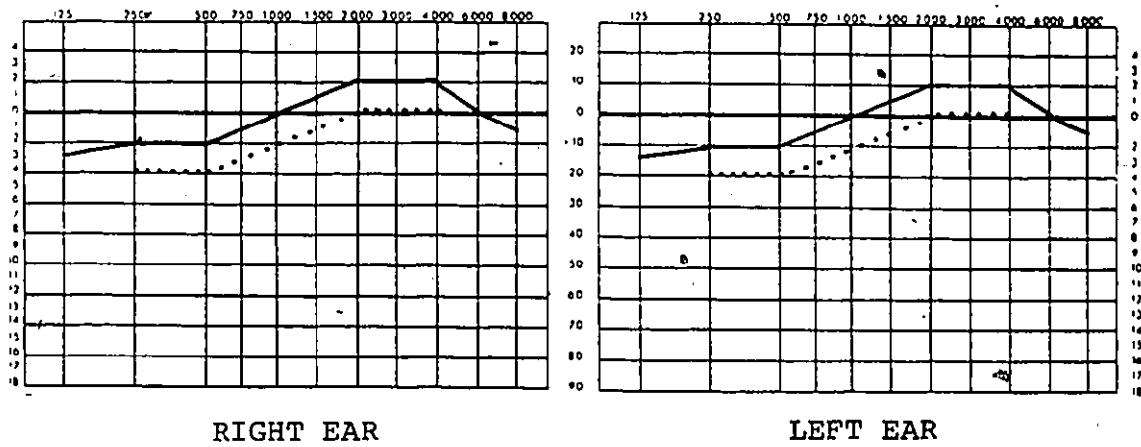


Figure 3. The ideal listening curve.

should rest below the air curves by 5 or 10 decibels, as illustrated in Figure 3. This is the "musical ear" curve referred to in the previous chapter. The ascending slope is said to allow a person to perceive and appreciate sounds with effortless discrimination and to favor accurate and easy vocal expression. Furthermore, the heightened sensitivity to the upper-range frequencies is said to provide greater cortical energy and tonus.

Tomatis indicates that a person can adopt one or more non-listening dispositions such as lowering of the listening threshold in total or in part. He maintains that up to 30 db are normally under one's voluntary control. A non-listening disposition as indicated by a lowering of thresholds, if maintained over time, can become habitual. For example, a child may lower thresholds throughout the entire frequency range, as illustrated in Figure 4a. This represents an essentially non-accomodating listening posture, keeping sounds at a distance so to speak.

Dyslexic children frequently show a lowering of thresholds in the middle range and speech-related frequencies, from 500 or 1000 up to 3000 Hz. Tomatis maintains that this reflects an habitual "tuning out" of sounds vital to human dialogue and social interaction, which may be a consequence of painful encounters or imitations of others with ineffective listening curves. This mid-range dip is illustrated in Figure 4b. It may occur on one or both ears although a right

ear dip is said to be more significant. A mid-range dip may appear on air conduction, bone conduction or both. When bone conduction alone registers the dip, the child is said to be compensating or fighting his dyslexia. When the dip has settled into both air and bone conduction curves, the child is said to have given into his dyslexia.

A gradual ascendance of a listening profile is desirable. Dyslexic children often reveal a high but flat threshold as illustrated in Figure 4c. Such a profile is said to indicate undifferentiated listening ability, or yet another non-accommodating posture. The sensitivity to the lower frequencies which are made up of long sound waves is said to mask or drown out discrimination of shorter wavelength sounds that are higher on the frequency scale and more pertinent to speech and energizing potential. Tomatis adds that the lower frequencies are discharge frequencies: they strike the body and rob the organism of its energy rather than stimulate it. Hence a child with a flat TLT profile tends to tire easily as well as experience auditory discrimination problems.

The parallelism of air and bone conduction curves, with the latter slightly below the former, is considered normal and desirable. Dyslexic children however may present with a partial reversal or non-parallelism of curves, the bone curve being above the air curve in the lower frequency range, as illustrated in Figure 5a. This profile is said to reflect bodily tension that fatigues the child and encroaches upon

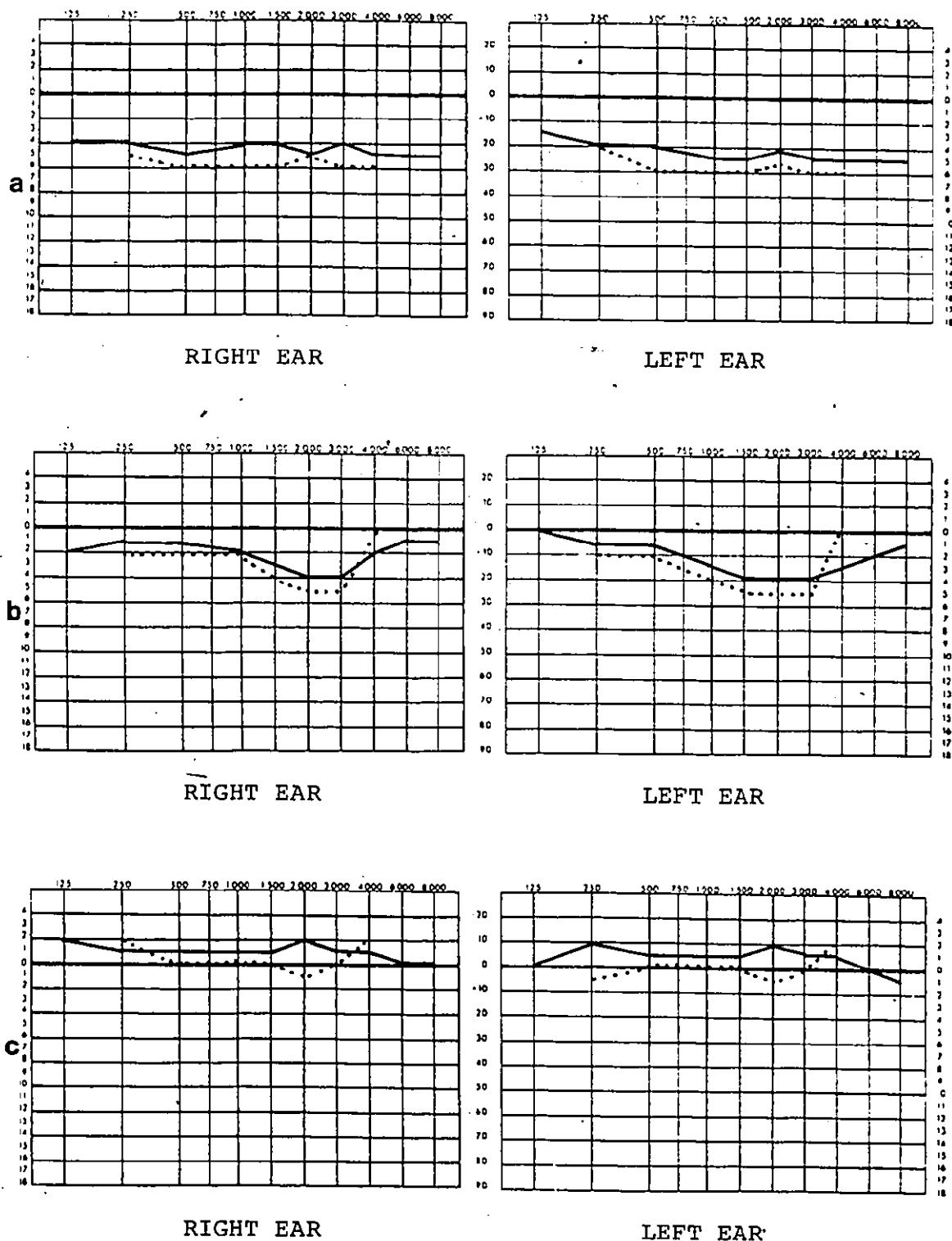


Figure 4. Various non-listening attitudes.
 a. Lowered thresholds.
 b. Mid-range dip.
 c. High flat thresholds.

the ability to attend or concentrate. Dyslexic children may also present with a discontinuous "sawtooth" profile on the TLT (Figure 5b). Sharp spikes and crossovers on the air and bone curves indicate oversensitivity and overreactivity to some sounds with a distorted perception of others, much as an astigmatism distorts vision. Such a profile is not unusual with dyslexic children who have become very touchy and display behavior problems.

Similarity of right and left ear curves on the TLT is also normal and desirable. With dyslexic children, one may find an asymmetry of right and left ear listening curves, as shown in Figure 5c. This is said to reflect strain because both ears do not work conjointly to integrate information and responses. Tomatis has noticed that asymmetrical curves in the middle-frequency range are often accompanied by problems in fine motor coordination. The more the asymmetry affects the lower frequency range, the greater the likelihood of finding problems in gross motor functions.

Auditory spatialization. This refers to the ability to localize one's self in space on the basis of auditory cues. During the threshold evaluation procedures for bone conduction, the subject is not only asked to lift his hand as soon as a sound is first perceived, but also to lift the right or left hand in accordance with the side on which the sound is perceived. The subject is asked to lift both hands if a sound is perceived on both sides simultaneously or perceived without

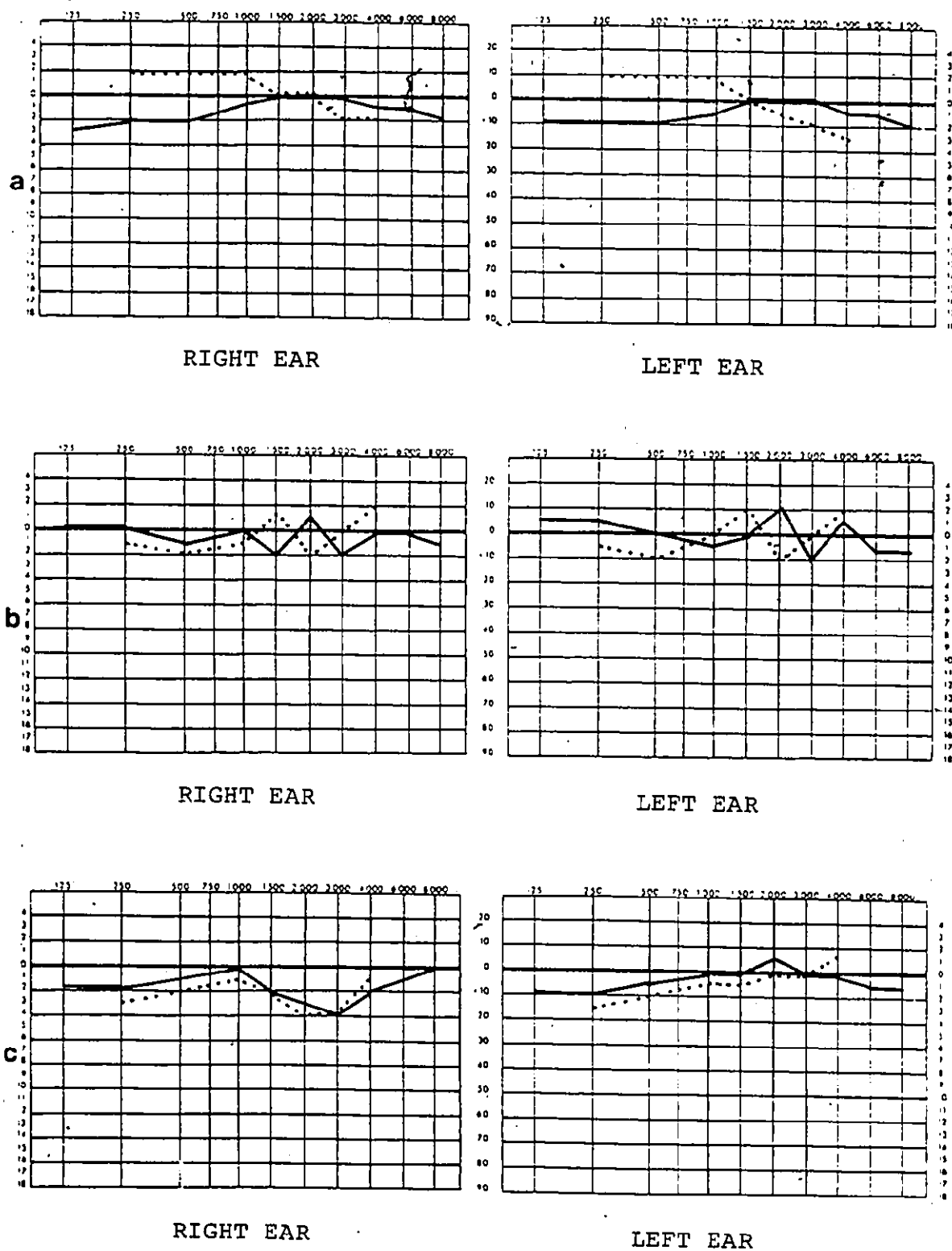


Figure 5. Additional non-listening attitudes.
 a. Non-parallelism of listening curves.
 b. Discontinuous "sawtooth" listening profile.
 c. Assymetry of listening curves.

clear localization. Inversions or confusions are noted on the TLT grid at the frequencies where they occurred, as shown on Figure 6. Ideally no spatialization errors should occur. However Tomatis indicates that dyslexic children manifest a surprising degree of confusion in this area, particularly in the speech-related frequencies. They frequently do not perceive sounds directed to the right or left ear as emanating from any specific direction, or they may perceive them as coming from the opposite direction. Behaviorally, spatialization errors can manifest themselves in momentary hesitations when reacting to sounds or requests, or in awkward body movements. Academically, such errors are believed to be related to inversions and reversals of letters and words, and also to problems in mathematical understanding.

Auditory selectivity. In another simple yet important procedure, via air conduction only and at a comfortably experienced intensity of forty to sixty decibels, a subject is presented with pure tones in a quick sweeping succession from 8000 down to 125 Hz. This is done for the right ear first and then for the left ear. The subject must indicate if a sound is higher, lower or the same as the preceeding one. The critical factor here is not one of simply perceiving differences between sounds but of being able to indicate correctly the direction of the difference by using one's experience and perceptual acuity as a reference point. In APP, this quick test is said to be a powerful indicator of

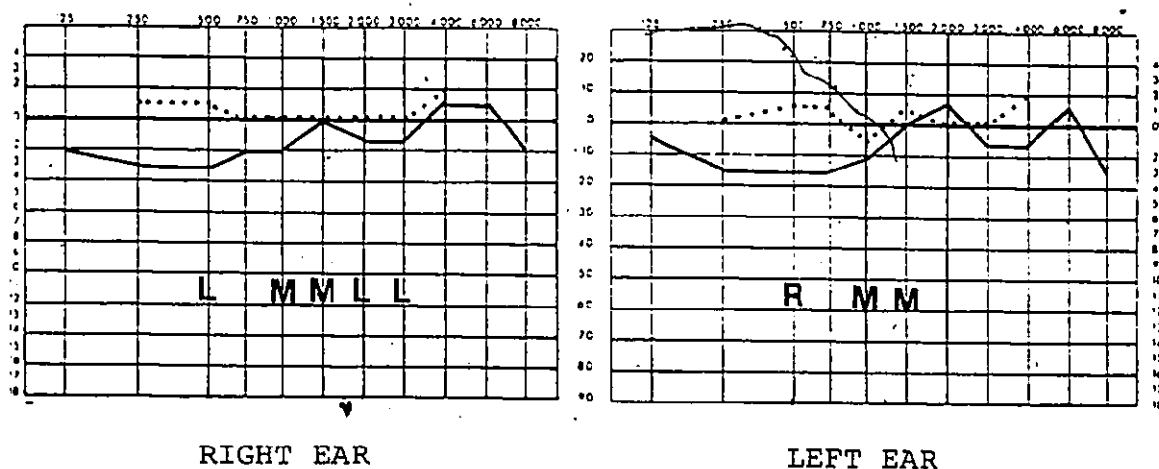


Figure 6. Spatialization difficulties.

dynamic auditory discrimination, that is of the degree of one's involvement in the analysis of sounds and all that they represent.

Figure 7 depicts partially closed selectivity on the TLT. Since the stimulus sounds are always given in a downward sweep, responses indicating "higher" or "same" are incorrect: these errors are indicated by an oblique dash on top of the grid at the frequency level that was mistakenly analyzed. Any frequencies above the lowest error are considered "closed" to selective analysis, whether answered correctly or not in the selectivity procedures, since lower frequencies tend to mask the higher ones. This is indicated by drawing hash marks across those closed frequencies as illustrated.

The ability to selectively analyze sounds is said to unfold along developmental lines from the lowest frequencies up so that by nine or ten years of age ideally, a child's selectivity should be fully open. According to Tomatis however, a number of conditions may prevent the proper unfolding of selectivity, e.g. emotional problems, lack of stimulation, insecurity, painful verbal exchange with significant adults, and ear infections; in short, any condition that leads a child to avoid using audition in an analytical way. With dyslexic children, it is not uncommon to find a total or near total closure of selectivity. Although they may hear adequately, they cannot listen because they have no clear audi-

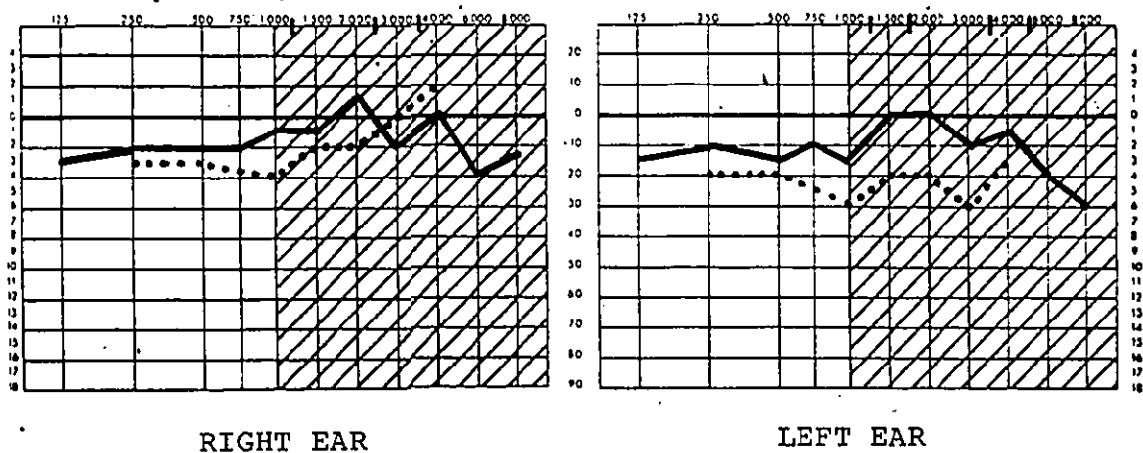


Figure 7. Partially closed selectivity.

tory references to appreciate or reproduce sounds accurately. With closed selectivity, the voice is generally low with a lack of harmonics above 1000 Hz, and one may note difficulty dealing with phonetically similar sounds such as "m" and "n", "p" and "b". Some dyslexics have closed selectivity only in the higher frequency range from 3000 Hz up: they cannot effectively appreciate the energizing sounds, and are said to have difficulty sustaining concentration.

Audiolaterometry (ALM)

In the domain of lateral preferences, Tomatis seeks to determine if the right "leading ear" or the left ear is dominant in the control of speech. Tomatis (1963) maintains that because of its shorter neural interconnections with cortical speech centres and with the larynx, the right "leading ear" has a clear advantage in self-listening or in self-monitoring of one's speech. When the right ear assumes its leading role, speech flow is said to be generally smooth, coming from the front of the mouth with clearer articulation. The voice is evenly paced as well as rich in timbre and intonation. Furthermore the facial expression is then described as harmonious and animated. Finally movements of hand and eye are reported to be synchronized with speech emphases while the rest of the body assumes a relaxed upright posture subservient to vocal expression. When the left ear is dominant in the control of speech, longer neuronal circuits are held to come into play, thereby causing time delay and inefficiency.

Speech flow is said to become hesitant or broken, emanating from the back of the mouth, with poor articulation or enunciation. The voice is described as flat and monotonous. The facial expression is said to be frequently blank or tensed up. Gestures and movements accompanying speech are said to be less coordinated, or the whole body may be too rigid or slumped to participate in vocal self-expression.

Tomatis has developed an instrument called the audio-laterometer as an aid in assessing the relative degree of left or right-ear laterality in the monitoring and control of speech. This instrument is used with a two-channel amplifier, a microphone and a set of earphones in such a way that the intensity of a subject's voice as fed back via the earphones can be increased or decreased without affecting the intensity in the other ear. Using established procedures, and starting with a balanced feedback of fifty decibels to both ears, the intensity of the left-ear feedback is augmented or diminished five or ten decibels at a time until the right "leading ear" dominance is clearly gained or lost as evidenced by the aforementioned auditory or visual correlates. A detailed explanation of procedures for conducting the ALM test and recording its results can be found in Appendix C, along with illustrations of the instrument itself and its proper montage.

The ALM test was designed by Tomatis to assess auditory laterality and self-listening as the subject is actively en-

gaged in speech. Tomatis cautions that while a subject may be right dominant in listening ability, he may nevertheless be left dominant in the active regulation of speech. The proper administration of the ALM requires much observational skill and practice on the part of the examiner.

According to Tomatis, dyslexic children frequently reveal left-eared control of speech on the ALM. They generally do not listen to themselves properly, and their speech is often as broken and hesitant as their reading.

The Personal Interview

Tomatis also uses a semi-structured interview to assist in the diagnosis of dyslexia. It consists of three phases all aimed at assessing the behavioral and relational attitudes of the child in his social milieu.

In a first phase, the child is received in a room along with his parents or a few peers. The interviewer will initiate a conversation with the parents or peers while observing the child's attitude towards these exchanges. Does the child participate, act indifferent or draw back, or again does the child follow the conversation easily or does his attention falter or wander? Typically, according to Tomatis, the dyslexic child, because of deficient listening skills, is unable to stay with or make sense out of such encounters.

In a second phase of the interview, the child is seated directly in front of the interviewer who asks leading questions to engage the child in conversation. The child's pos-

ture, listening and language skills are noted. A normal child can pay attention to the questions, generally turning the right ear slightly towards the interviewer, mobilizing the muscles of the right side of the face and slackening the jaw. According to Tomatis (1972a), the body generally remains stationary in a receptive posture, possibly with a slight movement of the right hand in the area of the thumb and index finger, or perhaps with slight lip movements in concert with the speaker's articulations. The dyslexic child, under similar conditions, may turn one ear then the other towards the interviewer. His face may be lifeless and dull, or tense with a contracted jaw. The body may be restless and show surplus uncoordinated movements in the upper and lower limbs. These signs are said to reflect the dyslexic child's inability to assume an effective listening posture or to master his bodily instrument for purpose of dialogue.

In answering the interviewer's questions, the normal child is said to use his body in a coordinated, attentive and efficient way. Verbal flow is rapid, fluid, lively, well timbered and well articulated. Thoughts are expressed clearly and confidently without straying from the topic at hand. The dyslexic child however is said to show a variety of symptoms of inefficient listening and language skills, many of which are associated with left-eared control of speech as previously described. In addition, the body as a whole may be lifeless, or again restless with synkinesias of upper and lower limbs

giving evidence of loss of energy through motoric overflow. The dyslexic child is said to become more exhausted with each response, soon lacking energy to make sense out of the questions or to organize answers. He is soon left with little to say, and what statements he does put forward become increasingly confused and imprecise.

The third phase of the personal interview focusses on the child's ability to relate to himself and to others in close social encounters. The interviewer asks the child to point to an ear, an eye and to the mouth, on himself first and then on the interviewer. The normal child, who listens and speaks correctly and is fairly comfortable in relating to others, will generally use his right index finger to point out the right-sided bodily parts on himself and on the interviewer. The dyslexic child, often ill at ease with himself and others, may become tense and confused, perhaps pointing out left-sided bodily parts with either hand. Finally, on a simple task called "auto-information", the child is asked to pretend that he is holding a microphone in his right hand and to verbalize some pertinent information about himself, such as name and address, into the microphone. In using the right hand in this way, the normal child's voice is said to become warm, animated and well timbered. However this phenomenon apparently disappears when the left hand is used as a microphone. Tomatis attributes this phenomenon to cutaneous sensitivities that affect the left parietal cortex. It is

said to exist in every child in varying degree although in cases of severe dyslexia, such right-handed auto-information may be non-existent. In addition, Tomatis notes that many dyslexics have to search for their name and address when asked to do this little exercise.

The TLT, ALM and personal interview are procedures developed by Tomatis over the years in diagnosing and treating listening and language problems. Although they have not been scientifically validated in any controlled fashion, they have been refined in everyday clinical practice. On the basis of these criteria, Tomatis found all eight of the original candidates to be dyslexic in varying degrees. This suggests that his definition of dyslexia may indeed be broader than those generally entertained. As to the five candidates that met the criteria of the composite operational definition of dyslexia, Tomatis described one as a mild case of dyslexia according to APP criteria, three as moderate to severe cases and one as a severe case.

Results of Selection Procedures

Having applied Tomatis' diagnostic criteria and those from the composite definition of dyslexia, five of the eight original candidates were retained for the present study. The diagnostic findings and background information specific to each youngster chosen will be presented in detail in the next chapter. The ages of these boys ranged from seven years and eight months to nine years and three months. All five

came from English speaking caucasian families. All were natural children except one, a negro lad, adopted by his family as a baby. The socio-economic status of these families ranged from average to privileged. Using Blishen's Socio-Economic Index for Occupations in Canada, four of the families were placed in the first or highest socio-economic class, while the other family was placed in the third of seven possible classes (Blishen, 1967, p. 44-45).

Measurement Devices

As mentioned in the previous chapter, the effects of Tomatis' APP training program on the academic skills and perceptual processing abilities will be investigated. The psychometric tools used towards this end are described in the following sections.

Academic Achievement Tests

Reading was evaluated by more than one test and at different levels of difficulty. Other basic skills such as spelling and arithmetic were also assessed at regular intervals throughout the research project. For these purposes, two psychometric instruments were used: the Wide Range Achievement Test (WRAT) (Jastak and Jastak, 1965) and the Gates-MacGinitie Reading Tests (Gates and MacGinitie, 1965).

The Wide Range Achievement Test (WRAT). This test has often been employed in research for the quick and effective measurement of basic reading, spelling and arithmetic skills.

The first level of the test is suitable for children from five to twelve years of age. The oral reading subtest, essentially one of single word recognition, yields valuable clues as to word attack skills. The written spelling subtest can provide evidence of omissions, reversals, sequencing confusions and psychomotor problems. The arithmetic subtest is helpful in bringing out problems of attention and concentration in addition to those of mathematical understanding and computation. Results from the WRAT can be described in terms of grade levels, standard scores or percentile ranks.

The normative population used in the standardization of the revised WRAT was selected from schools of various socio-economic levels throughout several states in the U.S.A. This population was split into nineteen age levels from five years of age to adulthood, with both sexes equally represented at each level. The test's authors report split-half reliability coefficients ranging from .92 to .98 for the reading and spelling subtests, and from .85 to .92 for arithmetic. Validity studies have been approached through correlation of WRAT results with academic performance, through correlation with other achievement or mental ability tests, and through factor analysis to determine the factor loading in each subtest. The results of these validity studies seem acceptable and are reported in the WRAT manual (Jastak and Jastak, 1965).

The WRAT was chosen for this research project because of its brevity and because of the clinical material it can provide. In addition, Woodward et al. (1975) investigated the test-retest reliability and consistency over time of Level I of the WRAT (for ages five to twelve) and for two time intervals, two weeks and twenty-two weeks. The study involved over one hundred Canadian elementary school children with emotional and learning problems, as often seen in a clinic. The WRAT was demonstrated to be a remarkably consistent and stable measure of academic achievement. At two-week intervals, test-retest reliabilities ranged from .88 to .98 for the three subtests, and at twenty-two week intervals, from .87 to .96. This suggests that this single-form test may be readministered repeatedly within a time-series research design with little practice effect. The strongest limitation of the WRAT is that the reading subtest does not do justice to the complexity of reading process and may overestimate true reading ability.

The Gates-MacGinitie Reading Tests. These tests provide an estimate of higher level reading skills such as word understanding (Vocabulary), passage understanding (Comprehension), and rapidity of extracting information from written passages (Speed and Accuracy). For grades one to three, two parallel forms of each subtest are offered, and for grades four to twelve, three parallel forms of each subtest are available. The Speed and Accuracy subtest however is not offered for grades one and two, and is optional at grade

three. Results from the Gates-MacGinitie Reading Tests can be converted to grade scores, standard scores and percentiles.

The normative population used for standardizing these reading tests is large and suitably representative as to geographical location, educational level and family income. The mean reliability ratings for the tests used in this project (Primary A, B, C, CS and Survey D, covering grades one to six) is .82; split-half reliability ranges from .85 to .99; and alternate-form reliability ranges from a low of .67 for the Speed and Accuracy subtest of Survey D to a high of .89 for the Comprehension subtest of Survey D (Gates and MacGinitie, 1972). The authors discuss validity in terms of content validity, and suggest that examiners judge for themselves if these tests are suitable for their purposes. In one study, Davis (1968) found strong concurrent validity coefficients for the correlation of Primary C at grade three and Survey D at grade five with four other standardized reading tests: the median coefficients were .84 for Primary C Vocabulary, .79 for Primary C Comprehension, .78 for Survey D Vocabulary, and .80 for Survey D Comprehension. The validity and reliability data on the Gates-MacGinitie Reading Tests seemed acceptable for the present research project.

The Gates-MacGinitie Tests were chosen for this research project because they provide measures at a higher and more conceptual level of the reading process. In addition, the subtests are long enough in themselves to be used reliably.

rather than to have to depend on the total test score alone as is often the case with many of the most frequently used reading achievement tests (Farr and Anastasiow, 1969). Finally, the alternate forms of the subtests proved useful in a research design that called for repeated testing.

Tests of Perceptual Processing Ability

As indicated in the previous chapter, perceptual processing deficits have been associated in important ways to dyslexia. Selected tests of perceptual processing abilities, especially those related to language, memory and attention, might reveal changes during or even after APP training of dyslexic children. Several investigators have called for greater refinement in the evaluation of such perceptual processing skills. A major step in this direction has been taken, according to Torgeson (1975), by Kirk et al. (1968, 1971) in their revision of the Illinois Test of Psycholinguistic Abilities (ITPA). This test was chosen to assess perceptual processing functions in this research project.

It should be noted that the term "psycholinguistic" as used in the ITPA title is employed in a broad sense inasmuch as all twelve ITPA subtests reflect some aspects of communicative transactions. Only about half of these subtests clearly involve English language functions. Carroll (1972), in his extensive review of the ITPA, states that it taps cognitive skills. Chase (1972), in his review, prefers to describe it as a test of language, perception and short-term

memory. In view of the fact that perceptual processing, as described by Cruikshank (1978) in the previous chapter, encompasses various perceptual, cognitive, memory and language functions, the writer felt justified in employing the ITPA to assess perceptual processing abilities.

The ITPA. This test was designed primarily for use with children encountering learning problems. In its revised (1968) form, it contains twelve subtests purporting to measure discrete functions related to learning and to practical life situations. The battery was designed to highlight intra-individual rather than interindividual differences, and to provide a profile of a child's relative strengths and weaknesses in the twelve functions evaluated. The ITPA was also designed to assess the effectiveness of remedial programs. Scores on the twelve subtests can be converted into age norms or scaled scores, from two years and four months up to ten years and three months of age. The scaled scores are particularly helpful in determining if postintervention gains are above and beyond normal maturational growth.

The three theoretical dimensions of the ITPA will first be explained, followed by a brief description of the twelve subtests. Questions of reliability and validity will be considered afterwards.

The clinical model of the ITPA. Kirk and his colleagues modified Osgood's (1957) model of the communication process and proposed that a person's communication with the environ-

ment and with other individuals can be considered in terms of three dimensions of perceptual-cognitive abilities: channels of communication, psycholinguistic processes, and levels of organization of communicative habits. These dimensions provide a conceptual framework for the ITPA and its subtests, as illustrated in Figure 8.

Channels of communication refer to the sensori-motor modalities through which communication flows from initial sense impressions, subsequent perceptual-cognitive deciphering and organization, and eventual forms of expression through which a response is made. Many communication channels are possible, such as auditory-vocal, visual-tactile, auditory-motor and tactile-verbal. Because of practical limitations, the ITPA incorporates only those two channels that were deemed the most educationally relevant: the auditory-vocal channel, dealing with sense impressions received by the ear and with responses expressed verbally, and the visual-motor channel, dealing with sense impressions received by the eye and with responses expressed by gesture or movement.

The second dimension of psycholinguistic processes postulates three processes in the handling of information: the receptive process which refers to the ability to recognize or understand what is seen or heard; the organizing or associative process which involves the internal manipulation of percepts, concepts, linguistic symbols and mediational activities to elicit relationships between what has been seen

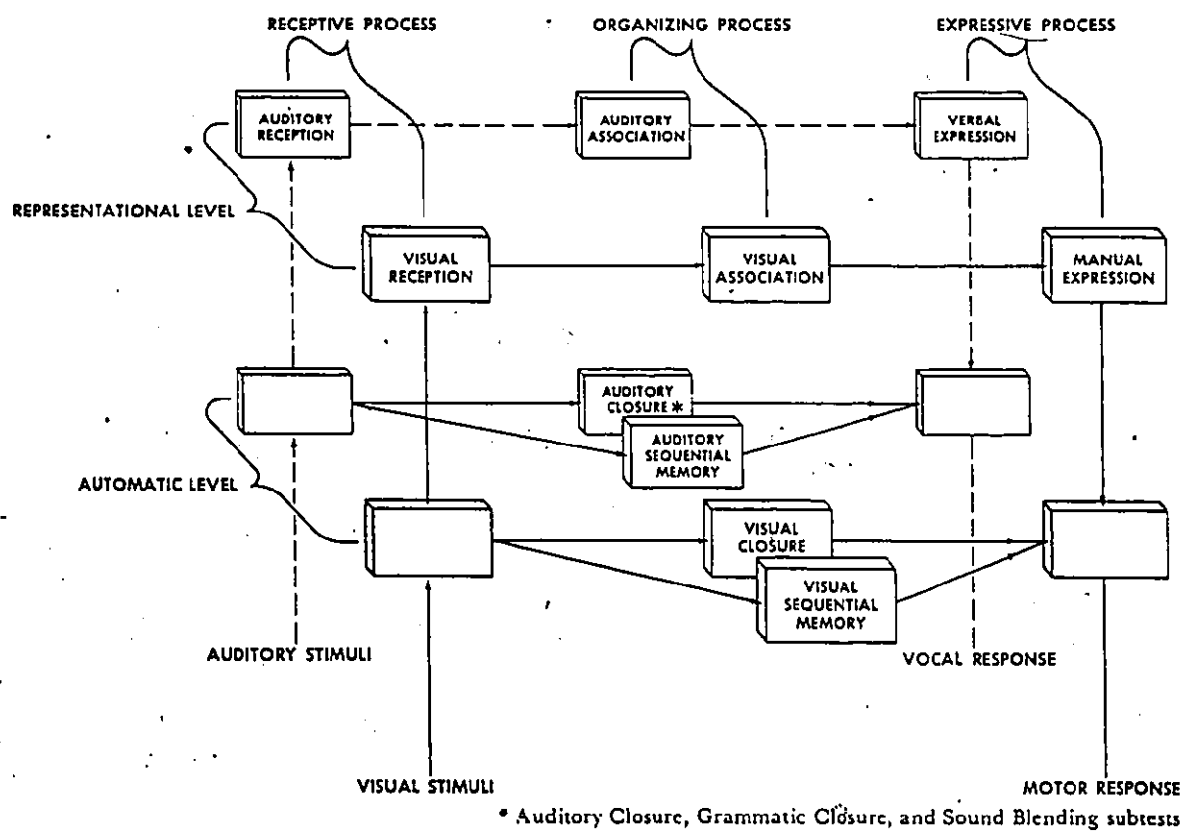


Figure 8. Clinical model of the ITPA.

or heard and past experience; and the expressive process which refers to the ability to express ideas or meaning either vocally or by gesture or by movement.

As to the third dimension, that of levels of organization, the ITPA model postulates two levels of communicative habits: a representational level, which involves behaviors requiring complex mediational processes or responses dependent upon the utilization of meaning and symbols; and an automatic level involving responses that reflect organized and integrated habit chains.

The ITPA subtests. Carefully detailed descriptions of each subtest can be found in the ITPA examiner's manual (Kirk et al., 1968) and technical manual (Paraskevopoulos and Kirk, 1969). Only the most basic features of each subtest are presented below.

Starting at the representational level and with the receptive process, two subtests assess a child's ability to comprehend visual and auditory symbols. Auditory Reception assesses the ability to derive meaning from short verbally presented questions. Since the receptive rather than the expressive process is being evaluated, the expected response is kept at the level of a simple "yes" or "no". Visual Reception measures the ability to gain meaning from visual symbols as presented on black and white pictures.

At the representational level, and with the organizing process, Auditory Association taps the child's ability to

relate concepts presented orally. This is accomplished through verbal analogies of increasing difficulty yet simple vocabulary. Visual Association taps the ability to relate visually presented concepts in a meaningful way while minimizing the requirements of the receptive and expressive processes. This is accomplished through a picture association test using simple black and white stimulus pictures and requiring a simple gestural reply to optional response pictures.

At the representational level, and with the expressive process, Verbal Expression, assesses a child's ability to express his own concepts vocally. The child is asked to verbally comment and elaborate upon four familiar stimulus objects presented one at a time. Manual Expression assesses the ability to express ideas manually. This is done through a gestural manipulation task: fifteen pictures of common objects are shown one at a time with the request, "Show me what we do with this". The child must pantomime, not verbalize, the appropriate action or actions.

At the automatic level, only functions dealing with the organizing process are evaluated. Two types of auditory and visual abilities are assessed at this level: closure and short-term sequential memory. Closure is the ability to recognize a unit of experience when only part of it is presented, or the ability to synthesize isolated parts into a whole. The more commonly known sequential memory functions

have generally been tapped by the WISC-R Digit Span and Coding subtests.

Grammatical Closure evaluates the child's ability to employ the redundancies of standard North-American oral English in acquiring spontaneous habits for handling syntax and grammatical inflexions. Auditory Closure taps the ability to recognize and reproduce a word by filling in parts which were omitted in its oral presentation. Sound Blending measures the ability to synthesize two or more isolated sounds into a whole. The component sounds of a word or nonsense word are spoken singly at half-second intervals, and the child is asked to identify the word. Visual Closure assesses the ability to correctly identify a common object from its incomplete visual presentation: Perceptual speed is emphasized through the use of a time limit.

Auditory Sequential Memory evaluates the ability to reproduce from recall, immediately after oral presentation by the examiner, sequences of digits of increasing length. Visual Sequential Memory assesses the ability to reproduce from memory, immediately after visual demonstration, sequences of increasing length of non-meaningful visual figures.

Standardization, reliability and validity of the ITPA.
The standardization samples for the revised ITPA were made up of eight different age groups ranging from 2 years and 7 months up to 10 years and 1 month. Each group consisted

of approximately 120 normal children from middle-class communities and middle-range schools in medium-sized cities within Illinois and Wisconsin. The children were judged free from physical handicaps or emotional disturbances. Their IQ scores ranged between 84 and 116. The ITPA authors justify this restricted sampling in maintaining that normal children provide the best reference group against which to evaluate deficits due to learning disabilities or mental retardation.

Although there may be some merit in this reasoning, Carroll (1972) questions the appropriateness of the ITPA for groups significantly different from the normative population. He urges caution in using ITPA test results with lower class or minority group children or again with adolescent and adult retardates.

Since the profile of ITPA subtests is designed to be diagnostic, subtest reliabilities and intercorrelations are important characteristics that have been seriously considered by Paraskevopoulos and Kirk (1969). As the standardization sample for the revised ITPA was limited to normal children, the range of scores was limited and resulted in a lowering of reliabilities. Paraskevopoulos and Kirk therefore present the original reliabilities and those corrected for restricted intelligence range. With twelve subtests and a composite score at each of eight age levels from 2 to 10 years of age, this yields 104 internal consistency coefficients. Of the 104 uncorrected reliabilities, 51 fall below .80, 23 below

.70, and 15 above .90. The corresponding numbers for the corrected coefficients are 15, 6 and 40 respectively. The total test and most of the subtests seem acceptably reliable at each age level with the exception of Visual Closure and Auditory Closure whose reliabilities remain weak.

Because the ITPA was designed for intraindividual subtest comparisons, differences between pairs of scores in a child's profile must be stable. Paraskevopoulos and Kirk (1969) report reliabilities of the differences among all subtest pairs as ranging from .57 to .88, with a median of .74. The corrected-for-range reliabilities range from .67 to .91, with a median of .81. Score profiles thus appear to be moderately reliable.

To obtain an estimate of stability, the ITPA was readministered after a five-month interval to three age groups of children: 4-year-olds, 6-year-olds and 8-year-olds. The retest reliabilities for the twelve subtests range from .12 to .86 with a median of .50; the corrected-for-range reliabilities range from .28 to .90 with a median of .71. The retest correlations for the composite ITPA score at the three age levels were .83, .70 and .70 respectively, and .90, .87 and .87 when corrected for restricted intelligence range.

Overall, the revised ITPA seems to have adequate reliability with a fairly stable profile of scores. However these scores may hold up only fairly well with time.

As to the validity of the ITPA, Kass (1966), using the

earlier experimental edition of the test, found children with reading problems, when compared to normal readers, to be deficient on the Auditory-vocal Association subtest and on the automatic level Visual Memory subtest. These same children were found to be superior on the Visual Association subtest, perhaps because of habitual reliance on pictorial cues in books rather than on the printed word. Macione (1969) conducted a similar experiment with the revised ITPA and found his second and third-grade reading-disabled group lower on five of the six automatic level tests: on Grammatical Closure, Visual Closure, Auditory Closure, Sound Blending and Visual Memory. Only Grammatical Closure did not reach significance at the .05 level. Neither Kass' nor Macione's study found any difference between normal and disabled readers on Auditory Sequential Memory. Bannatyne and Wichiarajote (1969a), using the revised ITPA, found Sound Blending to be significantly correlated to spelling ability, attributing this to a common oral-kinaesthetic factor. Interestingly, while Auditory Closure did not correlate significantly with spelling ability itself, it did correlate significantly with Sound Blending and may thus be a prerequisite to proper sound-blending skills.

Hirshoren (1969) carried out a predictive study using the experimental version of the ITPA, and found that Grammatical Closure, Auditory and Visual Sequential Memory subtests given at the kindergarten level were significantly related

to academic achievement in reading and spelling two years later.

These studies of concurrent and predictive validity suggest that tests at the automatic level of the ITPA are particularly related to reading and spelling achievement.

While Kirk and Kirk (1971) provide additional evidence of the ITPA's concurrent and predictive validity, investigations pertaining to the construct validity of this test have produced conflicting and uninterpretable results (Newcomer et al., 1975). It would seem important to confirm that the subtests do measure discrete abilities and that they are consistent with the three theoretical dimensions of the clinical model on which the ITPA was built.

Numerous factor analytic studies of the experimental and revised editions of the ITPA have been carried out, the large majority of them finding little evidence in support of the clinical model or the discreteness of abilities. Yet as Carroll (1972) pointed out, the large majority of these studies contained various methodological weaknesses that make their conclusions doubtful. Carroll emphasized the need for factor-analytic studies using appropriate external reference tests which he considers the only proper way to identify the unique abilities tapped by the subtests. Hare et al. (1973) accordingly investigated the construct validity problem with criterion tests designed to parallel functions measured by six of the revised ITPA subtests, specific-

ally Auditory and Visual Reception, Verbal and Manual Expression, Auditory and Visual Sequential Memory. All six subtests loaded on separate factors with the matched criterion tests, thereby suggesting that they measure discrete independent abilities. In addition, Hare and his colleagues found that the subtests loaded with other related tasks on factors clearly identifiable in terms of the three dimensions of the ITPA model. Newcomer et al. (1975) used a similar procedure with all twelve ITPA subtests: their findings suggest that nine of the subtests tap discrete abilities, and that the existence of the level and process dimensions of the clinical model are tenable. The results of these two studies give encouraging evidence of the construct validity of the ITPA and support its use as a valuable clinical tool.

While generally utilized for diagnostic purposes, Okada (1969) found the ITPA also helpful in measuring the effects of certain kinds of perceptual training.

The ITPA was chosen for the present research project because it provided for a battery of language-related perceptual processing tests within a seemingly valid conceptual framework. In addition, the ITPA focussed on intraindividual comparisons and its results could be converted into scaled scores to help place maturational effects into proper perspective. The latter advantage cannot be underestimated in a time-series research design. However the possibly weak reliability of the ITPA over time presents a difficulty that

was tentatively overcome by modifying the test's administration procedures.

Modifications to the ITPA. The writer carried out a preliminary investigation to verify the suitability of repeated administrations of the ITPA. All twelve subtests were administered each month over a six-month period to three eight-year-old boys. Their ITPA results proved relatively stable from the third month on. Upon analysis, it appeared that the boys had become familiar with the test demands by the third administration. Prior to this, in the first and second administrations, these youngsters had failed some of the earliest and easiest test items because they had not fully understood test demands despite the one or two practice items given before each subtest proper.

In using the ITPA for the present research project, the writer modified the administration procedures by giving, wherever possible, three or four extra practice items taken from the "before six years of age" items usually credited to older children. This was done to help the testee fully understand subtest requirements from the start, hopefully augmenting thereby test-retest reliabilities. A somewhat similar preparatory procedure has been incorporated into some of the subtests of the WISC-R by Wechsler (1974) to strengthen reliability. In addition, the Visual Closure subtest was eliminated from the test battery because it had shown, during the preliminary investigation, a marked

learning effect from the third or fourth monthly testing on.

Research Procedures

This section describes the setting of the research project, the Electronic Ear apparatus, the APP training program, and the ongoing procedure for collecting behavioral reports as well as the measures of academic achievement and perceptual processing abilities.

The Research Setting

All five boys selected for this investigation were full-time pupils at the Child Study Centre (CSC) of the University of Ottawa.

The CSC is an educational and treatment facility for children with varying degrees of emotional and learning difficulties. It is also a teaching and training unit for graduate students in Child Clinical Psychology. The APP training program has been employed at the CSC for over ten years as part of a comprehensive remedial and treatment program geared towards the individual needs of each child. The CSC program has its own school and residence. It offers a regular school program along with special classes in psychomotor training, musical training, remedial tutoring, and creative skills. It also offers parental guidance and counselling, as well as individual, group and family-oriented psychotherapy.

The CSC school can accommodate about ninety children

from 4 to 14 years of age. At the time of the investigation, a third of them had severe emotional and adjustment problems; a third had various degrees of learning disabilities and a third could be considered as well-adjusted normalizers. The classrooms were organized for small groups of children to facilitate individual attention and personalized programs. About sixty of the ninety children attended the CSC only during the regular school hours. Thirty children with severe problems lived in the CSC residence located on the two upper floors of this facility.

The CSC's educational and treatment programs ran from September to June, and were extended through a five-week summer camp for added continuity. Although the summer camp introduced a significant change in the children's daily routine, it did allow for close control and continued evaluation of treatment programs.

In view of the nature and size of the CSC program, teachers, psychologists and support staff worked closely together and were quite familiar with the children through direct contact with them and/or through biweekly case reviews. Consequently the children's daily behavior was closely monitored.

Three of the boys selected for this project attended the CSC during school hours only. The other two boys attended school at the CSC, and also lived in its residence because of the severity of their learning problems and their need for a more intensive structured program.

The children's parents were fully informed of the nature of the research program and agreed to participate in it.

They attended frequent interviews with the CSC staff and regularly reported any noteworthy changes they observed in their children during and after APP training. The CSC teachers and staff working with these children were also involved in reporting their behavioral observations. The children's difficulties and their treatment program were explained to them also. They were told that this would involve considerable periodic testing and that they would be given feedback on their progress in the training program. This was done not only for ethical reasons but also to gain their continued involvement and cooperation.

It is important to note here that as the writer was carrying out this investigation, two other doctoral students were also researching the same remedial program with the same five children. However they were studying different psychological dimensions of APP training. The second doctoral student was investigating the program's effects on language behavior and cognitive controls, while the third doctoral student was evaluating APP training effects on emotional and social adjustment. The combined investigations were designed to permit a broader evaluation of Tomatis' APP program for dyslexia within the context of intensive single case studies.

APP training was carried out in individual treatment

rooms at the CSC or at summer camp facilities. Each room contained an Electronic Ear apparatus on a large table in full view of the child. There was sufficient space for the youngster to play, draw or lie down during training sessions.

Testing of academic achievement and perceptual processing abilities was carried out in the testing locales of the CSC. These were comfortable and well lit rooms equipped with only a large table and two chairs. All evaluations were done on an individual basis.

The APP Remedial Training Program

The program was carried out over a period of ten months as suggested by Tomatis. Two half-hour APP training sessions were given to the children every school day. Each child's program was set up, monitored and modified by a Program Consultant. The daily implementation of the prescribed programs was carried out by Therapeutic Assistants who also recorded pertinent behavioral observations on these children. The auditory-vocal exercises were all done through the Electronic Ear apparatus.

The Electronic Ear (EE). The EE is depicted in Figure 9a, and its main components are schematically illustrated in Figure 9b.

It may be seen that output from either a tape recorder, a microphone or both is amplified and passed through either of two filtration channels, C1 or C2. A gating switch, which can be variably set, is activated on the basis of the

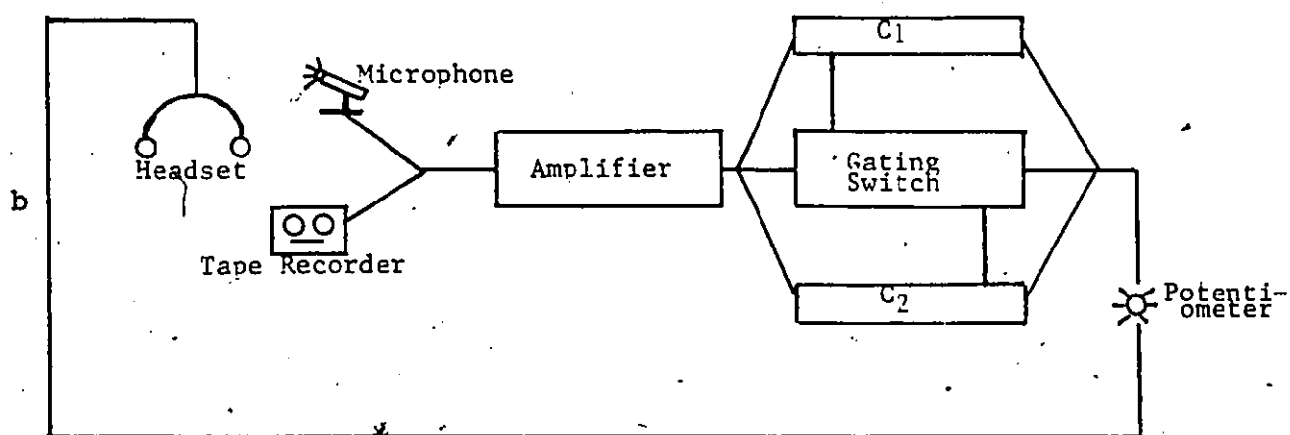
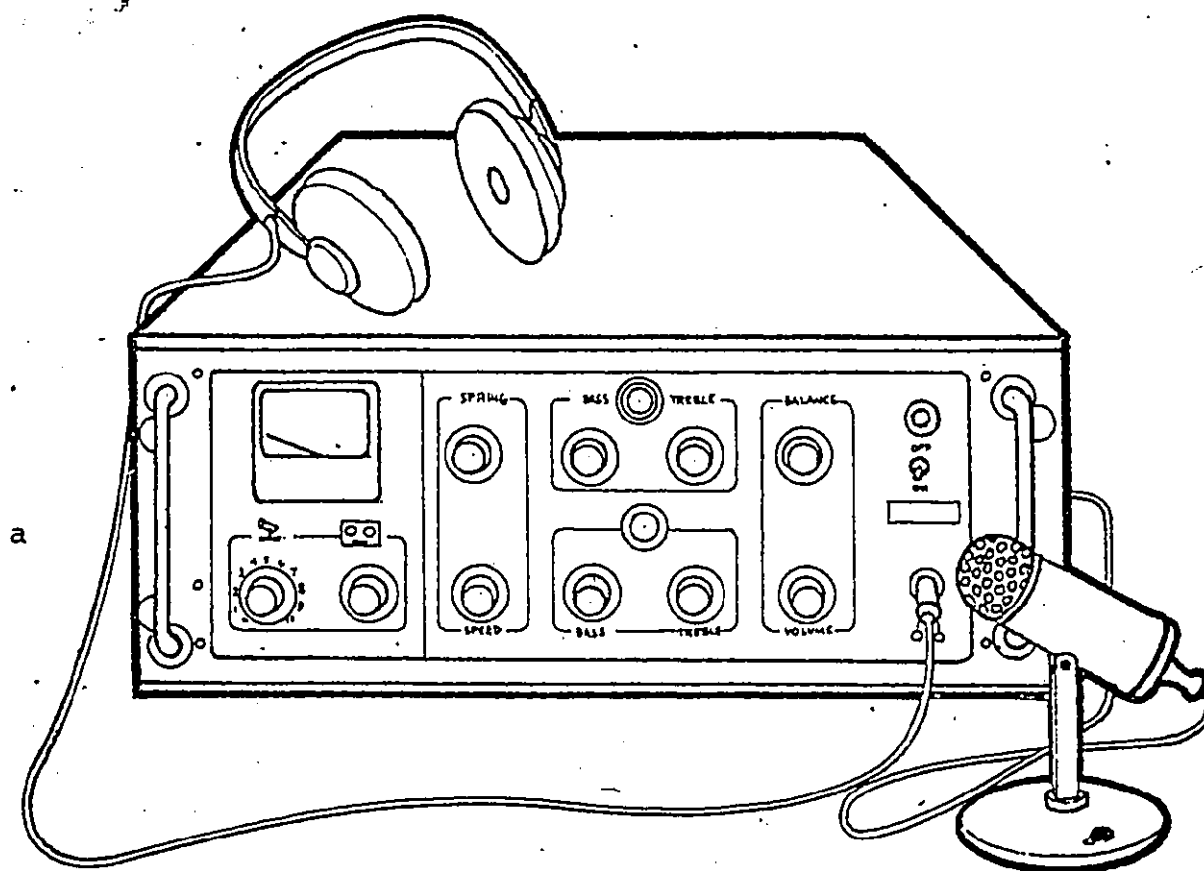


Figure 9. The Electronic Ear.
 a. The instrument itself.
 b. Schematic drawing of its components.

volume of vocal or recorded input such that this input is directed through C1 if above a certain threshold of intensity, or through C2 if below that threshold. Both C1 and C2 can be set to modify the relative intensity of the input frequencies in a variety of ways. In addition, at the output level, a potentiometer is used to vary the intensity of auditory feedback to the left ear only of the headphones. Recorded input is presented on a REVOX A 700 tape recorder, recommended in setting up the EE system.

For the present research project, Channel C1 was set to amplify treble and attenuate bass frequencies according to the ideal "musical ear" listening curve. To be perceived, such sounds are said to require a tensing of the muscles of the hammer and stirrup. Channel C2 was set to modify sounds in the opposite way in keeping with a less desirable listening curve: these sounds are said to require little effort to be perceived, and to actually impose themselves on auditory mechanisms which may be fatigued in the process. A continuous contrasting of C1 and C2 sounds is said to effect a physiotherapeutic or reflexotherapeutic action on the tensor muscles of the middle ear. Auditory mechanisms are thereby reeducated to gain control over listening ability and to adopt the desirable "musical ear" curve. In so doing, phonation is said to be modified for the better by counter-reaction. Left ear feedback is reduced gradually but never eliminated during APP training since the goal here is to

strengthen right-eared control of speech. Tomatis (1972a) stresses that both ears must work in concert but that the right ear plays a leading role.

More specifically, the filtration system in C1, as indicated in Figure 10, was set to attenuate the intensity of bass frequencies from 50 to 800 Hz while enhancing the intensity of treble frequencies from 2000 Hz up. Those frequencies between 800 and 2000 Hz were only slightly modified by this programming..

The program. The training consists of two main phases of auditory-vocal exercises called simply the passive phase and the active phase. These are designed to recapitulate, in abbreviated and simulated fashion, the normal stages of listening and language development, from their earliest pre-natal beginnings to the level of the fairly articulate and confident school-age child capable of succeeding in basic academic skills.

Following Tomatis' initial diagnostic evaluations and recommendations, a Program Consultant set up the training programs for the five children in this research project. Dr. Agatha Sidlauskas, Director of the CSC, acted as Program Consultant in view of her lengthy experience with APP methods. The writer, and the other two doctoral students previously mentioned, acted as Therapeutic Assistants to implement the programs.

The direction and steps of APP training were identical

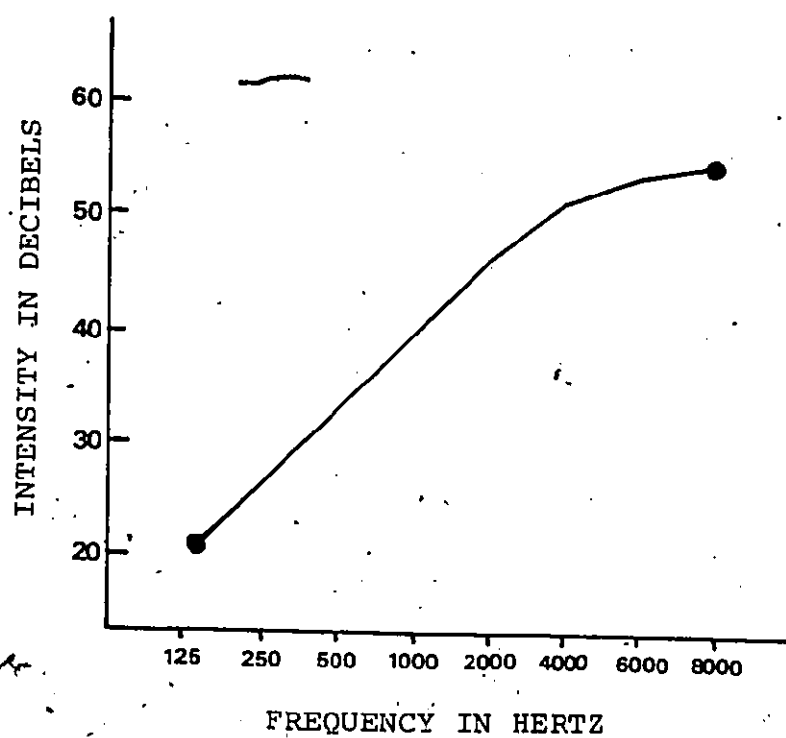


Figure 10. Frequency modification curve for channel C1 of the Electronic Ear.

for all children, but the rate of progression through the different phases and subphases was dictated by the needs of each case. After every twenty half-hour training sessions, a repeat TLT was given to each child. An interview was then held with the Program Consultant who monitored progress and modified programs accordingly. The specific application of the APP training program for each child will be described in detail in the following chapter. A general description of the APP program is called for at this point.

The first main phase of APP training consists essentially of passive listening exercises designed to relax the child and to rekindle or enhance the desire to relate. Tomatis (1972a) considers this phase as the "encounter with mother" because it aims to recreate the child's listening and language relationship with the mother from 4½ months prenatally to about 3 or 4 years of age. According to Tomatis (1972b) this relationship is vital to a child's continuing desire to adapt and communicate.

The first passive subphase is called "Filtered Sounds". Here the child receives auditory stimulation through the EE in the form of tapes of classical music, or in the form of a tape of his mother's voice which has been electronically filtered so as to retain mainly those frequencies above 8000 Hz. These tapes then sound as if they are coming through a liquid medium, supposedly like the foetus in the womb hears through the amniotic fluid. The foetus can apparently per-

ceive sounds at 4½ months (Tomatis, 1972b). Such recorded "prenatal sounds" are said to stimulate memory traces of an earlier state where the desire to relate on a primitive affective level finds its roots. These sounds are held to be a fundamental element in the successful initiation into an APP treatment program (Tomatis, 1972a, p. 146-148).

A half-hour recording of the mother's voice is taken before the start of APP training without the child's knowledge. The mother is asked to read stories she feels the child will enjoy. If the mother's voice is too low, the recording of the stories is done through the EE to obtain a cluster of enhanced high frequency sounds required for the subsequent filtering. Once the filtering has been done, the tape recording contains no recognizable words although the mother's characteristic rhythm and intonation are retained in the leftover high frequencies.

In Tomatis' experience, the maternal voice is the most effective means for stimulating the desire to listen and also to induce relaxation while activating the cortex. In the case of adopted children, the adoptive mother's voice has sometimes been used successfully. However certain forms of filtered classical music are generally used as an alternative. The most successful themes are reportedly those rich in treble frequencies and rhythmically similar to Mozart's music. When such music is used in lieu of the maternal voice, the desired effects are not attained as quickly. In the case

of one of the five children in this research project, an adopted negro lad, such filtered music was utilized.

All the listening training at this first subphase is done through the EE with the upper and lower filtering channels set as previously described. The gating switch is set to shunt incoming sounds from the tapes to either channel in continuously alternating succession, thereby producing an unconscious deconditioning and reconditioning of auditory mechanisms. Little emphasis is placed on lateralizing at this stage: the right ear receives 100% of the EE output and the left ear receives 70%. During this time the child is invited to draw, play cards, and to keep himself amused with activities requiring little concentration. Depending on the severity of the listening deficiency, the "Filtered Sounds" subphase can last from 20 or 30 half-hour sessions to over 100, until the results of the TLT and reports of behavioral changes indicate that the next subphase can be initiated.

There are several indicators of successful training at this first subphase and of readiness to move on to the next. On the TLT, ascendancy of listening curves, parallelism of air and bone conduction at least for the right ear and, in the case of children 8 years of age or more, opening of selectivity at least up to the 3000 Hz speech range are all positive signs. Behaviorally, a greater degree of energy, motivation and involvement on the child's part, and a greater

awareness of the presence of others accompanied by a desire to share experiences, are all considered significant. This part of the APP program is said to energize as well as exteriorize or "excentricize" the dyslexic child who is all too often turned in on himself (Tomatis, 1972a).

The second passive subphase is called "Sonic Birth". It represents the transition from prenatal audition through a liquid milieu to postnatal audition via an air medium. Tomatis (1972a) states that this is normally accomplished within the first 10 days after birth as the middle ear and Eustachian tubes slowly drain themselves of amniotic fluid and fill up with air. This forces the infant to adapt his listening to the air milieu and to recognize the mother's voice in a different form. In APP, this is recreated by having the child listen, via EE, to a specially prepared recording of the mother's simulated prenatal voice where the frequencies previously eliminated are gradually reintroduced from 8000 Hz down to 125 Hz, until the child can recognize the mother's voice and the source of his comfort. This discovery usually brings about a joyful strengthening of the child's relationship to the mother. After a successful "Sonic Birth", the child is asked to listen to about 10 sessions of recordings of the mother's natural voice alternated with recordings of filtered classical music. In some cases, a longer and slower "Sonic Birth" process may be indicated. Overall this subphase generally entails from 15 to 30 half-

hour training sessions.

The second main phase of APP training is designed to help the child make the best use of newly awakened or enhanced listening habits through more involved auditory-vocal exercises requiring active participation.

The first active subphase is called "Performing". Here the child is required to listen attentively through the EE to a series of specially prepared tapes containing words and phrases of varying length. These words and phrases contain many sibilant sounds rich in high frequencies. During pauses on the tapes, the child must carefully repeat these words into a microphone hooked up to the EE. Left ear feedback is gradually reduced to 10% while right ear feedback is fully retained: this promotes right-eared self-listening and speech control. The child is required to sit upright, with chin pulled slightly inward, and to push the lips forward while repeating the words. The microphone is held in the right hand, encircled by the thumb and index finger. These positions are said to train the child's bodily being to assume its most effective posture for communicating.

The words and phrases to be repeated are contained in series of tapes filtered at different frequency levels from 500 Hz up to 8000 Hz. This enables the child to listen closely to sounds throughout the frequency range and to spend more time at those levels that may present greater difficulty. In general, the more highly filtered the tapes,

the harder it is to perceive the words correctly and reproduce them. Some children however may require special emphasis on the middle-frequency speech range. Once a child has mastered 90% of the content of each tape, he can move up to the next tape or to a more difficult series in keeping with his age level. These training sessions last half an hour and are interspersed with sessions of listening to filtered music for relaxation.

This active "Performing" subphase could be considered as an "encounter with father" or an "encounter with others" according to Tomatis (1972a). In his developmental framework, by three or four years of age the child should normally enter into a more articulated two-way dialogue with others beyond the maternal orbit. This dialogue is assisted by right-eared self-monitoring of speech which favors clearer articulation of one's words and thoughts. Tomatis (1972b) stresses that the child's father, or a suitable substitute, provides the example in these matters as he sponsors the child into the wider social arena. The father's availability, support and personal listening habits are important factors in the child's mastery of socialized communication.

In the fourth and final subphase called "Training", even greater participation is required in repeating longer phrases or parts of a text, or segments of Gregorian chanting, which are presented on tapes. Occasionally a child may even be ready to read an easy text on his own through the EE. Again

emphasis is placed upon the correct postures and on right-eared self-listening. These more advanced exercises allow the youngster to gain greater awareness and control of timbre, intensity of voice and speech flow. During this final subphase, training sessions may be reduced from five to three or two times a week. Tomatis (1972a) considers "Training" as an "encounter with self"; this subphase is said to promote greater self-awareness, greater awareness of others, and a clearer expression of one's thoughts, all in preparation of better dialogue.

This final subphase and the APP program are brought to a close once the Program Consultant, on the basis of the TLT results and behavioral reports, concludes that the proper listening and language foundations have been acquired. By this time, gains in school achievement are frequently reported even though academically oriented remedial tutoring or exercises have not been undertaken as part of the program.

Data Collection

The intensive single case studies, using a time-series format, were conducted over a fourteen-month time span from December 1, 1975 to February 1, 1977. The first two months of this time span defined a baseline period. The intervention or APP training period covered the next ten months until December 1, 1976. A follow-up period involved the last two months of the research project until February 1, 1977. Considerable testing data and behavioral reports were collected

at regular intervals throughout the investigation.

Tests of basic academic skills and perceptual processing abilities were given at the outset of the research project and repeated every two months thereafter. In total, this yielded eight sets of formal test results. The first two sets delimited the baseline period, the next five covered the APP training or intervention period, and the last set of results marked the end of the follow-up period.

Throughout the investigation, pertinent behavioral observations were noted on a daily basis and documented in weekly file reports by the three investigators. The parents of four of the five boys in this project were interviewed weekly at the CSC or at their home. The parents of the fifth boy, who had been placed in the CSC residence, lived far away and were only interviewed every five or six weeks.

With regards to the formal tests, the WRAT and the ITPA were administered by the writer while the Gates-MacGinitie Reading Tests were given by a retired remedial teacher not otherwise involved with the children or the project. The writer assumed much of the testing duties because he was sure of being available for repeated administrations throughout the research time span. Further, he was thoroughly familiar with the administration of the WRAT and ITPA, and could therefore pay attention to important qualitative aspects of the children's responses.

The WISC-R, Myklebust PRS and Myklebust Learning Quotient,

obtained for diagnostic purposes prior to the investigation, were readministered or recalculated (Learning Quotient) at the close of the research project for the purpose of pre-post comparisons.

Finally, with regard to the APP training program itself, the TLT was given to each child every 20 training sessions by one of the three investigators who had been specifically instructed by Dr. Tomatis in this method. The ALM was administered only before and after the training program by the writer, who had also been instructed by Dr. Tomatis in this difficult technique.

Presentation and Analysis of the Data

The results from each of the five single case studies will be presented in the form of figures and tables comparing baseline, intervention and follow-up scores as well as comparing pre and postintervention scores. Visual analysis of the data will be emphasized, as has been the custom in intra-subject designs (Michael, 1974a; Hersen and Barlow, 1976). In addition, some tables of test scores will be discussed not only in terms of the data themselves but also in terms of process variables and pertinent behavioral observations.

Although some methods of statistical analysis have been proposed for single subject research (cf. Gentile, Roden and Klein, 1972; Shine and Bower, 1971), the adaptation of parametric techniques to intrasubject designs using repeated test measures is likely inappropriate because of the autocorrelated

nature of the data (Edgar and Billingsley, 1974; Hartmann, 1974; Kratochwill and Levin, 1978). A form of time-series analysis has been developed by Glass, Willson and Gottman (1974) to correct for the autocorrelation factor in interrupted designs, but not in a continuous design as used in this investigation. Consequently a statistical analysis of the data was not conducted in view of the nature of the data and of the design employed. Michael (1974b) and Jarayatne (1978) indicate that in evaluating interventions via single subject research statistical proof of progress is not always necessary, especially when the requirements for internal validity are met.

In the next two chapters, each child's diagnostic evaluations, individualized APP training program, academic achievement and perceptual processing test results will be presented. Their clinical significance will be stressed. Along with the presentation of figures and tables, attention will be given to the observations and remarks of those teachers, psychologists, staff members and parents who lived with these children on a day to day basis, and who were generally in an advantageous position to note significant change.

CHAPTER III

DIAGNOSIS AND REMEDIAL TRAINING PROGRAM

Introduction

This chapter describes the diagnostic findings and the remedial training program for the five dyslexic boys involved in this research project. Each boy has been given a fictitious name and will be dealt with in a separate section in keeping with the intensive case study format adopted. Background information, presenting problems and diagnostic indications will first be presented on the child in question. That youngster's individualized APP remedial training program will then be described, along with listening test results and behavioral observations that were used to monitor and modify the program in terms of its phases and subphases.

Diagnostic information on these children was accumulated in November and December 1975. The remedial training program for each boy lasted 10 months from the beginning of February to the end of November 1976. During the training period, behavioral reports were accumulated on a daily basis, and the Tomatis Listening Test (TLT) was given after every 20 half-hour training sessions.

Case #1: AndrewDiagnosisBackground Information

Andrew was a fair-haired and freckle-faced lad with a husky build. His babyish facial features stood in sharp contrast to his frequent adult-like behavior. Awkward in his movements, he shifted his body slightly from side to side as he walked. At over 7 years of age, he still descended stairs two feet at a time. Although he wrote with his right hand, he was ambidextrous in all other activities. Andrew was a restless but good-natured boy who gravitated towards adults rather than peers. He often impressed others as a good conversationalist, however he generally repeated what his parents or teachers had said and rarely expressed any ideas of his own.

Presenting problems. Andrew's parents recognized the boy's motor coordination and academic learning problems. Otherwise they described him as a rather angelic child, always proper and never causing anyone difficulty.

Andrew's teachers indicated that he was unable to relate to or assert himself amongst peers, often reverting to tears in such situations. His school performance was not in keeping with his mental ability. In the classroom, he was fidgety and easily fatigued but never disruptive.

Family constellation. Andrew is the second of four

children in a comfortably established family. Both parents had attained professional degrees: while the father worked full time, the mother now gave most of her time to homemaking duties. The oldest child, a very selfish and stubborn boy, presented such severe behavior problems that he had been placed in the CSC's residential treatment program. Although there is no mention of learning problems in the family background, three males on the paternal side of the family are left-handed or ambidextrous.

Developmental features. The mother remembers an easy and uncomplicated pregnancy and delivery. Andrew was a full-term healthy baby of average weight. As an infant he was docile and capable of amusing himself at length in his playpen. He began walking at 15 months and his motor development has always been slow. Andrew uttered his first words at 10 months and could speak in clear sentences at 2 years of age. As a preschooler, he proved to be a very considerate and accommodating child who had introjected parental modes of behavior to a remarkable degree.

Educational experience. In kindergarten at 5½ years of age, Andrew spent most of his time in gross motor play and was not ready for any formal learning activities. Anticipating learning problems, his parents placed him the next year as a day student at the CSC. At 7½ years of age and in a grade 2 setting, he was still struggling with basic readiness skills in reading and arithmetic.

Diagnostic Test Results

Intelligence. On the WISC-R given in November 1975, Andrew obtained a verbal IQ of 109, a Performance IQ of 123, and a Full-Scale IQ of 118. In addition to a low scaled score on the Arithmetic subtest, very unstable cognitive functioning was in evidence on the intelligence test. Such instability also characterized his everyday classroom performance.

Achievement. In December 1975, and theoretically in grade 2.4, Andrew obtained a mean achievement rating of grade 2.0 on the basis of the combined results from the WRAT and Gates-MacGinitie Reading Tests.

Learning Quotient. The degree of discrepancy between this boy's actual and expected achievement was calculated according to Myklebust's Learning Quotient method. The resulting quotient of 86 fell below the cut-off score of 90, thereby indicating classification in the learning disability category.

Pupil Rating Scale. Andrew was given a rating of 68 on the PRS, below the critical cut-off score of 70. This indicates potential learning problems. Relatively low ratings were obtained in the areas of Motor Coordination and Orientation to Time and Space.

In addition to the discrepancy criteria reported above, Andrew also met the exclusion and special education criteria from the operational definition of dyslexia proposed earlier.

12

Audio-Psycho-Phonological Criteria

Tomatis Listening Test. The TLT gave many indications of poor listening ability. Auditory selectivity was completely closed: this is considered a major sign of a non-listening disposition in a boy this age. Although the air conduction thresholds revealed a slight ascendancy, the bone conduction thresholds were flat and above those for air conduction. Spatialization errors were in evidence for both ears.

Audiolaterometry. The ALM indicated a left ear advantage of 1.5 in the control of speech.

Personal interview. In trying to follow ongoing conversations, Andrew quickly became fidgety and fatigued. In replying to questions, his lower and upper limbs moved in all directions: such synkinesias indicate poorly integrated listening and language skills as well as much energy loss. Dr. Tomatis observed that Andrew's laterality was mixed, that his body image was poorly defined, and that his body did not serve language well as an instrument of self-expression. The boy used both hands to point out an eye and an ear on himself. When asked to repeat this exercise on the interviewer's face, Andrew showed considerable hesitation: this is said to indicate uneasiness in social contacts. In speaking into a make-believe microphone held in his right hand, Andrew's voice rose slightly and became more fluent. When using his left hand, the boy's voice became low, flat and stodgy.

Dr. Tomatis described this boy as severely dyslexic on

the basis of deficient listening, language and psychomotor skills. He added that a psychological interpretation of the TLT suggested a fearful and dependent child who refused to relate to his mother. Dr. Tomatis recommended about 9 months of steady APP training with a strong emphasis on the initial phase of prenatal sounds using the mother's filtered voice.

Andrew met all the criteria for diagnosis of dyslexia according to the composite definition and APP evaluation methods.

The APP Remedial Training Program

Two half-hour training sessions were held daily, except for weekends and holidays, from early February to late October 1976.

The Passive Phase: Filtered Sounds

As cautioned by Dr. Tomatis, this first subphase was difficult and called for close to 110 training sessions over a 3½ month period. The initial sessions using the mother's filtered voice (VMF) produced little change on the TLT or in the boy's behavior. Since the mother's natural voice is quite low, it was re-recorded through the Electronic Ear (EE) to obtain a richer cluster of higher frequencies after filtering. Training sessions with this new VFM tape achieved an opening of selectivity up to 3000 Hz on the TLT. After 60 training sessions, an attempt to move on to the next Sonic Birth subphase failed: Andrew did not recognize his

mother's voice, and selectivity closed up on the TLT, thereby suggesting a refusal to accept the mother's voice and a strong resistance to listening. The first subphase was accordingly reinstated. A substitute female filtered voice, very rich in high frequency sounds, was thereafter alternated with the natural VFM until positive results were obtained in mid-May.

Tomatis Listening Test. On the positive side, by mid-May selectivity had remained fully open over the last 20 sessions, and the air conduction curves had taken on an ascending slope. On the less desirable side, the bone conduction thresholds remained flat and high while spatialization had become completely reversed on the left ear.

Program Assistant's observations. Andrew became physically and verbally overactive in the first month of training, settling down considerably in the second month after the introduction of the substitute VMF into the program. His posture began to straighten up. He also began to seek physical contact as he sat close to the Program Assistant.

Teachers' observations. Andrew's teachers noted that after a month of training, he was more energetic and could make better use of his time. He had also become a chatter-box, passing comment on whatever caught his attention. Such overtalkative behavior disappeared by the third month: the boy was then quite relaxed with better concentration. At this point Andrew began asserting himself on the playground

and gained some peer acceptance.

Parental observations. In the second month of the program, the parents were distraught as their little angel started to talk back and show his temper. At one point he struck out at his mother. The parents were advised on how to handle such forms of self-expression within safe and acceptable limits.

Subphase summary. The opening of selectivity and the ascendance of air conduction thresholds on the TLT, reports of greater energy, concentration, social interaction and self-assertion all indicated readiness to move on to the next subphase.

The Passive Phase: Sonic Birth

In late May, the Sonic Birth was gradually introduced over 15 sessions alternately using the natural mother's voice and classical music in the prescribed fashion. Andrew came to recognize and accept his mother's voice with mild enthusiasm.

Tomatis Listening Test. At this point, selectivity remained open, and the air conduction thresholds remained gently ascending. The bone conduction thresholds rose slightly indicating increased tension. Spatialization became reversed on both ears from 250 to 3000 Hz, thus mainly in speech-related frequencies.

Program Assistant's observations. Andrew now started to express his own ideas and opinions rather than repeat

what he had heard elsewhere. He made clear bids for physical closeness and contact with the Program Assistant as they sat at the training room table.

Teachers' observations. The content of Andrew's writing had become more personal. Despite considerable difficulty in phonetics, he suddenly showed an eagerness to read aloud to classmates and even explain what he had read afterwards.

Parental observations. Andrew's temper tantrums had subsided and he had found his easygoing disposition again. He suddenly became interested in reading to his 3-year-old brother despite awkward reading skills.

Subphase summary. The continued opening of selectivity on the TLT, and the positive behavioral reports along with the manifest interest in reading indicated that the active phase of the training program could be embarked upon.

The Active Phase: Performing

In this subphase, socially-oriented listening and language skills are promoted through auditory-vocal exercises that emphasize upright posture, clear articulation with lips pushed forward and right-eared self-monitoring of one's speech. Words and phrases of increasing length and degree of filtering are presented on tape, to be listened to and repeated through the EE with the prescribed postures. Andrew worked at these exercises for 140 sessions from early June to the end of October. At first he complied almost rigidly with the recommended postures. As he endeavoured to repeat dif-

difficult words or phrases with lips well forward, his head moved in an undifferentiated way. Synkinesias were especially evident in his feet but gradually faded by late September. In October, his facial expression and speech seemed more relaxed and refined.

Tomatis Listening Test. By late October, spatialization errors had disappeared while selectivity remained open. The air conduction curves took on a more pronounced ascending slope. Bone conduction thresholds started to fall below the air conduction curves at least in the middle and high frequency ranges.

Program Assistant's observations. In July and August, as the spatialization errors on the TLT cleared up, Andrew seemed to pull body and mind together and gain greater self awareness: as he played and talked, he seemed to direct his movements in a smoother, more coordinated and personalized way. By the end of the summer he seemed more relaxed, self-assured as well as optimistic about life in general. By October, he could express his thoughts more clearly and enjoyed sharing his opinions with others. He now impressed others as having a personality of his own.

Teachers' observations. Andrew gradually improved in social skills and self-confidence over the summer. On occasion, he asserted himself boldly in class, an event which was welcomed within limits. He now had mastered basic phonetic skills and his reading started to improve. His handwriting

ing, though slow, was better controlled and contained within the lines of his workbook. His spelling errors were now described as more logical and comprehensible. In September, it was noted that Andrew's oral and written expression was more concise and better organized while his concentration span had improved.

Parental observations. Andrew's father became intrigued with his son's personalized self-expression during this period, and spent considerable time conversing with the boy. The father also joined Andrew in sports activities that provided the boy with practice in right-handed throwing or batting.

In September 1976, Andrew's older brother moved back home from the CSC residential treatment program. This introduced a significant change in Andrew's living situation and his parents feared some setbacks. However with parental assistance, both boys managed to find their place within the family constellation with little conflict. When a confrontation did occur between these boys, Andrew stood his ground rather than back down as he had in the past.

Subphase summary. More positive results on the TLT, improvements in self-expression and academic performance were noted during this period. Since Andrew still had difficulty with some of the more demanding taped exercises, this subphase could have been prolonged further. However the next and last subphase was embarked upon because the overall training program was scheduled to terminate in a month.

The Active Phase: Training

This last part of the program consisted of sessions of oral reading from simple grade 1 texts alternated with sessions of listening to filtered classical music. Again, right-eared self-listening was emphasized to reinforce proper auditory-vocal skills. This more actively involved subphase is said to increase awareness of and confidence in one's communicative ability. By the end of this program in late November, Andrew had completed just over 300 training sessions, 35 of which were related to this final subphase.

Tomatis Listening Test. During this last month of training, the air conduction curve for the right ear took on a more pronounced ascending slope.

Program Assistant's observations. Andrew now seemed much more self-assured. He made noticeable use of a time perspective in his spontaneous remarks, reminiscing about past activities and planning for future events. In the last week of reading exercises, he effectively assumed the role of the story book characters with different rhythms and intonations.

Teachers' observations. At the close of APP training, Andrew's teachers commented on his improved motor coordination in walking, writing and sports activities. It was noted that he had become sufficiently independent and self-assured to occasionally become his peer group leader. He was described as lateralized to the right in all activities. His

home room teacher felt that his written self-expression suffered because of his slow handwriting. The same teacher reported a marked improvement in reading over this last month. Andrew could now read aloud quite fluently, with the proper pauses according to punctuation. His reading comprehension was described as excellent. His spelling, though phonetically more accurate, remained weak. His attention span had continued to improve since March or April.

Parental observations. Andrew has become more self-reliant in doing his homework as well as less anxious about making mistakes. The parents were pleased with his gains in reading ability but voiced concern about his poor spelling.

Subphase summary. During this brief period of training, the air conduction curve on the right ear had improved according to the TLT. Behavior-wise, Andrew showed progress in self-confidence and self-reliance. Reading skills improved remarkably although spelling ability remained weak.

Summary of Andrew's APP Training Program

According to APP criteria, Andrew had made significant gains in listening and language skills. Figure 11 compares the TLT and ALM results obtained before and after remedial training. In December 1976, shortly after the close of the program, auditory selectivity was open and spatialization errors were non-existent. The air conduction curves showed an ascending slope, especially for the right ear. The bone conduction thresholds were lower, particularly for the left

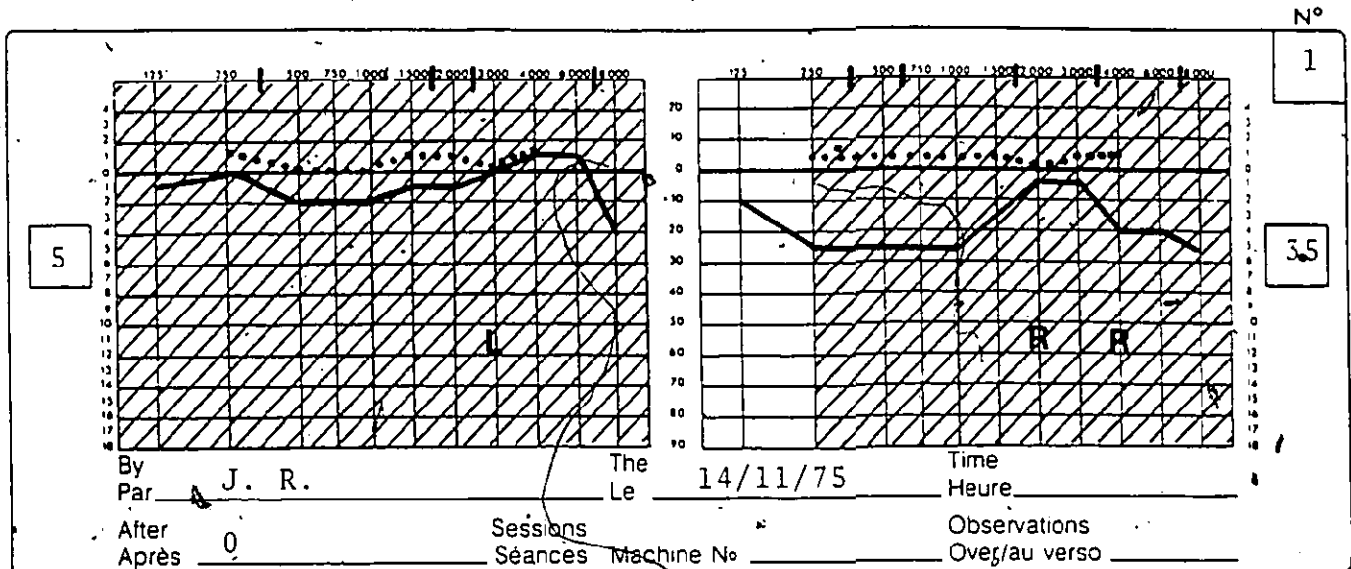


TOMATIS LISTENING TEST TEST D'ÉCOUTE TOMATIS

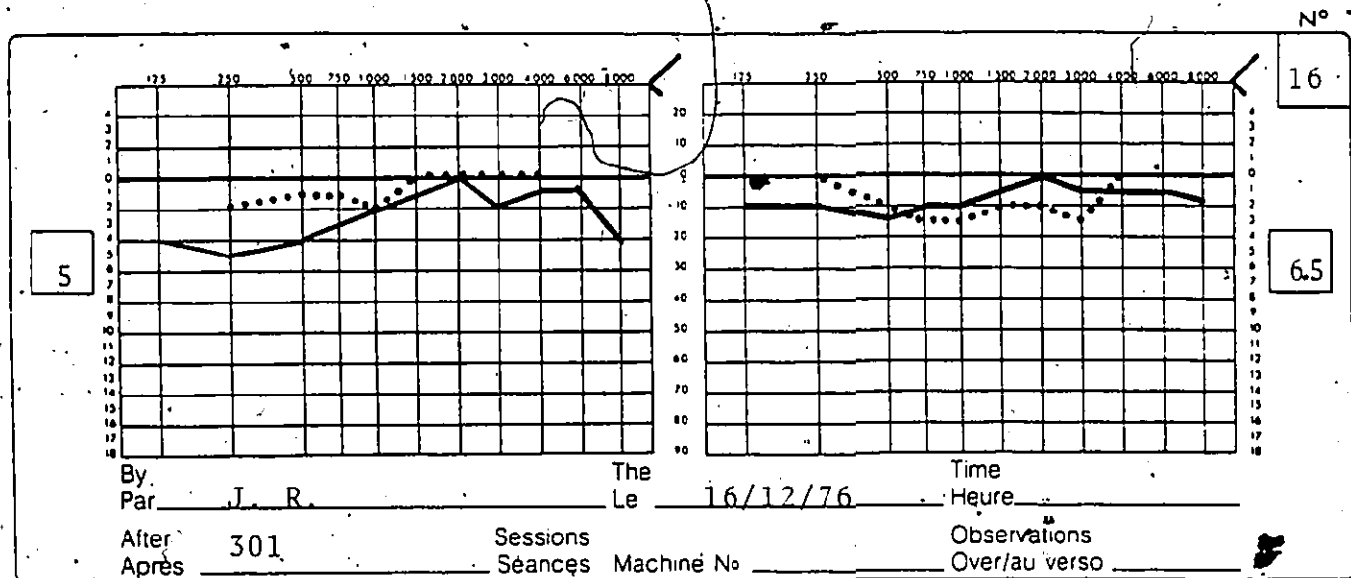
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166

FAMILY NAME Case #1 GIVEN NAME ANDREW
NOM de FAMILLE Case #1 PRÉNOM ANDREW AGE 7 yrs 8 mons



AT THE START OF APP TRAINING



AFTER TERMINATION OF APP TRAINING

Figure 11. Pre and post APP remedial training results on the Tomatis Listening Test and Audiolaterometry for Andrew.

ear. The ALM now indicated a right ear advantage of 1.5 in the control of speech as opposed to a left ear advantage of 1.5 at the onset of training.

Andrew had attained a better upright posture. His speech was clearer and his bodily movements were better controlled as he spoke. He related more comfortably to others and could express his thoughts in a more organized manner. His concentration and energy level has improved from the start of the training program, and reading skills began to improve noticeably towards the end of the program.

According to APP criteria, this program was a successful one although a more extended period of training might have brought the bone conduction thresholds fully below the air conduction curves. Further training might also have strengthened the right ear to an ALM advantage of 2.5 or 3.

Case #2: Brian

Diagnosis

Background Information

Brian was a dark and curly-haired lad of average height and sturdy build. Generally quiet and reserved, he seemed to come alive on the playground where he could be heard shouting brief remarks to his peers. At nearly 8 years of age, he could hardly express himself at length without groping for words or starting over a second time.

Presenting problems. Brian's parents realized that he

was slow in his language development and they expected some learning problems in keeping with the pattern an older son had presented. They recognized that the boy was quite intelligent, that he had become an astute manipulator with his siblings, and that perhaps even adults were being taken in by his cute non-verbal manner. They added that although Brian was perhaps the happiest of their children, he did not relate closely to anyone in the family.

Brian's teachers viewed him as a quiet and easy to manage student who enjoyed a lot of popularity among his peers, especially in sports activities. Within the classroom he preferred to observe rather than participate. When asked to read, he tried hard to appear competent in the eyes of his classmates but he could not easily cover up his labored decoding skills nor the frequent letter and word reversals. Behavior-wise he was an ideal student, but in reading and spelling he experienced considerable difficulty.

Family constellation. Brian is the third child in a very comfortably established family of five children. The father is a physician whose long work hours and quiet disposition did not favor much interaction with his children. The mother, a full-time homemaker, handled most of the discipline and everyday living problems. The two oldest siblings made up a duo, as did the two youngest: this left Brian as the odd man out. All four boys in this family gave indications of actual or potential learning problems. The father

described himself as having been dyslexic in his youth, adding that he overcame his reading problems alone as a result of sheer determination. The oldest boy's learning problems were recognized late and had negatively affected his personality. The father realized that a hereditary factor might be at play here and he sought early assistance for the other male children in his family.

Developmental features. Brian was slow in attaining developmental milestones. He started to walk at 17 months. He uttered some words at one year but did not speak in phrases until at least 3 years of age. He did however communicate a lot through gestures. As a toddler, he manifested little curiosity or exploratory behavior: he would remain seated for hours, entertaining himself with just one toy. The mother, busy with the demands of the other children, remembers Brian as a "very good child". As a preschooler, this boy often became so disorganized in finding his words as to forget what he wanted to say. He also found it hard to adjust to family moves which were frequent in his early years.

Educational experience. Brian entered kindergarten at 4½ years of age: at the end of that school year it was felt that he was not ready for grade 1. His parents expected learning problems and enrolled him at the CSC for specialized attention within a smaller group classroom. The boy spent another year in kindergarten on preparatory skills before

moving on to grade 1 and grade 2.

Diagnostic Test Results

Intelligence. On the WISC-R, Brian obtained a Verbal IQ of 101, a Performance IQ of 131 and a Full Scale IQ of 117. In addition to the generally weak verbal skills, the lowest scaled scores were recorded on the Arithmetic and Digit Span subtests.

Achievement. In December 1975, at a theoretical placement of grade 2.4, the combined results of the WRAT and the Gates-MacGinitie Reading Tests gave Brian a mean achievement rating of grade 1.8.

Learning Quotient. The degree of discrepancy between actual and expected achievement was calculated according to Myklebust's Learning Quotient method which gave Brian a score of 80. This quotient is well below the cut-off score of 90, thereby indicating classification in the learning disability category.

Pupil Rating Scale. Brian was given an overall rating of 66, below the cut-off score of 70, thereby indicating potential learning problems. He obtained low ratings in the areas of Auditory Comprehension and Spoken Language.

In addition to the discrepancy criteria reported here, Brian also met the exclusion and special education criteria from the operational definition of dyslexia proposed earlier.

Audio-Psycho-Phonological Criteria

Tomatis Listening Test. The TLT revealed severe listening problems. First and foremost, auditory selectivity was closed in all but the lowest frequencies. The listening thresholds were generally flat with a slight dip in the speech range between 1500 and 4000 Hz. The bone conduction thresholds were above the air conduction thresholds for both ears. Some difficulty in localizing sounds was indicated by spatialization errors within the speech range.

Audiolaterometry. The ALM indicated a left ear advantage of 1.5 in the control of speech.

Personal interview. Brian could not follow any ongoing conversation for any length of time and soon gave in to his own preoccupations. Dr. Tomatis pointed out the slumped posture and numerous synkinesias of upper and lower limbs as the boy struggled to respond to questions. Brian's voice was low and flat, his vocabulary was very concrete and his statements very brief. The boy could not identify left or right on himself or on others.

Dr. Tomatis qualified Brian as very dyslexic. He recommended an intensive APP training program of about nine months duration. He added that the boy's father should also follow an APP program in view of his past learning problems. The father declined because of his busy work schedule.

The APP Remedial Training Program

The Passive Phase: Filtered Sounds and Sonic Birth

Both subphases of the passive phase will be described together since they cannot be distinctly separated as was possible with the previous case. After 30 training sessions of listening mainly to the mother's filtered voice (VMF), Brian showed positive changes on the TLT. The Sonic Birth subphase was then attempted and smoothly managed within five sessions: the boy quickly recognized his mother's voice and listened to it with delight. Brian seemed ready for the active phase of training but after a few sessions of the auditory-vocal exercises, he became very fatigued in trying to clearly understand the words presented on tape. The Program Consultant decided to return to the passive Filtered Sounds subphase for another 20 sessions of VMF. After a total of 64 training sessions, the Sonic Birth was again briefly reintroduced in mid-April in preparation for the active phase of the program.

Tomatis Listening Test. By mid-April, selectivity had opened up completely and all spatialization errors had disappeared. However the air and bone conduction thresholds for both ears showed a more pronounced dip in the speech-related frequency range between 1500 and 4000 Hz. According to APP theory, this pattern represents a very resistive non-listening disposition: it is said to reflect an underlying sense of hopelessness about overcoming communication diffi-

culties.

Program Assistant's observations. Initially Brian seemed more relaxed and at ease but after 20 training sessions his general activity level increased noticeably followed by aggressive outbursts at home and at school. The Program Assistant offered suggestions to the parents and teachers on how to manage these generally short-lived reactions within safe and acceptable limits. At this point Brian suddenly seemed to understand that he was involved in some form of training related to his poor school performance.

Following the initial Sonic Birth, Brian began seeking attention in a positive way. He also sought physical closeness for the first time and did not pull back when patted on the back or shoulder. His spontaneous drawings had become more personal and less stereotyped.

Towards the end of this passive phase, Brian was noticeably more open and at ease in relating. He wanted to share his experiences with the Program Assistant. He reported with elation that his father had managed to find more time to spend with his family.

Teachers' observations. At the beginning of training, Brian became quieter in an almost detached manner. This was followed by a period of aggressive outbursts. These reactions were gradually replaced by a more relaxed and enthusiastic disposition with seemingly better control of gross motor activity during physical education classes. Towards

the end of this part of the program, Brian drew a picture and asked his teacher to allow him to write a story about it on the blackboard for the whole class to see. He had verified the spelling of his words and presented his ideas clearly. This was the first time he had shown a desire to relate something personal within the classroom setting.

Parental observations. At home Brian's usually reserved disposition gave way to verbal and physical aggression as he stood up for himself vis-à-vis his siblings. The parents found such behavior disruptive but accepted it within limits as a necessary step towards healthier self-expression.

Summary of the Passive Phase. The opening of selectivity on the TLT, along with slight ascendance of air conduction curves and a slight lowering of the bone conduction thresholds, suggested readiness to move on to the active phase of the program. The dip in the speech range could then be dealt with more effectively. Behavior-wise, Brian's mood was now more relaxed with indications of increased desire to relate on a personal level and to assert himself.

The Active Phase: Performing

This subphase involved over 220 training sessions during a 6½ month period from mid-April to early November. The active auditory-vocal exercises were very difficult for Brian who had experienced difficulty in auditory discrimination and self-expression since early childhood. He now had to listen carefully to words and phrases presented on a tape without

the benefit of any visual or gestural aids which he had become adept at using in reading or communicating. Brian's mood and involvement in the exercises fluctuated considerably during this period of time. He required much encouragement and support to continue on and overcome his difficulties.

Tomatis Listening Test. By early November, selectivity remained open but the bone conduction thresholds had risen, especially in the lower frequency range, denoting tension and easy fatigueability. More positively, the air conduction thresholds had taken an ascending curve, and the dip in the middle speech zone of both ears was much less pronounced.

Program Assistant's observations. Brian required constant encouragement to continue working at this subphase. Easily distracted by anything in sight, he was asked to close his eyes and concentrate on the auditory-vocal exercises. He was almost frightened to keep his eyes closed at first, but with time he adapted to this measure.

In June, after 2½ months at this subphase, Brian began to notice differences between the way he had previously heard some words and the more accurate manner he could now perceive them. This discovery provided him with some helpful positive feedback. Occasionally he argued that the voice on the taped presentations deliberately mispronounced words to deceive him. For example, he insisted that the word "describe" ought to be "descrive". The boy also began to recognize mistakes in his spontaneous speech and to correct them accordingly.

It was impossible for him to attempt exercises with longer words at this point: if a word was too long, he only discriminated and repeated the initial sounds accurately and synknesias became visible in his feet.

In July, Brian had mastered the easier simple word exercises. His posture was spontaneously maintained in the upright position. He indicated that he could feel his mouth shift from the left to the right side in speech during the training sessions. During periods devoted to passive listening to filtered music, he started to add words and captions to his drawings: whereas his spelling previously made little sense, it was now phonetically more accurate.

Progress was slow as Brian tackled lengthier words and phrases from August to November. If pushed too quickly, he would slip into a pattern of wild guessing and poor participation. Fortunately he could now be teased or coaxed into trying harder, something he did not previously accept.

Teachers' observations. Brian showed moments of progress and regression in his school work throughout this period. However socially he had gradually and consistently become warmer and more genuine in relating to peers and adults. He seemed to need and seek out people rather than just want to play with them. He also participated more in classroom discussions and shared experiences with the group. In October, he fell into an unexplained slump that lasted nearly the entire month before he bounced back.

Parental observations. In May, Brian's mother reported that he was now less isolated within the family and sought to be involved with family activities. The mother also reported that in June Brian was able to correct his own speech errors and with a greater degree of self-acceptance. He had also been able to tolerate his mother's departure over a weekend without being too upset. In autumn, the parents reported that Brian was now participating even more in family life; that he now used language to a greater degree in expressing himself, with a concern for proper grammar; and that he was generally much easier to discipline than before.

Subphase summary. In addition to the improvements on the TLT, increased social participation and greater effort towards accuracy in speech and language were among the main gains achieved during this lengthy period. However Brian's overall mood tone and motivation had been variable. He still experienced difficulty with some of the more demanding auditory-vocal exercises. More time yet could have been spent on this subphase but since the overall program was soon coming to a close, the next and last subphase was introduced.

Active Phase: Training

Training at this subphase consisted in reading simple first-grade books over the last 3 weeks of the program. Reading sessions were alternated with sessions of listening to filtered classical music.

Tomatis Listening Test. Although the air conduction

thresholds took on a more ascending slope as desired, the bone conduction thresholds rose again in the lower frequencies, suggesting increased tension. In addition the dip in the speech area of both ears became a bit larger.

Program Assistant's observations. During this period, Brian became fidgety and fatigued towards the end of the reading sessions. Initially he could decipher the printed words well without relying on picture cues. But as he tired, he started to skillfully guess at the meaning of words rather than sound them out. For example he would read "beige" for the word "tan".

Teachers' observations. No noteworthy behavioral or academic changes were recorded during this period. Reviewing Brian's overall progress during the training program, the teachers indicated that his attitude towards reading and spelling had improved while actual performance in these areas left a lot to be desired. The teachers also underlined the boy's increased self-confidence, his more personalized and genuine way of relating, and his improved speech and language. However in class Brian continued to have "good days" marked by a fair degree of success, and "bad days" characterized by struggles and frequent discouragement.

Parental observations. The parents noted an increase in self-confidence at this point. Brian had also started to reflect on past activities with surprisingly good recall rather than just live in the here and now. He insisted on

expressing his opinion in family matters despite some difficulty getting his ideas straight. He enjoyed being given responsibility but might regress to jealous childish ways if overshadowed by an older sibling.

Subphase summary. Training at this subphase was too short and perhaps premature. Despite reported gains in self-assurance, the TLT results suggested a slight regression.

Summary of Brian's APP Training Program

Brian's training program can be qualified as partially successful. This is indicated to some degree in Figure 12 which illustrates the boy's TLT and ALM results before and after the program. Although selectivity remained open and spatialization errors had disappeared by December 1976, the air conduction curve had attained only a slight ascendancy, mainly in the lower frequencies. The bone conduction threshold remained too high in the low frequency range, suggesting underlying tension. The dip in the middle range remained in evidence after it had been partially corrected earlier in the program. The ALM test indicated that the left ear still had an advantage of 1.5 in the control of speech: efforts at lateralizing auditory-vocal functions to the right had failed.

These results, in addition to Brian's proneness to fatigue and synkinesias during the more demanding active exercises, indicated that additional training might have been advisable. Reports of increased self-confidence and social

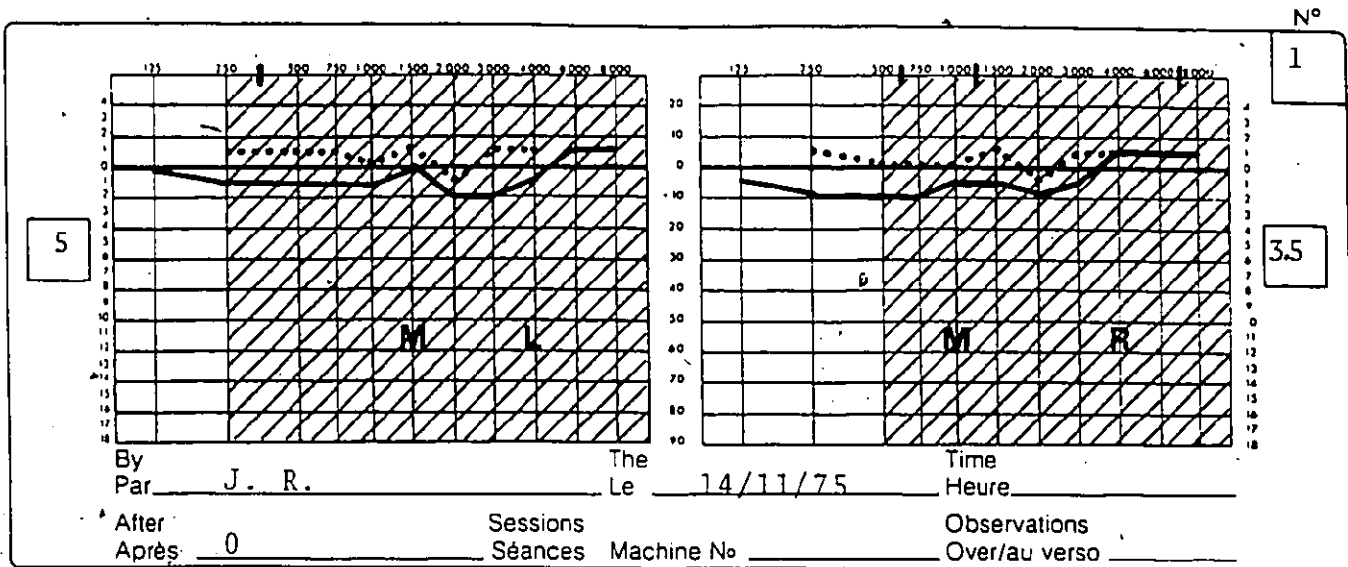


TOMATIS LISTENING TEST TEST D'ÉCOUTE TOMATIS

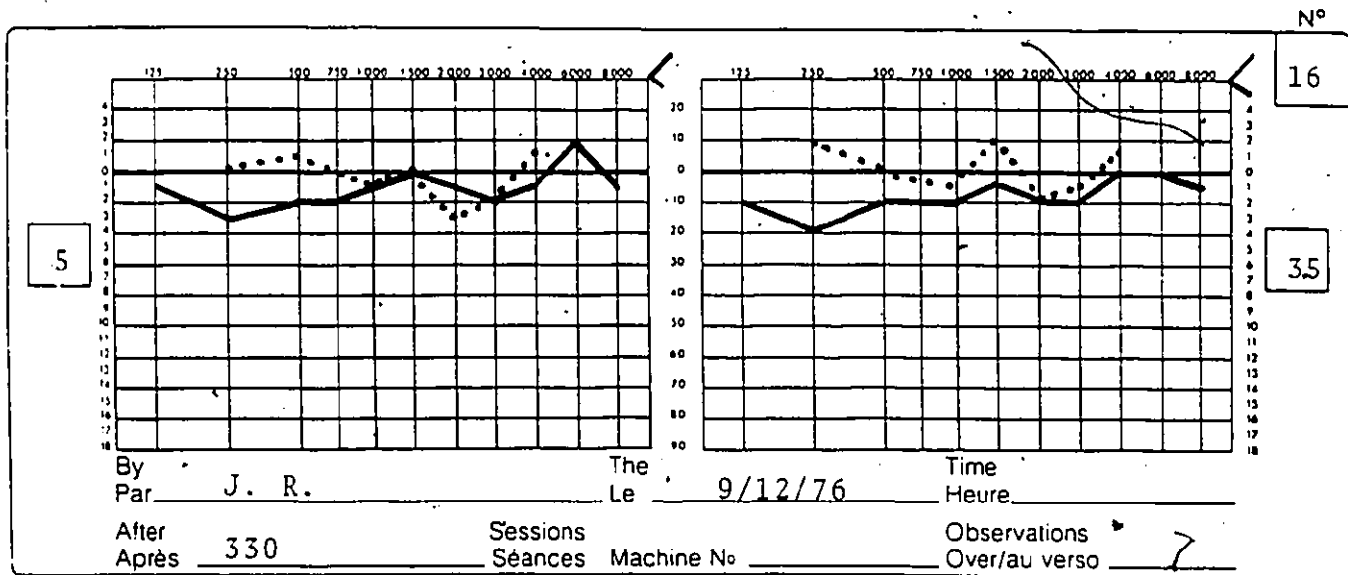
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180

FAMILY NAME Case #2 GIVEN NAME BRIAN
NOM de FAMILLE Case #2 PRÉNOM BRIAN AGE 7 yrs 11 mons



AT THE START OF APP TRAINING



AFTER TERMINATION OF APP TRAINING

Figure 12. Pre and post APP remedial training results on the Tomatis Listening Test and Audiolaterometry for Brian.

interaction as well as relatively improved verbal expression suggest that some gains had been attained.

Case #3: Charles

Diagnosis

Background Information

Charles was a blonde-haired and blue-eyed boy of frail and immature appearance. At just 8 years of age, he often spent his time playing on the floor with toy cars in a manner more characteristic of a preschooler. At school, he was unable to make friends and hesitant in relating to classmates. In his class work, he lacked frustration tolerance. These trials often brought tears to his eyes as he anxiously awaited his mother's arrival at the end of the school day.

Presenting problems. Charles' parents did not view his frequent self-absorbed behavior as problematic. They themselves lived a reserved and somewhat aloof life style. They were however frustrated with the boy's babyish reactions under mild stress. They seemed to expect Charles to behave like a little adult, rather than an 8-year-old. The parents were especially concerned with their son's poor school performance despite his reportedly bright mental endowment.

Charles' teachers had recognized his social immaturity and his continuing struggle with school work. At 8 years of age, he still reversed letters, words and numerals. In spelling, he confused the order of letters. He was fidgety with

a short attention span. The boy tried unsuccessfully to gain peer acceptance by telling tall tales: he usually ended up playing by himself.

Family constellation: Both parents described themselves as artistically inclined: they worked at jobs that allowed for independent creative outlets. They had chosen to live a somewhat secluded life style in a rural setting in which they emphasized self-sufficiency in terms of their social and nutritional needs. Charles, their only child, was unplanned. His arrival had interfered with the mother's completion of a Bachelor of Arts degree. The father had struggled to complete high school as a result of reading problems, and at fifteen years of age he was told that he was dyslexic. He had always experienced difficulty expressing himself verbally, and he quietly supported his more outgoing wife who organized most of the family's activities. The father was easily frustrated with his son's continual dependence on the mother despite his efforts to form a closer relationship with the boy.

Developmental features. The mother reported an uncomplicated pregnancy and an easy delivery. The boy's early milestones were all attained within normal limits. Like his father, Charles developed an allergic reaction to milk and wheat which was being controlled by dietary measures. Raised in a somewhat isolated setting, this youngster lacked opportunities to interact with other children. Even though he

was enrolled in a Montessori program from 2½ to 5½ years of age, he did not involve himself much in this experience, preferring to entertain himself with his toys.

Educational experience. When introduced to formal learning at 5½ years of age, Charles had considerable difficulty dealing with letters and number concepts. At 6½ years of age, he was enrolled at the CSC to receive extra help with his learning problems. At that point Charles gave evidence of mixed dominance of hand and foot, and of reversals of symbols. Laterality was subsequently established to the right after 18 months of psychomotor training, but reading, spelling and arithmetic problems persisted.

Objective Test Results

Intelligence. On the WISC-R, Charles obtained a Verbal IQ of 112, a Performance IQ of 114 and a Full Scale IQ of 114. Low scores were obtained on the Digit Span and Coding subtests.

Achievement. With a theoretical placement of grade 2.4 in December 1975, Charles obtained a mean achievement rating of grade 1.7 on the basis of the combined results of the WRAT and the Gates-MacGinitie Reading Tests.

Learning Quotient. Calculation of the Myklebust Learning Quotient gave Charles a score of 85. This quotient is well below the cut-off score of 90, thereby indicating classification in the learning disability category.

Pupil Rating Scale. Charles was given an overall rating

of 67 on this scale, below the cut-off score of 70, indicating potential learning problems. He obtained relatively low ratings in the areas of Orientation to Time and Space, Motor Coordination and Personal-Social Behavior.

In addition to the discrepancy criteria just given, Charles met the requirements for classification as dyslexic according to the exclusion and special education criteria of the operational definition of dyslexia proposed earlier.

Audio-Psycho-Phonological Criteria

Tomatis Listening Test. The TLT indicated relatively good listening ability. Auditory selectivity was fully open. The air conduction thresholds showed a slight ascending curve. Only one spatialization error appeared on the right ear.

Audiolaterometry. The ALM indicated a left ear advantage of 2.0 in the control of speech.

Personal interview. Dr. Tomatis was impressed with Charles' good posture, voice qualities and verbal expression. He indicated that the TLT and ALM suggested a basically secure boy who required more experience and self-confidence in socialized discourse. Dr. Tomatis considered Charles as only mildly dyslexic and believed that the boy would overcome his difficulties in three or four months of the APP training. It was pointed out that the lateralizing effect of the active phase of the APP program should help this boy make better use of his otherwise good listening and language skills. Dr. Tomatis also encouraged the boy's father to

follow an APP program because of his own learning and language difficulties. The father agreed to consider this.

The Remedial Training Program

The Passive Phase: Filtered Sounds and Sonic Birth

The two subphases of the passive phase will be described together since they were both of short duration. After 30 sessions of passive listening to filtered sounds using mainly the mother's filtered voice, the Sonic Birth subphase was very successfully introduced over five sessions. Charles was delighted to recognize his mother's voice reading a favorite story. By mid-March, after 35 training sessions, the boy was ready for the next step of the program.

Tomatis Listening Test. The TLT results remained essentially unchanged and favorable.

Program Assistant's observations. Initially Charles proved to be restless, talkative and attention seeking. He frequently talked about his mother. He started many drawings and plasticine sculptures, but usually depended on the Program Assistant to help finish them. By the 10th training session, the boy's bodily tension increased noticeably: he became more restless, disruptive and even a bit provocative. By the 20th session, he became somewhat dazed and distant, forgetful and disorganized in his habits. By the 30th session, Charles seemed more relaxed and in tune with his surroundings. He initiated a lot of tickling and play-wrestling

with the Program Assistant. Following the Sonic Birth, he again became talkative but in a more personal way. He completed his drawings with little request for help.

Teachers' observations. Following a brief period of restlessness, Charles had moved into a self-absorbed state, nearly dissociated from his surroundings. A few weeks later, he had become more relaxed, spontaneous and talkative. By the fifth week of training, despite his awkward social skills, he was mixing more with his peers and even involved himself in contact sports.

Parental observations. After a few training sessions, Charles complained of frequent stomachaches and dizziness. The parents expressed doubts about the appropriateness of the program. They were encouraged to comfort the boy through physical contact rather than with discussions. The mother agreed to this, admitting that she too often approached her son like another adult. The father was reluctant to participate in this manner. Towards the end of February, their son was noticeably more relaxed and started to assert himself in a bold independent way at home. The surprised mother felt threatened, as if afraid of losing control over the situation. Her first reaction was to withdraw Charles from the program. With some guidance from the Program Consultant and the Program Assistant, the mother was prevailed upon to let her son continue in the training session, and encouraged to view this as an opportunity for growth on her part as well as on

the boy's part.

Summary of the Passive Phase. The favourable TLT results, and behavioral reports of social outgoingness and self-assertion, indicated readiness for the Active Phase.

Active Phase: Performing

This subphase proved to be a happy and rewarding one for Charles who moved quickly through the taped auditory-vocal exercises in 70 sessions from mid-March to the end of May. His posture was upright yet relaxed, he discriminated sounds well and articulated clearly.

Tomatis Listening Test. The air and bone conduction thresholds gradually took on a more sharply ascending curve. The bone conduction threshold started to fall below the air conduction threshold as hoped for.

Program Assistant's observations. Charles cooperated diligently throughout this subphase. During those sessions devoted to listening to filtered music, his drawings began to reflect themes and interests more in keeping with his age. He began to show an interest in words by adding captions to his drawings in comic strip style: his spelling, though poor, was phonetically more appropriate. In conversation, he now seemed to express his thoughts more clearly and succinctly. Towards the end of May, he brought some books to the training sessions, indicating an interest in reading, but his choice of material was far beyond his capability.

Teachers' observations. Charles was reported to be

progressing slowly but surely in social interaction and peer acceptance. Two teachers had noticed that he was more logical in expressing his ideas. Improvements in reading and arithmetic skills were also encouraging.

Parental observations. The parents were now pleased with their son's ability to relate warmly to them and to share his day's activities with them. The parents in turn made an effort to reciprocate. They also encouraged the boy to invite classmates to the home over the weekend. Towards the end of this subphase, Charles surprised his father by reading a billboard caption as they drove to school one morning. A few evenings later he picked up his classroom reader and managed to read a few lines to his parents.

Subphase summary. The positive TLT results, quick success on the taped exercises, and signs of improved socialization, self-expression and academic performance all indicated readiness to advance to the last subphase of the program.

Active Phase: Training

Charles eagerly began reading on the EE. Initially he tended to gloss over some word endings. In early July, he read simple grade 1 books fairly fluently. His reading ability continued to improve slowly but surely over the next 4 months until the completion of the program at which time he had managed to read a few grade 2 level stories.

In October, Charles' father started an APP training program of his own, as had been recommended by Dr. Tomatis.

Unfortunately, after about 10 training sessions, the father began having outbursts of anger and withdrew from the program. He could not be prevailed upon to continue even when it was explained that such early reactions are not uncommon and usually short-lived.

Tomatis Listening Test. The TLT results remained generally positive throughout this period. However the bone conduction thresholds did rise noticeably, thereby indicating an increase in underlying tension.

Program Assistant's observations. By July, Charles spoke spontaneously with greater facial expression and clarity of speech. Despite progress in reading, he soon became tense and poorly motivated. One day he indicated that his parents had decided to take him on a holiday trip despite a previous commitment to leave him on the program throughout August with the other boys in the project. Charles felt caught between his desire to go on the trip and the reaction of the other boys. He settled down quickly when given permission to go on the two-week holiday because of his excellent cooperation and progress in the program.

In October and November, the boy's parents became uncooperative by keeping the boy home one or two days a week, thereby interrupting the program and classroom activities. Charles was visibly tense and uncomfortable during this period. In late November, the boy blurted out that his parents were sending him to a country boarding school the

next year, to the same boarding school his father had once attended. He was very distressed and in tears, unable to keep this move to himself even though he was told it was a secret. This situation did disrupt Charles' performance in the program and at school. At the close of the program, he had taken part in 239 training sessions. He had missed approximately 40 scheduled sessions.

Teachers' observations. In late July at the summer camp, Charles had become restless and self-absorbed. When given permission to go on a trip with his parents, he quickly settled down to work again. In October and November, his behavior and classroom performance fluctuated markedly: academically he did not produce what he was felt capable of.

Parental observations. In early June, the parents noted that Charles could concentrate better in everything he did. In November, at the close of the program, they had noticed that the boy was now more self-reliant as well as more considerate of the needs of others. Although pleased with their son's improved self-expression and reading ability, they were less satisfied with his progress in spelling.

In December 1976, prior to the Christmas recess, the parents indicated that they would be sending Charles to a residential boarding school in September 1977. They hoped this would provide him with more opportunity for peer contacts. They also indicated that such a placement would give them more freedom for their interests and life style.

Subphase summary. The TLT results and the boy's behavior indicated increased tension which interfered with his performance in the program and at school. Training during this period was not as productive as might have been expected. Unfortunate circumstances impeded further progress.

Summary of Charles' APP Training Program

Charles improved in many areas during the first half of the program, as had been anticipated by Dr. Tomatis. He became more relaxed, outgoing and successful in peer contacts. His general behavior was more age-appropriate. His concentration also improved, he acquired an interest in reading, and his school performance moved ahead. Although these areas continued to improve during the last 5 months of training, along with signs of greater self-reliance and consideration of others, his progress did not live up to expectation. Visibly tense and with periods of absenteeism, Charles' motivation and performance had become quite variable.

Figure 13 compares the TLT and ALM results before and after APP training. Shortly after the program, in December 1976, the air conduction thresholds had taken on a more distinct ascending curve. However the bone conduction thresholds were high again after they had fallen to a more appropriate level earlier in the program. One spatialization error appeared. The most positive gain was registered in auditory-vocal laterality: whereas Charles commenced training with a left ear advantage of 2.0 in the control of speech, he termi-

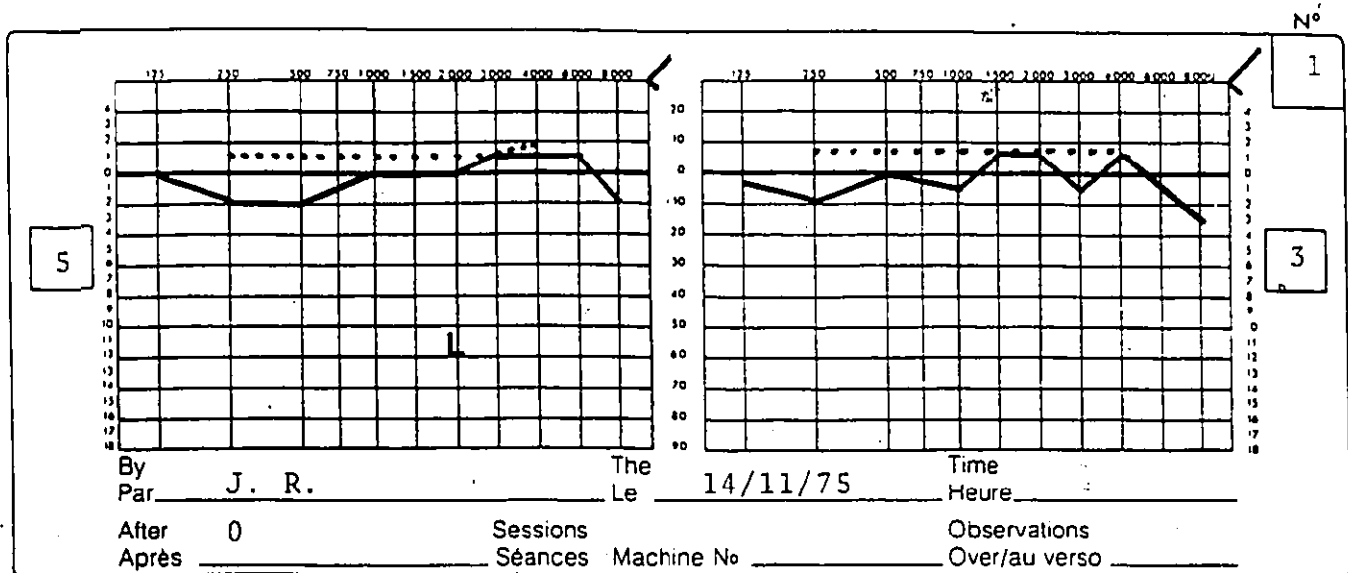


TOMATIS LISTENING TEST TEST D'ÉCOUTE TOMATIS

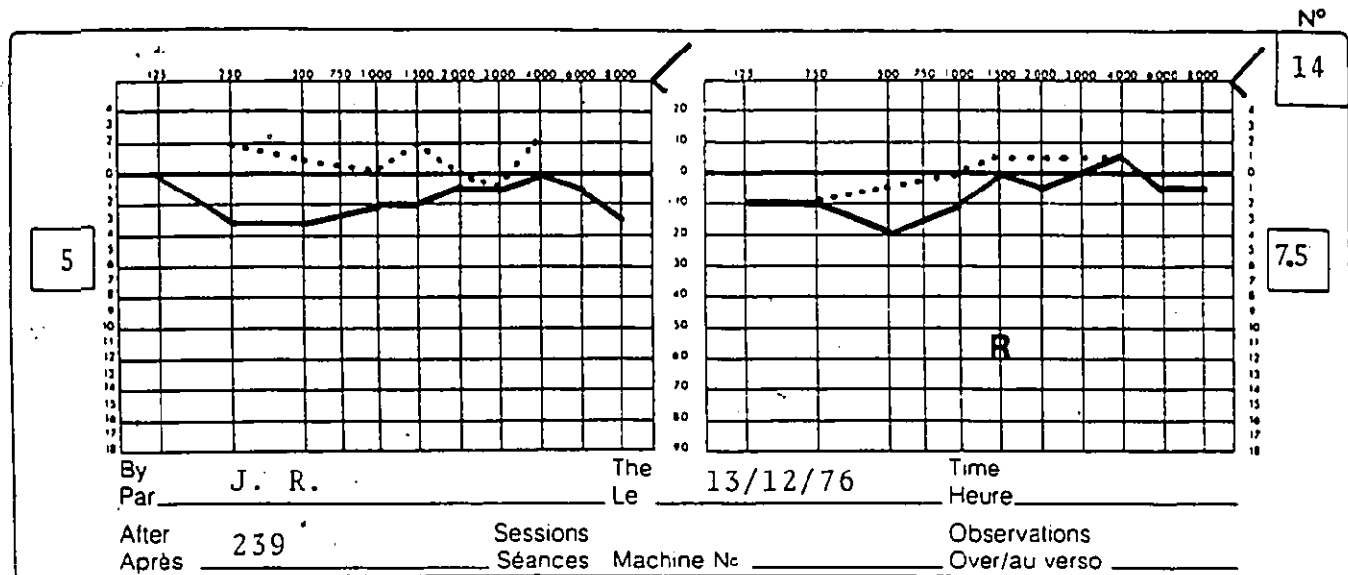
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192

FAMILY NAME Case #3 GIVEN NAME CHARLES AGE 8 yrs 0 mons
NOM de FAMILLE Case #3 PRÉNOM CHARLES



AT THE START OF APP TRAINING



AFTER TERMINATION OF APP TRAINING

Figure 13. Pre and post APP remedial training results on the Tomatis Listening Test and Audiolaterometry for Charles.

nated training with a strong right ear advantage of 2.5.

Overall, this training program could be qualified as moderately successful.

Case #4: Darryl

Diagnosis

Background Information

At the time of this research project Darryl was a tall and lean 9-year-old boy with dark curly hair and strong negroid features. Although his good looks and generally cheerful attitude endeared him to many peers, some teachers thought that his behavior was a bit superficial and manipulative. His teasing and talkative manners did betray an underlying need for attention. However his academic difficulties could quickly change his happy-go-lucky tone into a sullen and defeatist attitude.

Darryl is an adopted lad whose adoptive parents lived many miles from Ottawa. Because of this distance and because of the severity of his learning problems, he was enrolled in the CSC's combined school and residence program. For this project, the CSC residence was considered as his basic home environment. Some contact and counselling was maintained with the adoptive parents since Darryl did return home for holiday breaks and periodic long weekends.

Presenting problems. Darryl's parents referred him to the CSC because of learning and behavior problems. His pro-

gress in school had always been slow. He eventually acquired a defeatist attitude, expecting the worse from himself and others.

The CSC staff had observed Darryl for over a year. In residence, he switched from cheerfulness to tears or gloom when reminded of his chores or responsibilities. In his grade 3 class setting, he had not fully mastered basic grade 1 skills despite considerable systematic drill. His attention span was quite short.

Family constellation. Darryl's natural parents were unmarried. The father was a negro. The mother was white and a graduate nurse. She kept the infant for 13 months before giving him up for adoption due to family pressures. The adoptive parents took him into their home at 15 months. The adoptive father is a professor of Business Administration. The adoptive mother once taught in an elementary school. Their three natural children, all girls, ranged in age from 13 to 18 years at the time of this project. Darryl, at 9 years of age, was the youngest child and only boy in the family.

Developmental features. Upon adoption, the boy showed immediate affection towards his new father and sisters but did not trust his new mother for many months. He was an active, well coordinated and curious child, perhaps too quick in his reactions: he seemed unable to stop himself long enough to reflect on his behavior or plan ahead. He has al-

ways been socially outgoing. His language development was slow although he understood verbal instructions long before he spoke.

Educational experience. Darryl attended nursery school at 3 and 4 years of age: he was described as lacking in frustration tolerance and prone to temper outbursts. At 5 years he had become the kindergarten bully although he behaved acceptably at home. By 7 years of age, he had experienced so much difficulty in reading and arithmetic that he started to react negatively to demands both at school and at home. When enrolled at the CSC at 8 years, his cheerful behavior did not hide his very resistive stance. Now 9 years old, he could sound out letters to form words, but never quick enough to catch the meaning of words or phrases. Reversals of letters and words were frequent. He seemed unable to automatically recognize words he had sounded out many times before.

Diagnostic Test Results

Intelligence. On the WISC-R, Darryl obtained a Verbal IQ of 108, a Performance IQ of 111 and a Full Scale IQ of 110. He obtained a very low score on the Digit Span subtest, and below average scores on Information and Coding. He obtained an average score on the Arithmetic subtest by adeptly using his fingers to add and subtract.

Achievement. In December 1975, at a theoretical placement of grade 3.4, the combined results of the WRAT and the

Gates-MacGinitie/Reading Tests gave Darryl a mean achievement rating of grade 1.9.

Learning Quotient. Calculation of the Myklebust Learning Quotient formula gave Darryl a score of 77.3. This quotient is well below the cut-off score of 90, thereby indicating classification in the learning disability category.

Pupil Rating Scale. Darryl received an overall rating of 65 on this scale, below the cut-off of 70. He was rated low in all areas except Motor Coordination.

In addition to the discrepancy criteria just reported, Darryl met the requirements of the exclusion and special education criteria from the operational definition of dyslexia proposed earlier.

Audio-Psycho-Phonological Criteria

Tomatis Listening Test. Selectivity was fully open. The air and bone conduction thresholds for both ears were generally high and flat, indicating an undifferentiated form of listening with low frequencies masking the energizing higher frequencies. Spatialization errors occurred on both ears.

Audiolaterometry. The ALM indicated a left ear advantage of 2.0 in the control of speech.

Personal interview. Darryl became fidgety and restless in trying to follow ongoing conversations. Dr. Tomatis drew attention to the boy's strained flat voice, and to the many bodily synkinesias as he spoke. Interestingly, in addition to his poor posture, Darryl generally threw his head back

much like an infant does. When the boy's head and back were held upright, his voice rose noticeably.

Dr. Tomatis stated that Darryl was dyslexic according to APP criteria, and that several months of training would be required to overcome this condition. Tomatis indicated that a better perception of higher frequencies would improve this boy's posture and attention span; that stronger right-eared self-monitoring would allow for greater self-awareness and a more symbolic level of cognitive functioning, both necessary for better communication and reading.

In summary, Darryl could be considered as dyslexic according to the operational definition and to APP criteria.

The APP Remedial Training Program

Passive Phase: Filtered Sounds

Since Darryl was adopted, his natural mother's voice was unavailable. Because the adoptive mother's voice was low, and because Darryl had been reluctant to relate to her in his early years, Dr. Tomatis recommended starting the APP program with 20 sessions of filtered classical music followed by another 20 sessions with a filtered female voice rich in high frequencies. A carefully chosen substitute female voice is said to achieve the desired results more quickly than filtered music alone. After these first 40 sessions, the Sonic Birth was attempted with initially encouraging results. When Darryl's behavior deteriorated soon

afterwards, the Filtered Sounds subphase was reintroduced for another 40 sessions. In April, the Sonic Birth was again attempted with positive results, but Darryl again regressed in behavior the moment the active auditory-vocal exercises were presented to him. The Filtered Sounds subphase was reintroduced once more for an additional 60 sessions until Darryl's mood and motivation had stabilized. By the end of June, this boy had attended 140 training sessions in this passive subphase. He was by then more settled and willing to put an effort into learning rather than just seek free play.

Tomatis Listening Test. The seven listening tests obtained during this period fluctuated considerably. Selectivity remained open. Spatialization errors were overcome early in the program. The air conduction thresholds gradually took on an ascending curve towards the end of this subphase but had revealed occasional spikes prior to this. The bone conduction thresholds fluctuated considerably, but towards the close of this subphase, they took on the more desirable ascending curve although they remained a bit above the air conduction curves.

Program Assistant's observations. At first Darryl became quite overtalkative, flitting from one topic to another, complaining about all the school work and rules that interfered with his play time. By the 30th session, while listening to the filtered female voice, he became giddy for a short

while and soon settled into a somewhat depressed state. He became more focussed in his complaints about the structure and demands imposed upon him at home and at the CSC. He cried over his learning problems and seemed much more genuine in his feelings at this point.

The first attempt at the Sonic Birth seemed to go well. Darryl was fairly relaxed and absorbed in listening to the now recognizable female voice. Soon after he again became restless, overtalkative and a bit disorganized in the flow of his ideas. It was learned a few days later that Darryl's adoptive mother had left home as a result of a family misunderstanding, and had phoned the boy at the CSC to inform him of this situation. He felt upset and very insecure. Over the next 2 weeks, while back on the Filtered Sounds substage, he talked openly about family concerns and about his feelings of rejection since he had been placed at the CSC.

In April, after the second attempt at the Sonic Birth, it was evident that Darryl preferred the passive training sessions and would regress if pushed ahead on the active exercises. The Filtered Sounds subphase was reintroduced again.

In April, the Program Consultant and the Program Assistant worked intensively with Darryl's mother who had very ambivalent feelings towards the CSC. She had agreed to place the boy at the CSC, being unable to handle him at home. She now felt guilty that someone else was raising the child.

She admitted playing down the importance of the CSC program to Darryl so as to better her position in his viewpoint: this in part explained his continued resistance to anyone trying to help him. These issues were dealt with very directly, and the mother's role and importance in the CSC program were clearly defined. Thereafter the mother felt better about cooperating with CSC staff in their remedial work.

Teachers' observations. During the first month of training, Darryl became overtalkative and disruptive, and then fell into a depressive slump. From March to mid-June, he was more difficult to manage in the classroom although he seemed less superficial in his complaints. He appeared to be fighting for recognition. Only towards the end of this subphase did he show some motivation to learn.

Parental observations. Just before the first attempt at the Sonic Birth, residence staff noted that Darryl had become more positively involved in the organized activities. They also noted that he began to awake quickly and refreshed in the morning rather than drag himself out of bed in a half-dazed state. On a home visit at this time, the adoptive mother found him more relaxed and genuine in his feelings.

Shortly after, with the news of his mother's departure from home, Darryl's behavior in residence regressed to his previous moody and unpredictable state. He settled down and became more positive in outlook only in June.

Subphase summary. Although TLT results and behavioral

reports after 6 weeks of training suggested that Darryl was ready for the next subphase, this step may well have been premature. The adoptive mother's unexpected interference complicated this process. After 5 months in the Filtered Sounds subphase, the TLT results and behavioral reports again suggested that Darryl was ready to move on to the Sonic Birth.

Passive Phase: Sonic Birth

Over a 2-week period, at the start of summer camp in July, a slow version of the Sonic Birth was introduced using the filtered female voice as well as a purely musical version of the sonic birthing process.

Tomatis Listening Test. At the end of this subphase, the TLT results looked very positive. The bone conduction thresholds had started to take their expected position below the ascending air conduction curve.

Behavior reports. The Program Assistant, teachers and summer camp staff all noted that Darryl was gloomy at the beginning of each week, following a visit by his parents at the camp on Sundays. By the middle of each week, the boy's general attitude and motivation had again improved.

Subphase summary. The positive TLT results and the boy's generally positive behavior suggested readiness for the active phase of training.

Active Phase: Performing

Darryl worked well on the taped auditory-vocal exercises

which were alternated with sessions of passive listening to filtered music. This involved 90 sessions from mid-July to early October.

Tomatis Listenig Test. In general, the TLT results remained positive although the bone conduction thresholds rose slightly above the air conduction curve.

Program Assistant's observations. Following some brief moments of resistance in July, Darryl seemed to give up "fighting the system" in August, cooperating well thereafter. He could attend to the exercises without tiring and while maintaining the recommended postures. He successfully advanced through the exercises more quickly than expected. In August, changes in Darryl's articulation and facial muscle-play suggested right-eared control of speech. In late September, he asked to start reading over the EE as some of the other boys in the program were doing.

Teachers' observations. In August, Darryl's overall behavior changed for the better. His spirits were buoyant. His concentration had improved and he was eager to work in class. His basic reading skills had improved: he could now recognize words and their meaning rather than sound them out each time.

Parental observations. The CSC residence staff noted that from September on, Darryl had integrated himself more successfully into the group setting and no longer suffered mild grief reactions after each visit with his parents. He

now seemed more self-assured and cooperative.

Subphase summary. Darryl's mood became more stable and positive during this period. His concentration and reading ability improved. He was viewed as more cooperative and self-assured. The TLT results remained generally positive.

Active Phase: Training

The subphase involved over 60 sessions during the last 2 months of the program. Active reading sessions were alternated with passive sessions of listening to filtered classical music. The reading exercises were approached slowly as Darryl had just started to master basic skills. If he attempted material beyond a grade 2 text, he tired quickly, displayed mild synkinesias, and started to skip word endings.

Program Assistant's observations. Darryl was now thrilled with his ability to get to the meaning of words. By the end of November, he read some sentences fairly fluently although on occasion he reversed the letters "b" and "d". His attitude and motivation remained positive throughout this period.

Teachers' observations. Darryl's oral and written expression improved: he could now communicate his thoughts and feelings more clearly and systematically. His reading fluency and reading comprehension had also improved although, when tired, he would substitute small words.

Parental observations. Residence staff were struck by Darryl's increased self-awareness. For example, he suddenly

realized fully that he was dark-skinned. This made him feel momentarily uncomfortable. On the other hand, he had become more independent in doing his chores and homework: he no longer needed to be prodded or reminded. In general, the residence staff and the boy's adoptive parents were impressed with his increased self-confidence.

Subphase summary. The first indications of successful reading for meaning appeared during this subphase. Mild synkinesias and signs of fatigue during the APP reading sessions suggested that further training at this level might have been beneficial. Behavior-wise, the most striking changes were related to increased self-awareness, self-confidence and self-sufficiency.

Summary of Darryl's APP Training Program

It took 5 months of training in the Passive Phase before Darryl settled down into the more positive and cooperative disposition required for the Active Phase. From that point on, his concentration, work attitude, self-expression, self-confidence and academic performance improved slowly but steadily. His program involved 295 training sessions over the 10 months of the program.

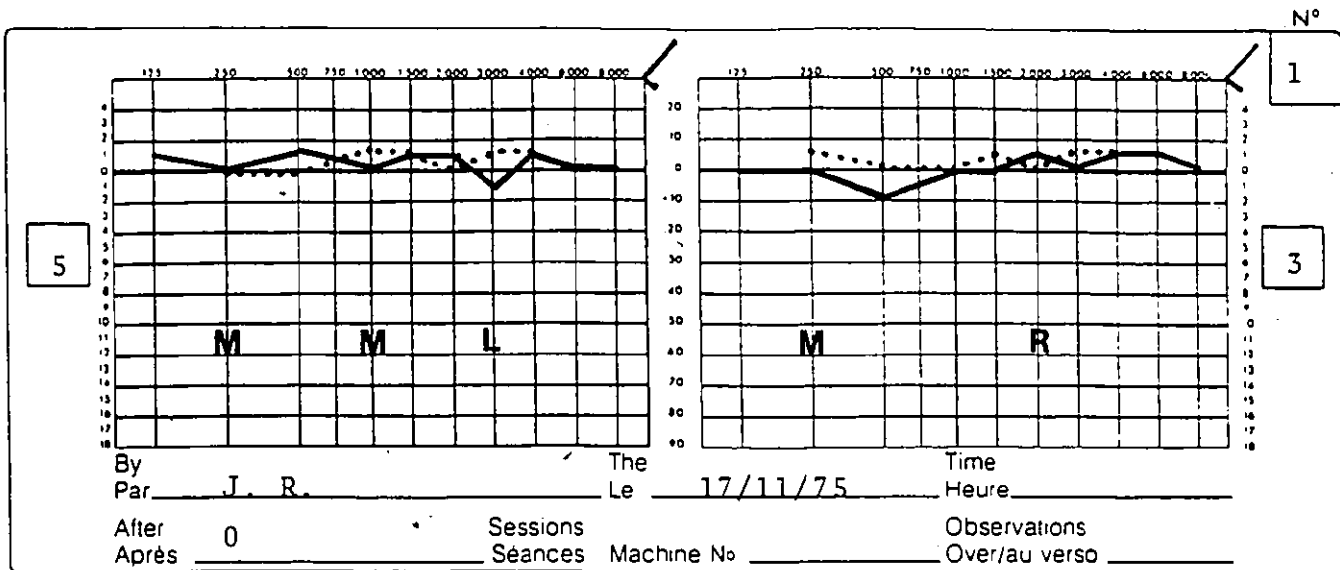
Figure 14 presents the TLT and ALM results before and after the APP training program. Shortly after the termination of training, in December 1976, selectivity had remained open and all spatialization difficulties had been overcome. The air conduction thresholds had taken on a more ascending

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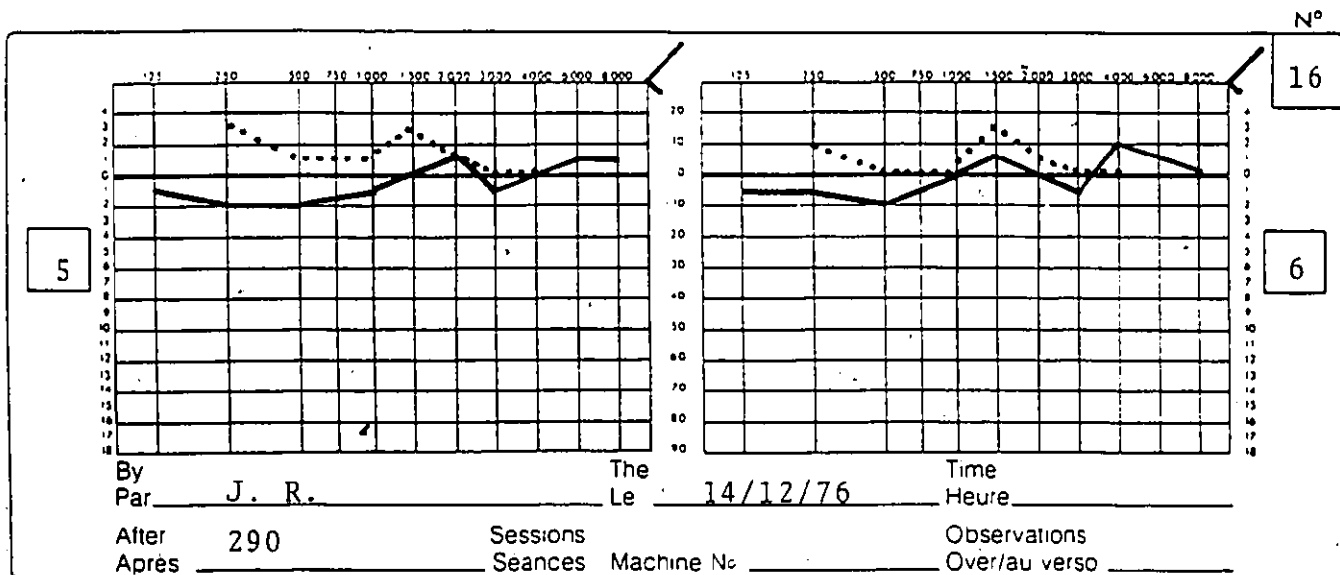
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205

FAMILY NAME Case #4 GIVEN NAME DARRYL
NOM de FAMILLE Case #4 PRÉNOM DARRYL AGE 9 yrs 0 mons



AT THE START OF APP TRAINING



AFTER TERMINATION OF APP TRAINING

Figure 14. Pre and post APP remedial training results on the Tomatis Listening Test and Audiolaterometry for Darryl.

slope, indicating a more differentiated form of listening. Bone conduction thresholds however were a bit higher than at the start of training, with spikes at 250 and 1500 Hz: this indicates some tension, and, according to APP theory, the pattern is often associated with an allergic condition. The ALM results show a shift from a left ear advantage of 2.0 in the control of speech to a right ear advantage of 1.0. The latter does not represent a strong advantage but it does point to a step in the desired direction.

Darryl's remedial training program could be qualified as moderately successful according to APP criteria. A stronger reinforcement of right-eared self-listening and the attainment of more appropriate bone conduction thresholds would have been desirable. A longer period of training in the Active Phase, until Darryl could speak and read more fluently without bodily synkinesias, would have been preferable.

Case #5: Ernest

Diagnosis

Background Information

The eldest boy in this research project was 9 years and 3 months old at the start of APP training. Physically, he was short for his age, with a stocky build and babyish facial features. He behaved in a timid, discouraged and often whiny way.

Presenting problems. Ernest's parents indicated that he was unhappy because of being unable to live up to his own high expectations. Although they valued academic achievement, they had not pressured their son in this respect. The boy had encountered serious learning difficulties from the start of schooling, and the parents had tried to provide him with the best remedial assistance thereafter. The parents also recognized that Ernest often cried when things did not go his way, and that he related more comfortably to younger children.

Ernest's teachers indicated that he had not yet fully mastered basic reading and spelling skills, and that he was becoming increasingly negative towards school work and himself. He sought the attention of adults or younger children while classmates called him a dummy or a sissy.

Family constellation. Ernest is the oldest of two children from a very comfortably established family. His sister, two years his junior, is academically very successful and socially very self-assured. The father is a Rhodes scholar and a high-ranking government officer. The mother, who holds a master's degree in social sciences, gave most of her time to her homemaking duties. Both parents enjoyed sports activities and social outings, and they involved their children in these interests whenever possible. There is no history of learning problems in the family's background.

Developmental features. Other than a breach presenta-

tion, pre, para and postnatal history offered little out of the ordinary. Most developmental milestones were attained a bit early but speech and language development were slow. Ernest invented his own words for everything, and between 2 and 3 years of age, only his parents could understand him. Although he could pronounce individual syllables, he had difficulty putting them together into words. At 5 years he could not enunciate clearly and did not appear to move his lips properly. As a preschooler, he displayed an inquisitive and independent temperament, untroubled by his weak speech and language ability.

Educational experience. Upon completion of kindergarten at 5 years of age, Ernest was described as immature and not yet ready for formal learning. He spent the next year in a preparatory open concept classroom: he was described as pleasant, attention seeking, but having learned very little. The family moved from Nova Scotia to Ottawa where the boy entered grade 1. At the end of that year he was still behind in phonetics despite remedial assistance after school hours. He had now become so conscious of his difficulties that he would not attempt any work without an adult's assistance. In September 1974, he was placed in the CSC's combined school-residence program for a more intensive approach to his learning problems and deflated self-image. Because of their proximity, frequent outings and visits with his parents and sister were possible.

Diagnostic Test Results

Intelligence. On the WISC-R, Ernest obtained a Verbal IQ of 102, a Performance IQ of 131 and a Full Scale IQ of 118. In addition to the weak verbal skills, low scores were obtained on the Arithmetic and Digit Span subtests.

Achievement. In December 1975, at a theoretical placement of grade 3.4, the combined results of the WRAT and the Gates-MacGinitie Reading Tests gave Ernest a mean achievement rating of grade 2.9.

Learning Quotient. Calculation of the Myklebust Learning Quotient formula gave Ernest a score of 80. This quotient is well below the critical cut-off of 90, thereby indicating classification in the learning disability category.

Pupil Rating Scale. Ernest received an overall rating of 63, well below the chosen cut-off score of 70. He obtained low ratings in the areas of Auditory Comprehension, Spoken Language, Orientation to Time and Space, and Personal-Social Behavior.

In addition to the discrepancy criteria reported above, Ernest met the requirements of the exclusion and special education criteria of the operational definition of dyslexia.

Audio-Psycho-Phonological Criteria

Tomatis Listening Test. The TLT gave many indications of poor listening skills. Selectivity was completely closed on the right ear, and closed from 1000 Hz up on the left ear. The air conduction thresholds were generally high and flat

except for a sharp drop in the high frequency range: this indicated undifferentiated listening ability and poor energizing capacity. The bone conduction threshold was distorted in the low frequency range. One spatialization error was recorded on the left ear.

Audiolaterometry. The ALM indicated that the left ear had a small advantage of 1.0 in the control of speech.

Personal interview. In trying to follow ongoing conversations, Ernest became restless, fatigued, and his attention soon wandered elsewhere. He expressed himself in a halting stodgy way, with many synkinesias in the upper and lower limbs. In the auto-information exercise, as Ernest spoke into a make-believe microphone held in his right hand, his voice rose noticeably and he spoke more fluently: this constituted a hopeful sign. According to Dr. Tomatis, a psychological interpretation of the TLT suggested that Ernest had a poor and guilt-laden relationship with his mother. Tomatis indicated that this boy was indeed dyslexic according to APP criteria, and recommended a lengthy emphasis on the Passive Phase of the training program using the mother's filtered voice.

Ernest could therefore be classified as dyslexic according to the composite definition proposed earlier and according to APP criteria.

APP Remedial Training ProgramThe Passive Phase: Filtered Sounds

As anticipated by Dr. Tomatis, training at this subphase was lengthy, involving over 120 sessions from early February to mid-May. After an initial 10 sessions of listening to filtered classical music, the remainder involved listening to the mother's filtered voice.

Tomatis Listening Test. Selectivity opened up slowly until completely open by late March. By mid-May, the air and bone conduction thresholds both took on a definite ascending curve although the latter remained slightly above the former. The one spatialization error was corrected by mid-March.

Program Assistant's observations. Seemingly bored in February, Ernest's spirits lifted in March and he became much more talkative. This coincided with the gradual opening of selectivity. It suddenly dawned on him that he had no friends: he discussed this matter with the Program Assistant and with his father. Prior to this, Ernest rarely talked so openly about his relationship with others. In April and May, Ernest's outlook on life seemed more hopeful and positive.

Teachers' observations. In March, Ernest became more active and very talkative in the classroom. Although he was able to persist more at his desk work, he was also easily distracted. In early April, he no longer had to be prompted to read and spell despite his obvious difficulties. General-

ly he seemed more buoyant. In early May, he joined his classmates in a very physical floor hockey game, congratulating and embracing team mates who had scored. He was now much more comfortable relating to children his own age.

Parental observations. The CSC residence houseparents noted that by April, Ernest no longer needed to be pushed to do his homework. They also noted that his sleep pattern had changed: he slept more soundly and awoke quickly in the morning, cheerful and refreshed. Prior to this, he slept restlessly and was hard to get up in the morning.

On a visit home in late March, Ernest manifested a strong need to be physically close to his mother. She found this surprising as well as annoying. She was counselled on how to meet these demands in a healthy positive way. That same weekend, Ernest invited a few neighborhood boys over to his house and organized a floor hockey game. He had never ventured himself socially like this before.

Subphase summary. The opening of selectivity with ascending listening thresholds on the TLT indicated readiness to move on to the Sonic Birth subphase. This was confirmed by behavioral reports of improved mood tone and work attitude, and of more positive social interaction.

Passive Phase: Sonic Birth

The Sonic Birth was successfully introduced in a single session: Ernest was delighted to recognize his mother's voice as the source of the taped sounds he had been listening to.

Following four sessions of listening to the mother's natural voice, Ernest's TLT results and behavior remained positive. The Active Phase was therefore started.

The Active Phase: Performing

Ernest advanced quickly through the taped auditory-vocal exercises and had little difficulty maintaining the prescribed postures during the repetition of words and phrases. This subphase involved 70 training sessions from mid-May to mid-July.

Tomatis Listening Test. The TLT results improved slightly: the bone conduction thresholds fell slightly below the ascending air conduction thresholds.

Program Assistant's observations. Ernest learned to clearly articulate and enunciate more quickly than anticipated. His facial muscle-play suggested right-eared control of speech. Synkinesias of upper and lower limbs gradually disappeared except when he repeated difficult phrases. In July, he suddenly seemed to pull himself together physically: as he talked, he maintained upright posture and good eye contact while his gestures were well coordinated with his facial expressions and speech intonations. He suddenly began to express his thoughts more clearly and succinctly.

Teachers' observations. Ernest now demonstrated a keen interest in being accepted by his classmates and peers. He took the initiative to organize games and no longer gave up or broke into tears when these activities did not always

turn out as he wanted them to. In class, his phonetic skills had improved noticeably with subsequent gains in spelling and word recognition.

Parental observations. The residence house parents noted that Ernest was very cooperative during this period and that he took the initiative to organize games with peers. In July, his parents underlined, during a Sunday visit at the summer camp, that for the first time in their recollection Ernest was expressing his ideas with logic and continuity in contrast to his habitual verbal rambling.

Subphase summary. Ernest performed well on the taped auditory-vocal exercises. The TLT results were favorable. He seemed to discover the need to be with others and to give a little of himself towards this end. His posture and bodily coordination during speech improved noticeably, and he became more organized in the expression of his thoughts. Gains in academic performance were also reported. This was a very rewarding subphase for Ernest who was now eager to move on to the last part of the program.

Active Phase: Training

This subphase involved 115 sessions from late July to the end of November. Reading sessions were alternated with sessions of listening to filtered classical music. By early September, Ernest had managed to read through several grade 1 and grade 2 level short texts with little evidence of fatigue or synkinesias. He started reading some grade 3

level stories. At this point, voice quality and speech control were very good. In October and November, training was reduced from 5 to 3 hours a week.

Tomatis Listening Test. The TLT results had changed little from the end of the previous subphase. The bone conduction thresholds had risen slightly above the air conduction curve, suggesting a slight increase in tension.

Program Assistant's observations. Although Ernest could read words and short sentences, he tended to do so too quickly in a staccato-like voice. After being encouraged to slow down and pace himself better, he became intrigued with the degree of rhythm and intonation he could inject into his voice and oral reading. By September this boy could read fairly fluently and with respect for punctuation.

Teachers' observations. Ernest started to exhibit a strong desire to communicate his ideas and feelings, and to have his say in every discussion. At the same time he could respect the same need in others and listen to their contribution. He had in fact become quite aware of the feelings of others and was seen one day consoling a tearful classmate. His ability to read had continued to improve but spelling remained weak. His enthusiasm remained high.

Parental observations. Ernest's improvement in overall behavior and in academic performance now justified his living at home rather than in the CSC residence, according to the Director of the CSC. While this move introduced a signifi-

cant unexpected change in the boy's lifestyle and in the research project, it does underline the reality of successful remedial training. This move did not alter Ernest's progress. Although he missed the structured activities of the residence setting, he managed to organize his own time and to make his own fun at home and in the neighborhood. Ernest's parents continued to be amazed at how well he could express his thoughts now. The father in particular appreciated the opportunity to discuss and exchange ideas with his son. Ernest felt accepted as an interesting and valued member of his family.

Subphase summary. The TLT results remained generally positive. Ernest's social skills continued to improve along with a greater sensitization to the needs of others. He could communicate his ideas clearly as well as relate on a give and take basis. His reading ability continued to improve although his spelling remained weak.

Summary of Ernest's APP Training Program

During the Passive Phase of Training, early improvements in mood tone, energy level, sleep pattern and concentration were followed by greater and more positive involvement in social and academic activities. During the Active Phase of training, successful social interaction at a more differentiated level was apparent: Ernest was now capable of discussing with others on a give and take level, and was more sensitive to the needs of others. During this phase, his

verbal self-expression became more logical and organized, and his reading skills improved remarkably.

Figure 15 presents the TLT and ALM results taken before and after the APP training program. The final listening test taken in December 1976 shows that Ernest had made considerable progress since the start of the program. Selectivity was open and no spatialization errors occurred. The air conduction thresholds revealed a more differentiated ascending curve with greater sensitivity in the energizing high frequency range. The bone conduction thresholds were less distorted than before although not below the air conduction curves. The slight peaks in bone conduction at 250 and 1500 Hz are often related, according to APP theory, to food allergies. Ernest is known to have a milk allergy. The final ALM test indicated a strong right ear advantage of 2.5 in the control of speech after APP training, a noteworthy advance over the slight left ear advantage shown before the program.

Overall, Ernest's APP remedial training program could be qualified as very successful.

Comparison of the APP Programs

The APP training programs for the five dyslexic boys were carried out over a 10-month period. Figure 16 depicts how each child's training time was utilized during that time span. As shown, all five children spent varying lengths of time in the specific subphases of the program. This under-



TOMATIS LISTENING TEST TEST D'ÉCOUTE TOMATIS

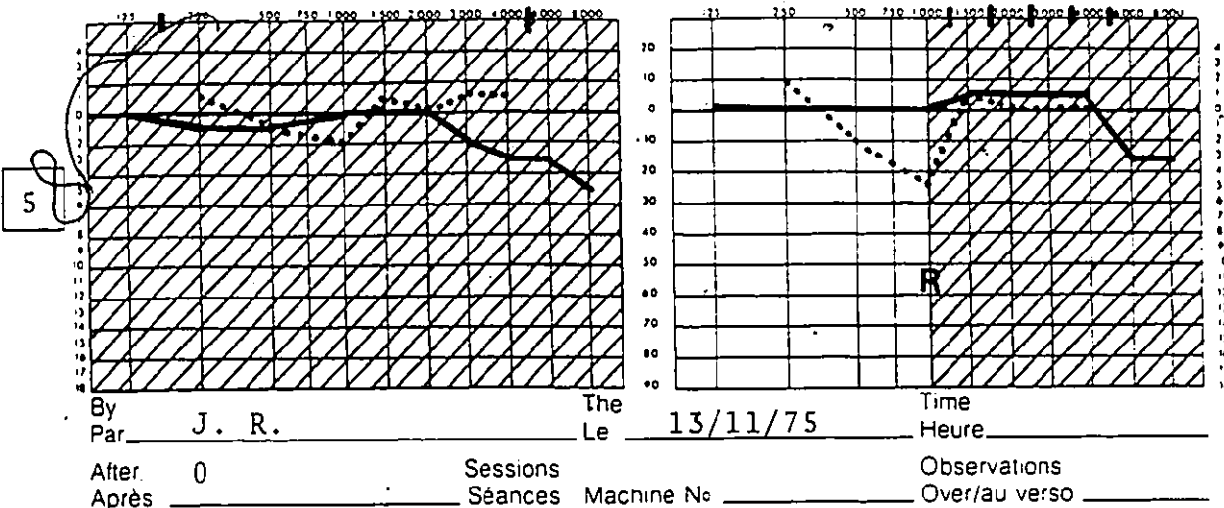
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FAMILY NAME Case #5 GIVEN NAME ERNEST AGE 9 yrs 3 mons
NOM de FAMILLE Case #5 PRÉNOM ERNEST

N°

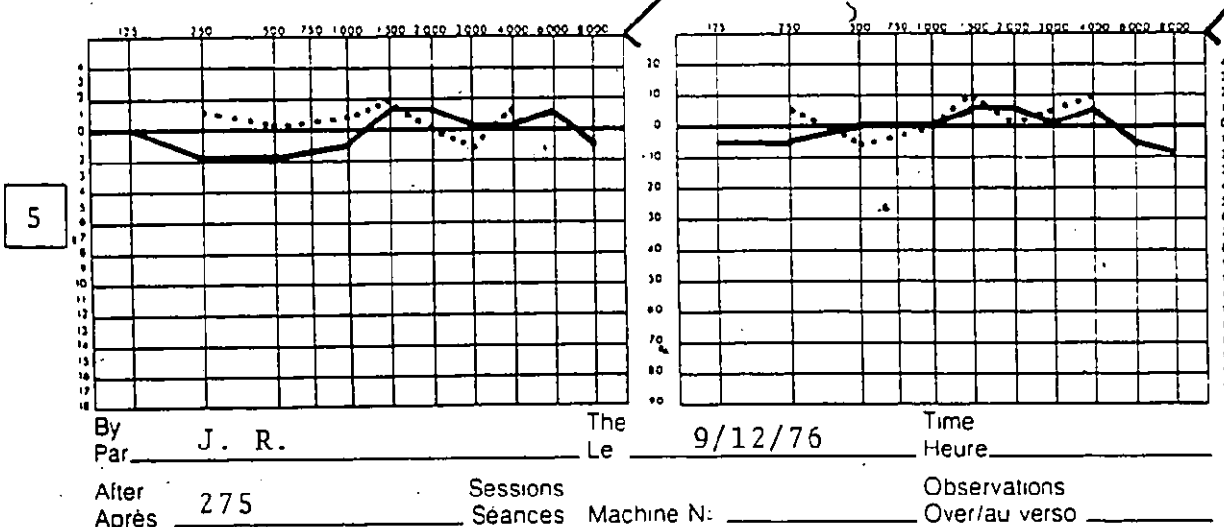
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AT THE START OF APP TRAINING

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AFTER TERMINATION OF APP TRAINING

Figure 15. Pre and post APP remedial training results on the Tomatis Listening Test and Audiolaterometry for Ernest.

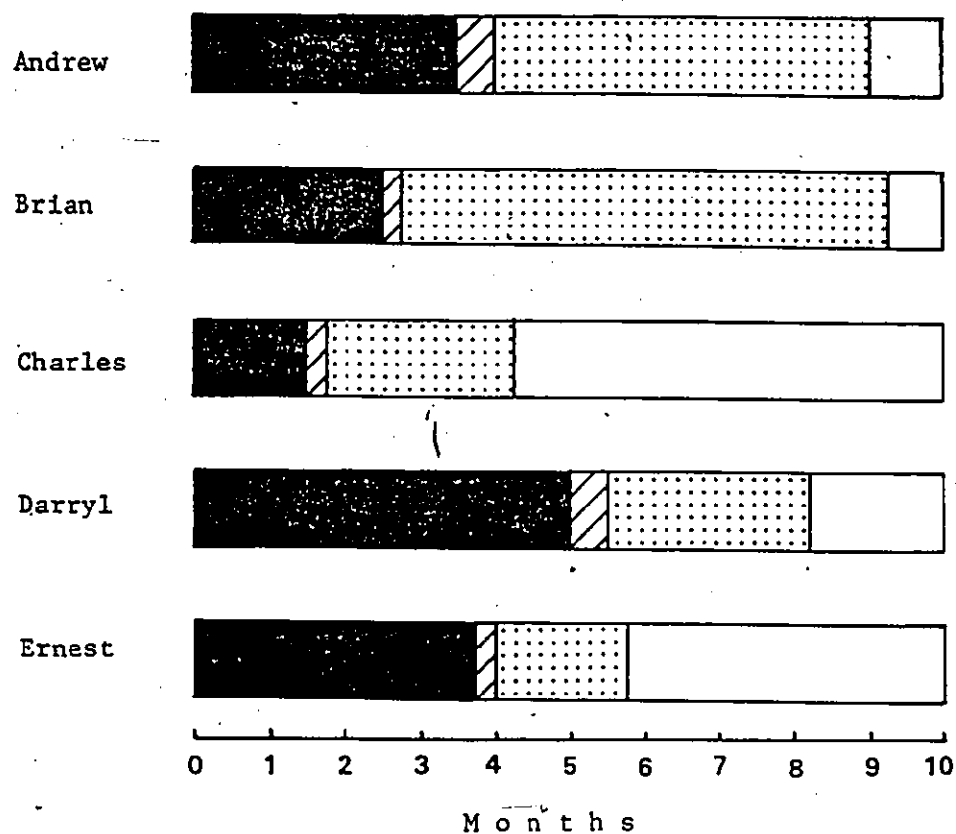


Figure 16. Comparison of time spent by each child on various subphases of the APP remedial training program.

scores the personalized nature of APP training based upon the particular difficulties and rate of progress of each child. The individualized application of the APP program, necessitated by the treatment needs of a heterogeneous phenomenon like dyslexia, could be respected and illustrated in the present research because of its intensive single case approach.

CHAPTER IV

PRESENTATION OF THE RESULTS

Introduction

This chapter presents the results of the perceptual processing (ITPA) and academic achievement tests for the five dyslexic boys who followed the APP remedial training program. These tests were given at the start and every second month of the 14-month long research project. This provided eight sets of results over the 2-month baseline period, the 10-month training program and the 2-month follow-up period. In addition, pre and posttraining comparisons will be presented on the WISC-R, the Myklebust Learning Quotient and on the Pupil Rating Scale. Each child's results will be presented separately in keeping with the case study format.

Case #1: Andrew

Perceptual Processing (ITPA) Results

As indicated in Chapter 2, all of the ITPA subtests except Visual Closure were administered during the research project. Of the eight sets of results obtained, the first two define the baseline period, the third to the seventh set cover the training period, and the eighth provides for the follow-up period.

Table 1 presents the eight sets of ITPA results for Andrew, from December 1, 1975 to February 1, 1977. The re-

Table 1
Andrew's ITPA Scaled Scores for Eight Testing Sessions

ITPA Subtests	Testing Sessions*							
	1	2	3	4	5	6	7	8
Representational Level								
Auditory Reception	41	42	43	45	44	44	44	44
Visual Reception	40	40	41	44	45	46	45	46
Auditory Association	48	50	48	48	50	50	51	50
Visual Association	32	32	43	49	51	53	50	49
Verbal Expression	41	41	40	44	40	44	43	42
Manual Expression	44	46	49	46	48	47	46	46
Automatic Level								
Grammatical Closure	46	43	46	44	45	45	44	43
Auditory Seq. Memory	51	49	49	49	47	48	49	50
Visual Seq. Memory	39	37	35	43	41	42	42	45
Auditory Closure	43	43	46	46	45	47	46	46
Sound Blending	44	45	44	46	45	45	45	46
Mean Scaled Score	42.6	42.5	44	45.8	45.5	46.4	45.9	46.1
Standard Deviation	5.03	5.16	4.27	2.09	3.36	3.08	2.91	2.61
Total Change Between Testing Sessions		-1	+16	+20	-3	+10	-6	+2

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

sults have been converted to scaled scores. A scaled score of 36 (with a standard deviation of 6) indicates the mean performance of each and any age group of the reference population on each of the subtests. The scaled score for any subtest at any age can be directly compared to any other. For each set of results on Andrew, the mean scaled score (SS) and the standard deviation have been calculated. Furthermore the total change from one administration to the next has also been provided to indicate the extent and direction of any change.

The ITPA manual indicates that differences between the mean SS and a subtest SS of ± 6 should not be considered an indication of a special ability or disability since this is the range within which over 80% of average children score (Kirk et al., 1968, p. 95-96). It is suggested therein that differences between the mean SS and a subtest SS of ± 7 , ± 8 or ± 9 be considered as borderline discrepancies, while a difference of ± 10 or more be considered as a substantial discrepancy.

The ITPA manual does not discuss differences in mean SS or subtest SS between two or more ITPA administrations. The writer has decided to consider a difference of ± 6 (one standard deviation) or more between any two administrations on a particular subtest SS or on the mean SS as indicative of a substantial change, while a difference of ± 3 , ± 4 or ± 5 will be considered as indicative of a small change.

The ITPA results are presented in terms of the baseline, APP training, and follow-up periods of the investigation.

Baseline Period

The first set of results from early December 1975 revealed one substantially discrepant function: Visual Association, with a SS of 32, was more than 10 points below the mean SS of 42.6. This is in sharp contrast to the Auditory Association SS of 48, the highest of all subtests at the representational level. Visual Sequential Memory, with a SS of 39, proved to be weakest of the automatic level subtests, in contrast to Auditory Sequential Memory which was the strongest. The standard deviation of 5.03 indicates a fairly large subtest scatter and a heterogenous mode of functioning.

Qualitatively Andrew was slow in understanding or retaining subtest demands, often asking for directions or questions to be repeated or for a test item to be shown again. He was also slow in arriving at an answer even though the eventual response was often correct. On Visual Association and Visual Sequential Memory, Andrew seemed perplexed and unable to retain the essence or the image of the stimulus material. On Verbal Expression, he offered short and purely descriptive statements. On Manual Expression, he was clearly ambidextrous in demonstrating his responses.

The second set of results, obtained in early February 1976, remained virtually unchanged from the first, thereby indicating a very stable baseline trend. Qualitatively, even

though Andrew understood the requirements of each subtest,, he remained slow and sometimes perplexed in dealing with many test items.

APP Remedial Training Program

The third set of results, obtained 2 months into the training program, recorded an overall gain of 16 scaled scores. More specifically, Visual Association advanced substantially by 11 scaled scores.

Qualitatively, Andrew responded more quickly to test items, perhaps too quickly. He seemed more alert yet in an overactive and impatient way. He succeeded on some difficult tasks yet failed on easier items he had previously answered correctly. Somewhat overtalkative, he did a lot of his thinking aloud in approaching some tasks. For example, on Visual Association he used verbal labels to deal with the conceptual demands of the task. On Verbal Expression he gave more elaborate answers but his ideas were not always relevant or creditable.

The fourth set of results from June 1976 showed an overall gain of 20 scaled scores. The standard deviation was reduced from 4.27 to 2.09, demonstrating considerable homogeneity in the subtest pattern. Visual Sequential Memory and Visual Association advanced substantially by 8 and 6 scaled scores respectively. Visual Reception and Verbal Expression recorded small gains.

Qualitatively, Andrew seemed more settled than previously

and responded in an alert consistent way. He did not fail easy items because of seeming impatience as he had done on the third testing. He delivered more personal and relevant responses to Verbal Expression, often prefacing his statement with "I think". He thought out loud in dealing with Visual Reception, Visual Association and Visual Sequential Memory, using verbal labels and mnemonics to benefit.

The fifth set of results from August 1976 brought little change except that the standard deviation increased from 2.09 to 3.36 towards greater subtest scatter. On Verbal Expression, which fell by 4 scaled scores, Andrew seemed fearful and hesitant in stating his replies. In his approach to many items, he continued to talk to himself, but more quietly and less frequently.

The sixth set of results from October 1976 showed a mean SS gain of .9. Verbal Expression recorded a small gain of 4 scaled scores to make up for a previous loss of the same degree. Qualitatively, Andrew was more self-confident. He gave better organized responses on Verbal Expression, however verbal fluency is not recognized in scoring this subtest. He whispered or subvocalized to himself only on a few difficult test items.

The seventh set of results, obtained in December 1976 at the close of APP training, recorded a loss of 6 scaled scores overall. Visual Association suffered a small loss of three scaled scores. In his approach to test items, Andrew

no longer talked to himself noticeably. On Verbal Expression, his responses included more abstract considerations.

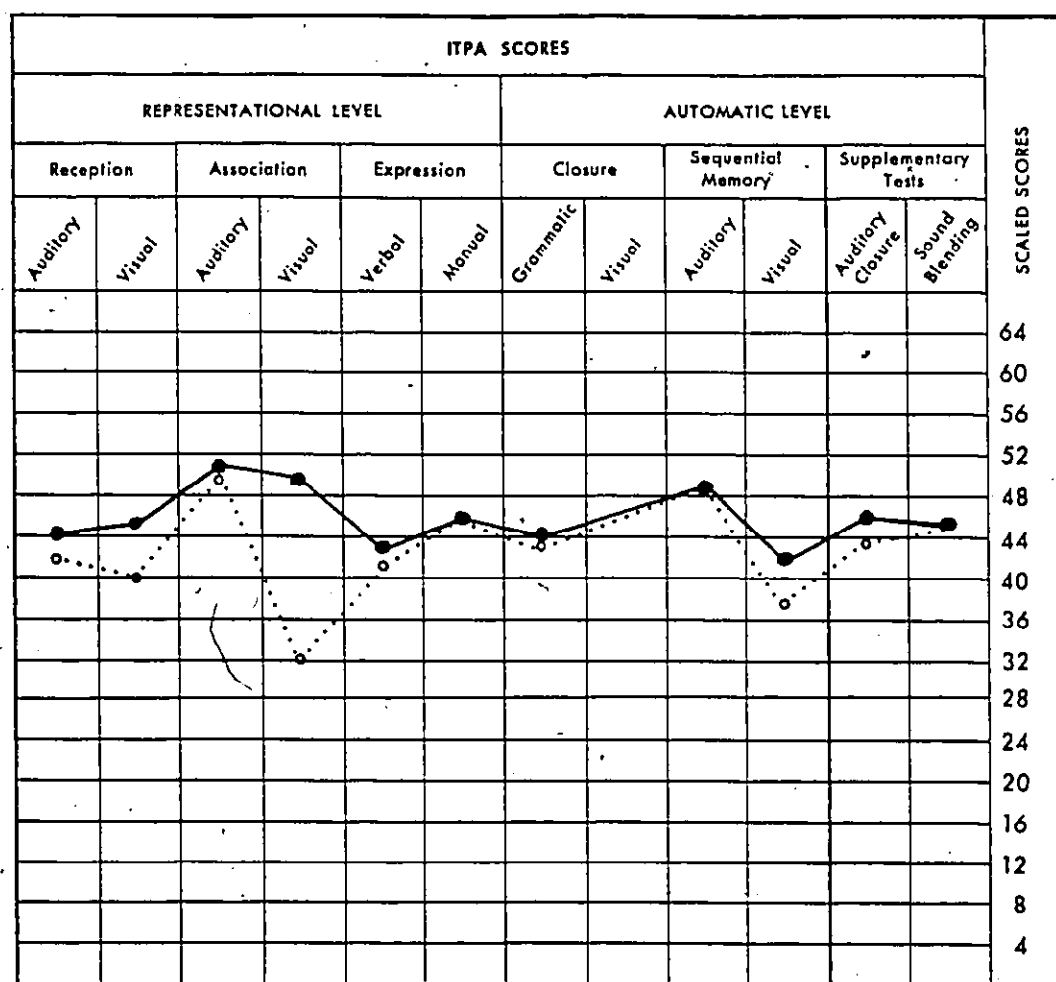
Figure 17 depicts Andrew's ITPA subtest profile before and after APP remedial training. The most striking changes occurred in visual-motor channel functions. Visual Association recorded a very substantial gain of 18 scaled scores (+30). Visual Reception and Visual Sequential Memory advanced by 5 scaled scores each. Auditory Closure made a small gain of 3 scaled scores. At the close of the training program, the overall ITPA subtest pattern was visibly better balanced; on the basis of the mean SS of 45.9 (see Table 1), no subtest function could be qualified as discrepant or even marginally discrepant.

Follow-Up Period

The eighth and final set of results brought little change save a small gain of 3 scaled scores on Visual Memory.

Table 1 also indicates that from the beginning to the end of the research project, the standard deviation for Andrew's ITPA results was reduced from 5.03 to 2.61. Following a fairly stable baseline, a sharp trend towards a more homogenous subtest pattern defined itself over the first four months of APP training. This trend was partially reversed in August and gradually resumed thereafter until the end of the follow-up period.

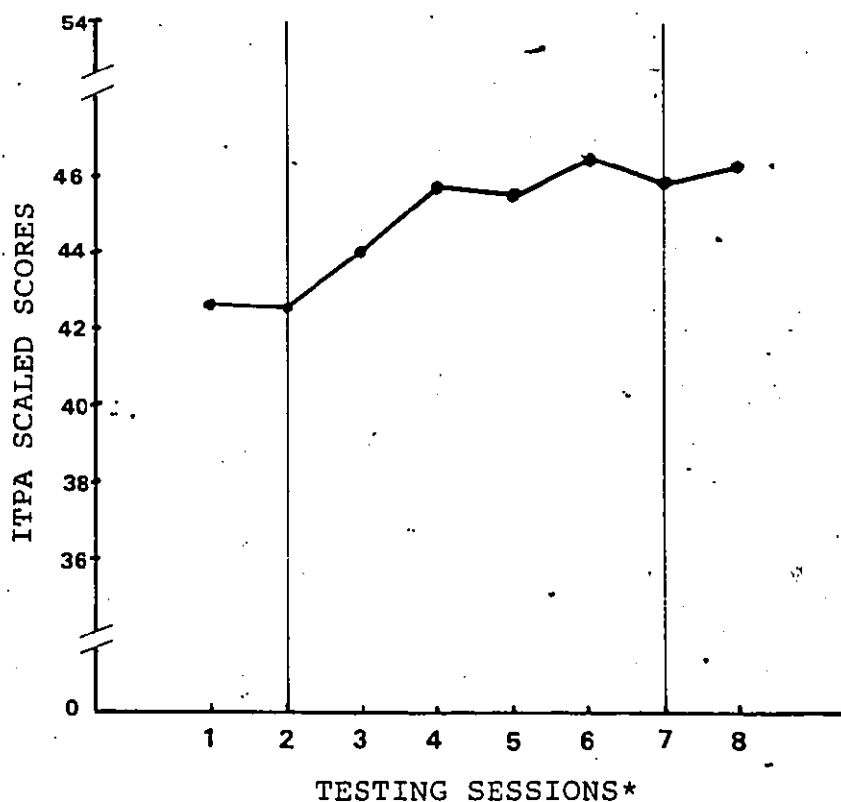
Figure 18 charts Andrew's mean ITPA scaled scores throughout the investigation. Following a stable baseline, the



..... Before APP training (Feb. 1, 1976).

———— After APP training (Dec. 1, 1976).

Figure 17. Andrew's ITPA patterned scaled scores before and after APP training.



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 18. Andrew's mean ITPA scaled scores during baseline, APP training and follow-up periods.

strongest gains were attained during the first half of the training program from February to June 1976. Slight additional gains were made from August to October, with relatively little change thereafter.

Academic Achievement Test Results

Since the results of the WRAT and Gates-MacGinitie Reading subtests proved to be quite variable, the mean of all five subtests given was adopted as a more stable index of academic achievement for purposes of comparison over the eight testing sessions. The academic achievement subtest results and the achievement index for Andrew are presented in Table 2. These will be described in the context of the baseline, APP training and follow-up periods.

Baseline Period

Andrew's overall achievement index of grade 2.0 did not change for the first two sets of results that form the baseline period. His word attack skills revealed a poor grasp of phonics. He tended to guess at words on the basis of their initial letters. He obtained his highest grade rating on the Vocabulary subtest because he used picture cues to his advantage. His spelling contained errors of letter sequence or omission. On the Arithmetic subtest, he counted with his fingers for purposes of addition and subtraction, and avoided multiplication items.

Table 2

Andrew's Achievement Test Grade Ratings for Eight Testing Sessions

Test	Subtest	Testing Sessions*							
		1	2	3	4	5	6	7	8
WRAT									
	Reading	2.1	1.6	2.2	2.6	2.9	3.3	3.6	3.9
	Spelling	1.6	1.9	1.8	1.8	1.8	2.0	2.2	2.5
	Arithmetic	2.2	2.2	2.6	2.6	2.8	2.8	3.0	3.6
Gates-MacGinitie									
	Vocabulary	2.6	2.4	2.8	4.1	3.1	4.1	3.7	4.4
	Comprehension	1.7	1.9	2.3	2.6	2.8	4.0	4.9	4.6
Achievement Index**									
		2.0	2.0	2.3	2.7	2.7	3.2	3.5	3.8

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

** Mean of all five achievement subtests.

APP Remedial Training Program

The third and fourth set of results show a rise in Andrew's achievement index to grade 2.3 by early April and to grade 2.7 by early June. These gains were more quantitative than qualitative: Andrew attempted more test items within time limits, and with some success. However his word attack skills and error patterns remained unchanged. On Arithmetic, he again avoided multiplication problems because, as he stated, "I don't know times".

Qualitatively, Andrew's concentration span had improved noticeably in April although he was very talkative and restless. By June, although still chatty, he was more settled and could apply himself with more purpose. In June, he had also started to sound out words as he tried to spell.

With the fifth set of results, the academic achievement index remained unchanged. Gains on most subtests were nullified by a large drop on the Vocabulary subtest. In reading, Andrew still tended to guess at difficult words rather than sound them out. On Spelling, errors of sequence or omission began to disappear.

The sixth set of results brought a sharp jump in the achievement index from grade 2.7 to grade 3.2, with gains on all subtests except Arithmetic. On Spelling, a more accurate sound-symbol association had been achieved. Andrew's concentration was remarkably good. He could now persist in sounding out longer and more difficult words rather than just

guess at them.

The seventh set of results in December 1976 registered another advance on the achievement index from grade 3.2 to grade 3.5. Andrew had started to decode words more quickly with increased comprehension. On Arithmetic, he no longer used his fingers to count and he succeeded on simple multiplication problems. His spelling was phonetically more accurate and his errors more comprehensible.

Qualitatively, one of the test administrators noted that Andrew now seemed self-assured of his reading skills and did not spend as much time as before checking over answers.

In the space of 10 months, from the start to the end of APP training, Andrew's overall achievement index advanced from grade 2.0 to grade 3.5. According to achievement test results and classroom performance records contained in his clinical file, he had advanced only half a grade in the 10 months that preceded this research project.

Follow-Up Period

The eighth set of results registered an advance in the achievement index from grade 3.5 to grade 3.8. Arithmetic moved ahead from grade 3.0 to grade 3.6 as Andrew had now learned his times tables sufficiently to tackle some multiplication and division problems. Spelling advanced from grade 2.2 to grade 2.5 as Andrew could now deal with those words that followed the regular sounds of the English language. At this point two months after the close of APP training,

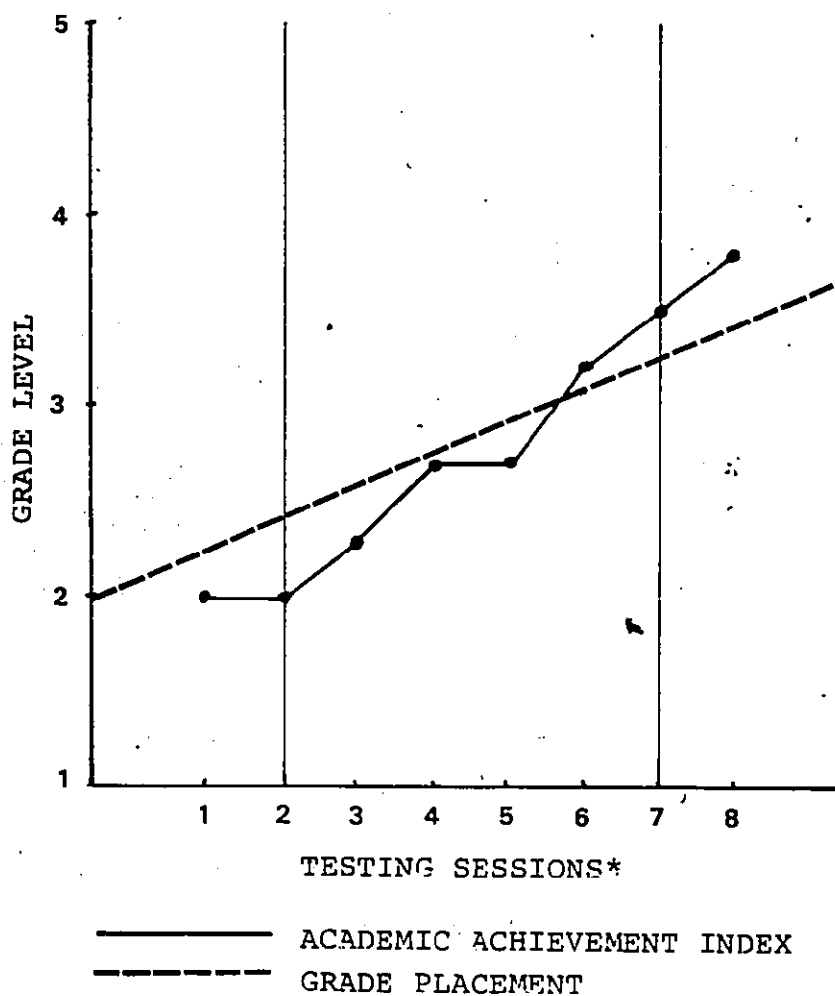
the degree of Andrew's concentration and self-assurance was maintained.

Figure 19 represents the academic achievement index ratings throughout the investigation. No gains in achievement occurred during the baseline period. A clear progressive trend was established during and after APP training, only briefly interrupted between June and August 1976. During the training period, Andrew's achievement index caught up to and surpassed his grade placement.

Table 3 contrasts Andrew's achievement test results, at the start of APP training and at the close of the follow-up period, in terms of grade ratings and percentile ranks. The February 1976 to February 1977 time span was chosen in preference to the shorter pre-posttraining period to make the best use of some of the percentile rank tables which are geared to the middle of the academic year in early February. As indicated, within a year Andrew gained more than a full grade on all subtests except Spelling. In February 1976, all subtests were ranked below the 50th percentile, while in February 1977, all subtests except Spelling were ranked well above the 50th percentile.

Additional Pre and Posttraining Data Comparisons

As indicated in Chapter 2, some of the tests and methods used at the start of the research project for diagnostic purposes would be employed after APP training for pre and post comparison purposes.



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 19. Andrew's academic achievement index during baseline, APP training and follow-up periods.

Table 3

Comparison of Andrew's Achievement Test Results
at the Onset of APP Training and at the Close of
the Follow-Up Period

Test	Subtest	February 1976* Grade	%ile	February 1977** Grade	%ile
WRAT					
	Reading	1.6	14	3.9	68
	Spelling	1.9	21	2.5	27
	Arithmetic	2.2	30	3.6	61
Gates-MacGinitie					
	Vocabulary	2.4	42	4.4	69
	Comprehension	1.9	27	4.6	69

* At the onset of APP training.

** At the close of the follow-up period.

Intelligence. Prior to the baseline period, in late November 1975, Andrew obtained a WISC-R Verbal IQ of 109, a Performance IQ of 123 and a Full Scale IQ of 118. He received his lowest scaled score of 8 on the Arithmetic subtest. Uneven cognitive functioning was in evidence throughout the intelligence test. Just after the follow-up period, in early March 1977, Andrew obtained a WISC-R Verbal IQ of 119, a Performance IQ of 117 and a Full Scale IQ of 121. In addition to a more stable mode of cognitive functioning, the Arithmetic scaled score rose from 8 to 11, and the Comprehension scaled score from 13 to 16.

Learning Quotient. At the start of the research project, the discrepancy between Andrew's actual and expected achievement was estimated according to Myklebust's (1967) Learning Quotient method. The resulting score of 86 was below the recommended cut-off score of 90, indicating classification in the potential learning disability category. At the close of APP training in December 1976, Andrew's Learning Quotient had risen to 94.

Pupil Rating Scale. Just before the baseline period, Andrew received a rating of 68 on the PRS, below the chosen cut-off score of 70. He obtained comparatively low ratings in the areas of Orientation to Time and Space, and Motor Coordination. In December 1976, after APP training, he received a PRS rating of 73. This reflected gains mainly in the areas of Auditory Comprehension and Orientation to Time

7

and Space as well as a loss in the area of Personal-Social Behavior.

A summary of these pre and posttraining comparisons is presented in Table 4.

Case #2: Brian

Perceptual Processing (ITPA) Test Results

Brian's ITPA results are presented in Table 5.

Baseline Period

The first set of results did not reveal any substantially nor marginally discrepant functions. At the representational level, all auditory-vocal channel functions were weak in comparison to their visual-motor counterparts. At the automatic level, two other auditory-vocal channel functions, Grammatic Closure and Auditory Sequential Memory, attained relatively weak scaled scores. Qualitatively, on Verbal Expression, Brian groped for words and often produced short vague answers. On Visual Reception and Verbal Expression, he had difficulty going beyond the concrete aspects of the stimulus materials to accede to a more abstract or conceptual level of response.

The second set of results showed little overall change quantitatively or qualitatively from the former set. The baseline period was thus quite stable as to ITPA functions.

APP Remedial Training Program

The third set of results recorded a total gain of 16 scaled scores and a mean SS gain of 1.5. While Auditory Clo-

Table 4
Pre and Posttraining Data Comparisons for Andrew

Source of Data	Pretraining	Posttraining
WISC-R		
Verbal IQ	109	119
Performance IQ	123	117
Full Scale IQ	118	121
Learning Quotient*	86	94
Pupil Rating Scale**	68	73

* A Learning Quotient of 89 or less indicates classification in the learning disability category.

** A PRS score of 69 or less indicates potential learning difficulties.

Table 5
 Brian's ITPA Scaled Scores for Eight Testing Sessions

ITPA Subtests	Testing Sessions*							
	1	2	3	4	5	6	7	8
Representational Level								
Auditory Reception	38	39	44	35	41	41	38	37
Visual Reception	42	41	45	46	45	48	46	46
Auditory Association	37	40	41	44	42	44	40	40
Visual Association	46	47	49	52	52	50	48	49
Verbal Expression	37	38	34	35	44	39	43	42
Manual Expression	47	46	47	48	46	48	43	46
Automatic Level								
Grammatical Closure	37	35	32	34	34	36	40	40
Auditory Seq. Memory	36	34	36	36	35	36	34	34
Visual Seq. Memory	39	36	37	41	38	40	31	38
Auditory Closure	43	42	49	47	46	46	46	46
Sound Blending	43	42	42	42	45	46	45	44
Mean Scaled Score	40.5	40	41.5	41.8	42.6	43.1	41.3	42
Standard Deviation	3.91	4.19	5.99	6.16	5.30	4.95	5.31	4.63
Total Change Between Testing Sessions		-5	+16	+4	+8	+6	-20	+8

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

sure advanced substantially by 7 scaled scores, a number of subtests registered small gains or small losses. The standard deviation increased from 4.19 to 5.99, indicating a more heterogeneous mode of functioning on the ITPA.

Qualitatively Brian proved to be much more alert although in a jumpy and mildly distressed way. He responded very quickly to test items, sometimes in a brash manner as on the Visual Reception subtest. He was quickly frustrated on Verbal Expression and Grammatic Closure when he could not organize his answers to his satisfaction.

The fourth set of results showed little overall change from the third testing. A substantial loss of 9 scaled scores on Auditory Reception balanced off small gains on Auditory Association, Visual Association and Visual Sequential Memory. Qualitatively, Brian seemed dazed and confused on the Auditory Reception subtest. He verbalized overtly in his approach to most visual-motor channel subtests, using language to guide his responses, classify concrete visual stimuli or assist in recall. On Grammatic Closure, he was often ambivalent about his vocalized responses, sometimes rejecting an initially correct answer.

With the fifth set of results, Auditory Reception and Verbal Expression moved ahead substantially while Sound Blending showed a small gain. Qualitatively Brian no longer appeared dazed or confused on Auditory Reception. He was noticeably quicker and more accurate in his responses to Sound

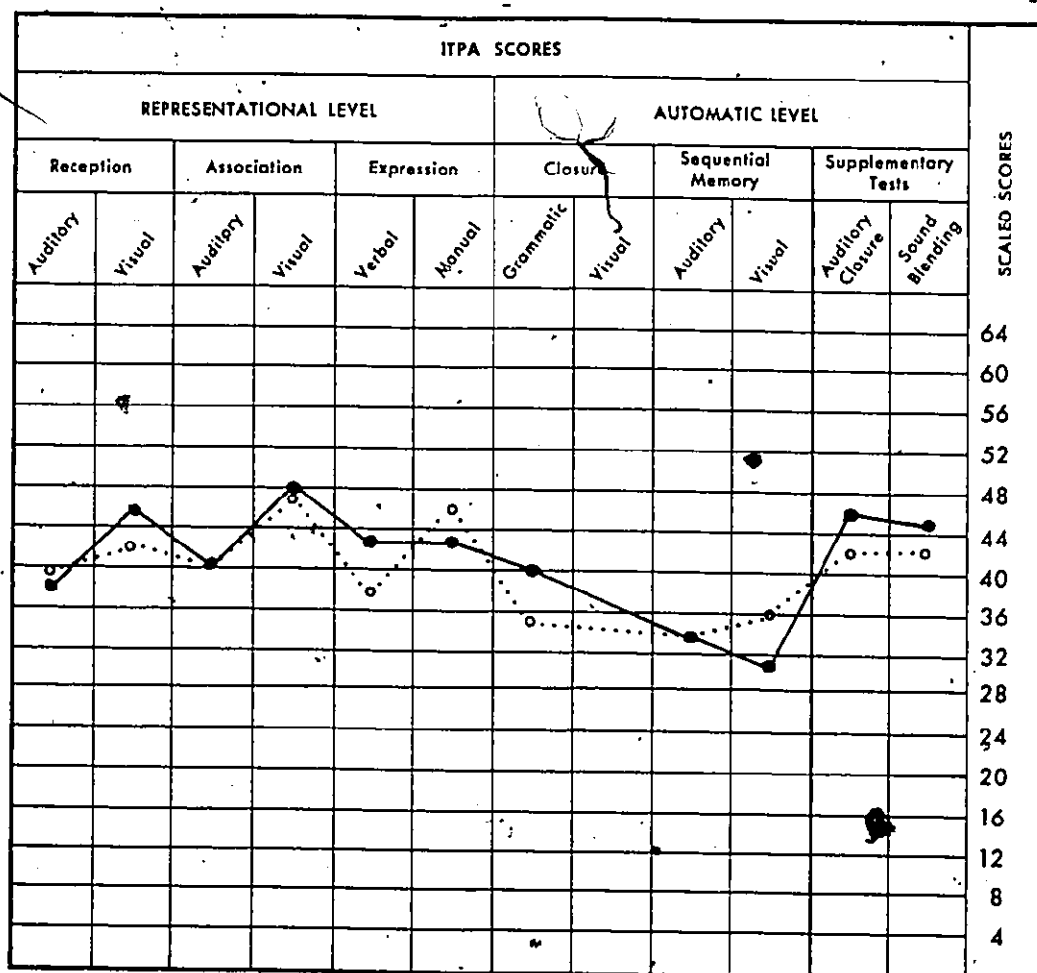
Blending. On Verbal Expression, he provided more personal and abstract level answers. Generally he expressed his ideas more quickly and accurately than before.

The sixth set of results offered little overall change from its predecessor. Verbal Expression fell back by 5 scaled scores as Brian made little effort on this subtest. He had been moody for several days prior to testing.

The seventh set of results obtained at the close of APP training indicated an overall loss of 20 scaled scores and a decline of 1.8 in the mean SS. This came as a result of losses on eight subtests, particularly on Visual Sequential Memory and Manual Expression. In contrast, Verbal Expression and Grammatic Closure both advanced by 4 scaled scores.

Qualitatively, Brian formulated his ideas more clearly on Verbal Expression and in his general remarks. On Grammatic Closure, he listened closely to his answers and corrected improper ones because, in his words, "That doesn't sound right". However on other subtests such as Visual Sequential Memory and Manual Expression, he was perplexed and frustrated because he could not perform as well as he had previously.

Figure 20 depicts Brian's ITPA results and subtest pattern before and after APP training. No subtest changed substantially although Visual Reception, Verbal Expression and Grammatic Closure showed a positive trend in this direction with gains of 5 scaled scores each, and Visual Sequential Memory showed a negative trend with a loss of 5 scaled scores.



..... Before APP training (Feb. 1, 1976).

———— After APP training (Dec. 1, 1976).

Figure 20. Brian's ITPA patterned scaled scores before and after APP training.

At the representational level, auditory-vocal functions remained relatively weak after APP training. At the automatic level, both sequential memory functions remained weak despite small gains in other functions. On the basis of the mean SS of 41.3 (see Table 5), Auditory Sequential Memory could be considered marginally discrepant, and Visual Sequential Memory could be classified as substantially discrepant. On the overall, the posttraining profile appears less balanced than its pretraining counterpart.

Follow-Up Period

The eighth and final set of results saw Visual Sequential Memory and Manual Expression advance by 7 and 3 scaled scores respectively, to partially make up for their previous declines. The standard deviation was reduced from 5.31 to 4.63, the lowest since pretraining evaluations. Qualitatively, the confusion noticed during the seventh testing sessions was no longer evident, especially in regards to Manual Expression and Visual Sequential Memory. However Brian seemed unable to perceive sounds as clearly as before, especially on Sound Blending. Nor were responses to Verbal Expression as clear and succinct as before.

Table 5 also indicates that the standard deviation for each set of ITPA results was appreciably larger during APP training than during baseline or follow-up periods. This underlines a more heterogeneous mode of functioning during the intervention phase. This was particularly evident over

the first 4 months of the training program.

Figure 21 charts Brian's mean ITPA scaled score throughout the investigation. Following a slight drop during the baseline period, gradual gains in the mean SS were made during the first 8 months of APP training. Half of these gains were lost during the last 2 months of training, with a partial recovery during the follow-up period.

Academic Achievement Results

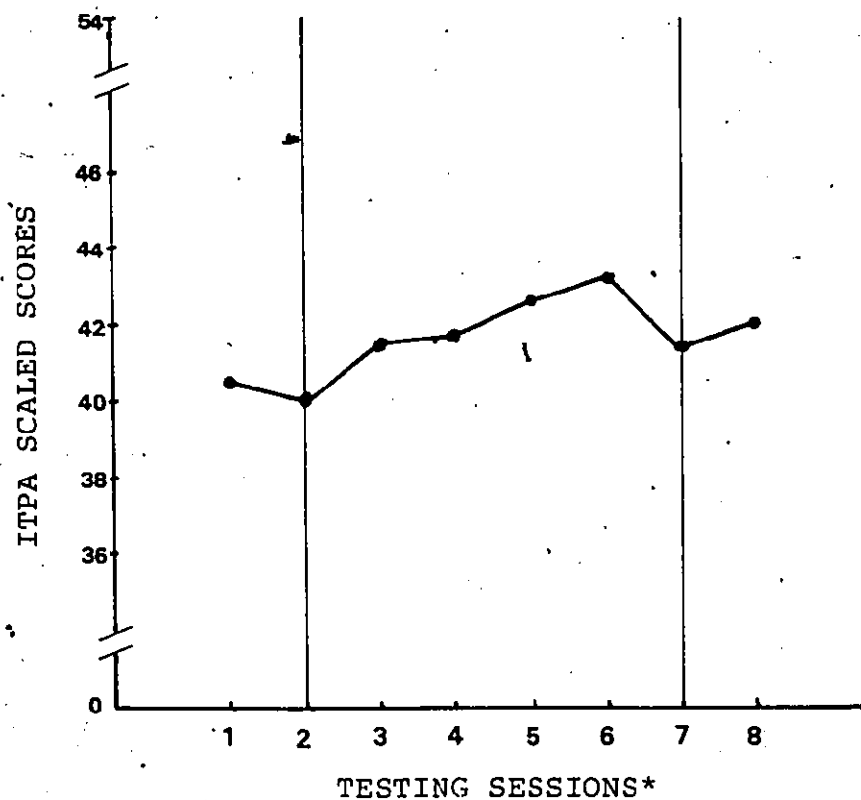
Brian's achievement test results are found in Table 6.

Baseline Period.

Brian's overall achievement index of grade 1.8 did not change between the first and second testing session. In reading, he generally guessed at words on the basis of their beginnings and/or endings. His spelling mistakes gave evidence of poor sound-symbol association, especially in regards to vowels. He preferred to work at Arithmetic problems but occasionally reversed numerals.

APP Remedial Training Program

By the third set of results, Brian's overall achievement index advanced from grade 1.8 to grade 2.1. Gains were noted on every subtest given, with the largest gains shown on the Spelling and Arithmetic subtests. On Spelling, Brian attempted more words than before and some of them successfully. On Arithmetic, he attempted some simple multiplication and division items successfully.



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 21. Brian's mean ITPA scaled scores during baseline, APP training and follow-up periods.

Table 6

Brian's Achievement Test Grade Ratings for Eight Testing Sessions

Test	Subtest	Testing Sessions*							
		1	2	3	4	5	6	7	8
WRAT									
	Reading	1.9	1.8	2.0	1.7	2.3	2.3	2.5	2.7
	Spelling	1.3	1.5	2.0	2.0	2.2	1.8	2.2	2.5
	Arithmetic	2.2	2.2	2.8	2.8	3.0	3.2	3.2	3.6
Gates-MacGinitie									
	Vocabulary	1.9	1.7	2.1	1.9	2.2	2.5	2.0	2.8
	Comprehension	1.5	1.5	1.7	1.6	1.7	1.6	1.6	2.3
Achievement Index**									
		1.8	1.8	2.1	2.0	2.3	2.3	2.3	2.8

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

** Mean of all five achievement subtests.

Qualitatively, Brian seemed more energetic and motivated to do the tests. He could persist in his efforts longer than before. On the Spelling subtest, he seemed less perplexed by the words given to him orally to write out.

The fourth set of results registered a drop in the achievement index from grade 2.1 to grade 2.0, as a result of poorer performance on the Reading and Vocabulary subtests. Brian again seemed confused about proper sound-symbol association, a problem he had overcome on the previous evaluation.

With the fifth set of results, the achievement index moved ahead to grade 2.3 as a result of gains on all subtests. Basic word recognition (WRAT Reading) and word understanding (Vocabulary subtest) were approached more successfully: Brian had now started to sound out words fully rather than guess at them on the basis of a few letters only. In his spelling, he made fewer mistakes of letter omission or letter sequence but continued having difficulty with sound-symbol association of vowels. One of the test administrators noticed improved concentration.

The sixth set of results brought no change on the achievement index. The spelling grade-rating dropped because of confusion with vowel sounds. Interestingly, Brian could now correct most of his reversal problems with the exception of the letters "b" and "d".

With the seventh set of results, the achievement index again remained unchanged at grade 2.3. On the Reading and

Spelling subtests, he sounded out more accurately. He showed impatience on the Vocabulary subtest whose rating fell by half a grade.

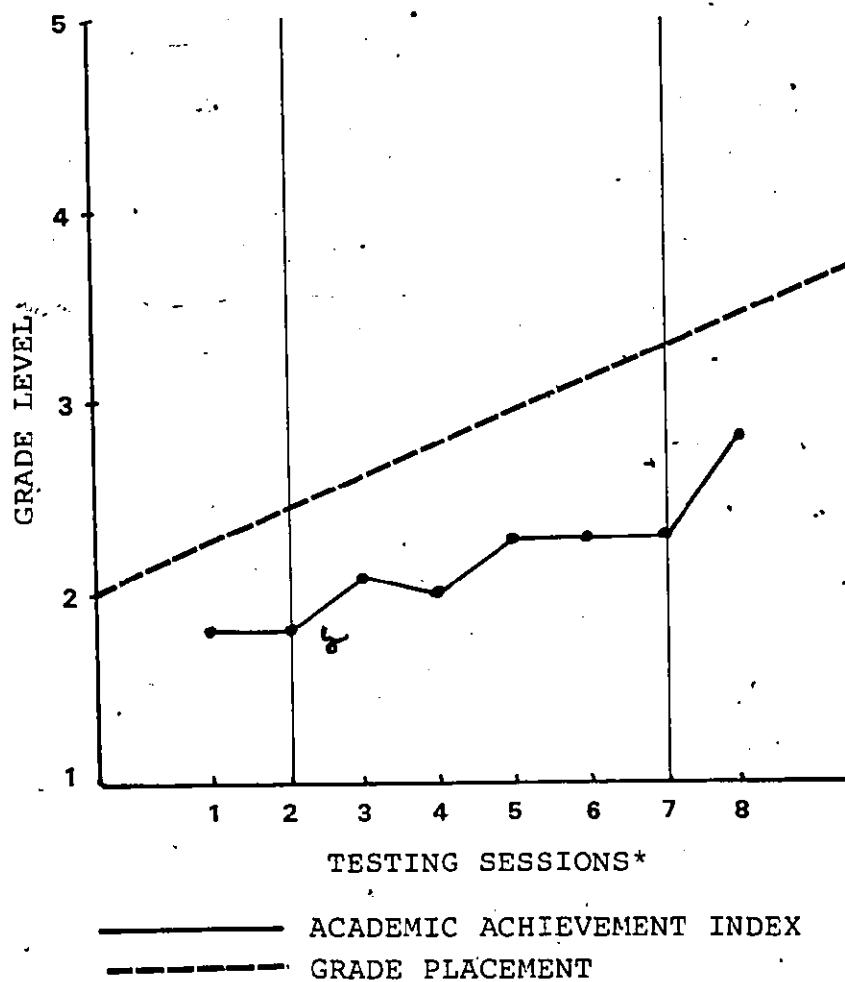
In the 10 months of APP training, Brian's overall achievement index advanced by half a grade. This pace was similar to that reported in his clinical file for the 10-month period that preceded this investigation. Only the Arithmetic subtest rating advanced along normal lines with a gain of a full grade over the intervention period.

Follow-Up Period

With the eighth set of results, gains on all subtests pushed the achievement index ahead by half a grade. The comprehension subtest rating, relatively unchanged over the last year, advanced from grade 1.6 to grade 2.3. On the Spelling subtest, confusion with vowel sounds and reversals of "b" and "d" were still in evidence.

Figure 22 graphically depicts Brian's academic achievement index ratings throughout the research project. During the short baseline period, Brian's achievement level was falling behind his grade placement. From February to April 1976, a more progressive trend was indicated, with a slight regression between April and June, and a return to the progressive trend between June and August. From August to the close of APP training in December, no gains were recorded on the index as Brian's achievement fell further behind his grade placement. In the follow-up period, a large gain of

)



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977.

Figure 22. Brian's academic achievement index during baseline, APP training and follow-up periods.

half a grade was attained. Despite this last gain, Brian's overall achievement remained further behind his grade placement than it was at the start of the research project.

Table 7 compares Brian's achievement test results at the start of APP training with those at the end of the follow-up period, in terms of grade ratings and percentile ranks. As indicated, within a year Brian advanced a full grade or more on the Spelling, Arithmetic and Vocabulary subtests, and close to a full grade on the Reading and Comprehension subtests. However the percentile ranks remained generally low. In February 1977, only Arithmetic had advanced beyond the 30th percentile.

Additional Pre and Posttraining Data Comparisons

Intelligence. Prior to this investigation, in late November 1975, Brian obtained a WISC-R Verbal IQ of 101, a Performance IQ of 131, and a Full Scale IQ of 117. In addition to the relatively weak verbal skills, the lowest scaled score of 8 was obtained on the Arithmetic and Digit Span subtests. In early March 1977, a month after the follow-up period, Brian obtained a WISC-R Verbal IQ of 102, a Performance IQ of 131, and a Full Scale IQ of 117. The Arithmetic subtest advanced to a scaled score of 10 while Coding fell from 17 to 12.

Learning Quotient. Prior to the research project, Brian obtained a Learning Quotient of 80, below the cut-off score of 90. At the close of APP training in December 1976, he

Table 7

Comparison of Brian's Achievement Test Results
at the Onset of APP training and at the Close of
the Follow-Up Period

Test	Subtest	February 1976* Grade	%ile	February 1977** Grade	%ile
WRAT					
	Reading	1.8	13	2.7	19
	Spelling	1.5	9	2.5	16
	Arithmetic	2.2	21	3.6	39
Gates-MacGinitie					
	Vocabulary	1.7	24	2.8	27
	Comprehension	1.5	10	2.3	18

* At the onset of APP training.

** At the close of the follow-up period.

obtained a Learning Quotient of 81, thus still considerably below the cut-off score.

Pupil Rating Scale. Prior to the research project, Brian was given a PRS rating of 66, below the chosen cut-off score of 70. He received low ratings in the areas of Auditory Comprehension and Spoken Language. In December 1976, after APP training, he received an overall PRS rating of 70, on the basis of slightly higher individual scores in the areas of Spoken Language and Personal-Social Behavior.

A summary of these pre and posttraining comparisons is presented in Table 8.

Case #3: Charles

Perceptual Processing (ITPA) Test Results

The ITPA results for Charles are presented in Table 9.

Baseline Period

The first set of results revealed two marginally discrepant functions: Visual Reception was nearly 9 scaled scores above the mean SS of 41.2, and Visual Sequential Memory was more than 9 scaled scores below the mean SS. In addition, the automatic level functions, with the exception of Sound Blending, proved to be generally weaker than representational level functions.

Qualitatively, Charles proved to be fidgety and talkative during the testing session. On Visual Reception, he often spontaneously corrected an initially brash or poor re-

Table 8

Pre and Posttraining Data Comparisons for Brian

Source of Data	Pretraining	Posttraining
WISC-R		
Verbal IQ	101	102
Performance IQ	131	131
Full Scale IQ	117	117
Learning Quotient*	80	81
Pupil ³ Rating Scale**	66	70

* A Learning Quotient of 89 or less indicates classification in the learning disability category.

** A PRS score of 69 or less indicates potential learning difficulties.

Table 9
Charles' ITPA Scaled Scores for Eight Testing Sessions

ITPA Subtests	Testing Sessions*							
	1	2	3	4	5	6	7	8
Representational Level								
Auditory Reception	40	41	44	47	47	41	42	42
Visual Reception	50	50	52	52	51	51	51	50
Auditory Association	42	42	43	46	47	46	45	44
Visual Association	42	43	43	44	49	45	48	48
Verbal Expression	43	43	49	46	47	46	47	45
Manual Expression	46	48	49	48	48	48	51	50
Automatic Level								
Grammatical Closure	38	38	42	41	45	44	44	43
Auditory Seq. Memory	38	37	41	38	42	41	43	43
Visual Seq. Memory	32	30	33	36	36	36	41	40
Auditory Closure	37	38	42	45	43	42	44	46
Sound Blending	45	45	47	48	48	48	48	48
Mean Scaled Score	41.2	41.4	44.1	44.6	45.7	44.4	45.8	45.4
Standard Deviation	4.93	5.55	5.13	4.67	4.13	4.18	3.43	3.32
Total Change Between Testing Sessions		+2	+30	+6	+12	-15	+16	-5

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

sponse. On Verbal Expression, he gave many irrelevant answers from an egocentric viewpoint not easily understood by the examiner.

The second set of results did not change appreciably from the first, quantitatively or qualitatively, thereby providing a stable baseline.

APP Remedial Training Program

The third set of results underlined a large overall gain of 30 scaled scores, and an advance of 2.7 in the mean SS. Most individual gains involved auditory-vocal functions, particularly at the automatic level. Verbal Expression registered the only substantial increase of 6 scaled scores.

Qualitatively, Charles now seemed more relaxed and settled. On Grammatic Closure, he spontaneously corrected initially poor answers because, as he stated, "It doesn't sound right". On Visual Association and Visual Sequential Memory, he verbalized his thoughts and strategies, using verbal mediation and mnemonics to advantage. On Verbal Expression, his responses proved to be relevant and understandable.

The fourth set of results saw a number of small gains and losses, again mainly in the auditory-vocal channel, moving the mean SS ahead by half a point.

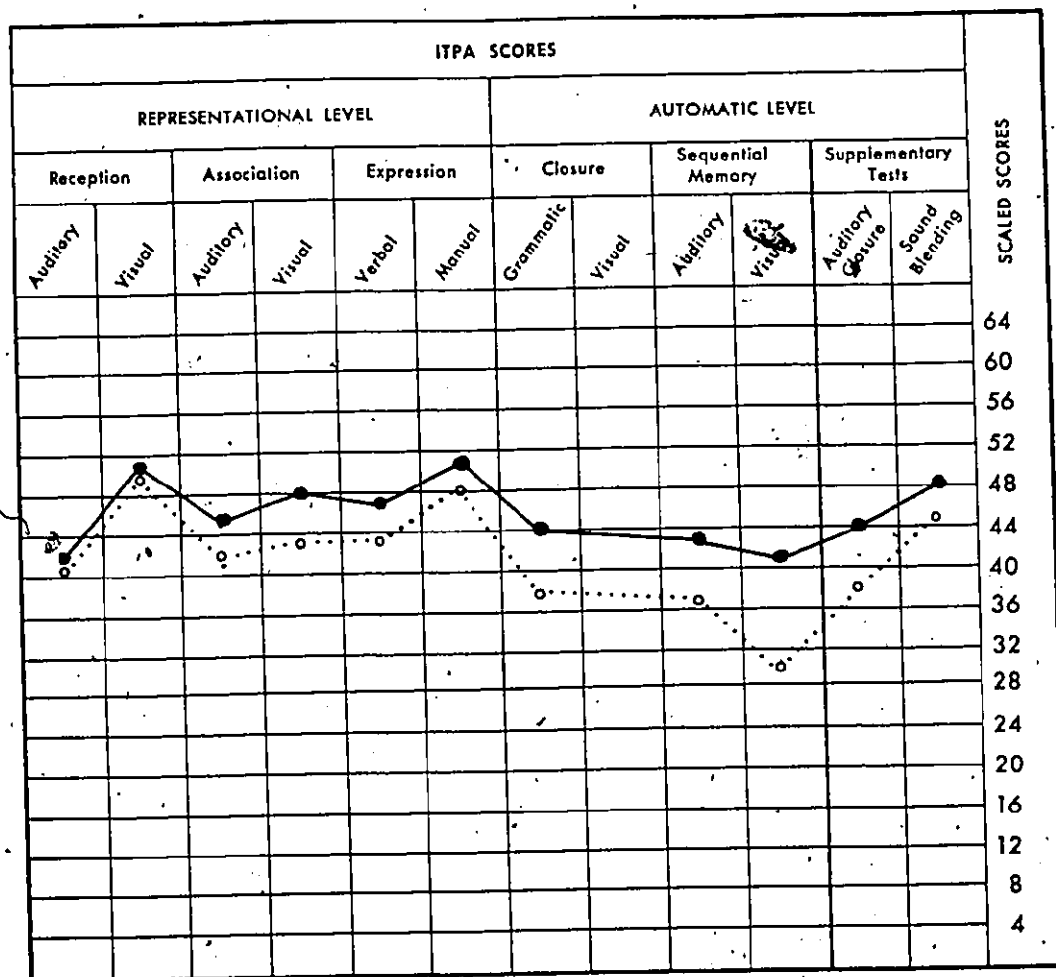
The fifth testing session produced an advance of over a point in the mean SS on the strength of small gains on Visual Association, Grammatic Closure and Auditory Sequential Memory. Qualitatively, Charles no longer thought aloud in

his approach to some visual-motor channel subtests. On Grammatic Closure, he again corrected his own responses after listening to them once or twice for effect.

The sixth testing session brought an overall drop of 15 scaled scores. Auditory Reception registered a substantial loss of 6 scaled scores, and Visual Association, a small loss of 4 scaled scores. During this testing session and the week that preceded it, Charles appeared quite tense and seemingly preoccupied.

The seventh set of results made up for the previous loss with an overall gain of 16 scaled scores, mainly because of small gains on visual-motor channel functions. Qualitatively, Charles' responses to Verbal Expression were more abstract, original and better formulated; unfortunately these features are not given due credit in the ITPA scoring system.

Figure 23 depicts Charles' ITPA results and subtest pattern before and after APP training. While all subtests advanced to some degree, substantial gains only occurred at the automatic level: three auditory-vocal functions moved ahead by 6 scaled scores, and Visual Sequential Memory moved ahead by 11 scaled scores. No subtest score could be considered even marginally discrepant, on the basis of the mean SS of 45.8 (see Table 9). At the close of the training program, a more balanced subtest pattern had been attained.



..... Before APP training (Feb. 1, 1976).

———— After APP training (Dec. 1, 1976).

Figure 23. Charles' ITPA patterned scaled scores before and after APP training.

Follow-Up Period

The eighth set of results did not change appreciably in any respect from the previous set. An overall drop of 5 scaled scores was due to slight gains and losses on several subtests.

Table 9 also indicates that the standard deviation for the sets of ITPA results was gradually reduced from 5.55 at the onset of APP training to 3.32 at the close of the follow-up period. A trend towards greater homogeneity of functioning on the ITPA was clearly established.

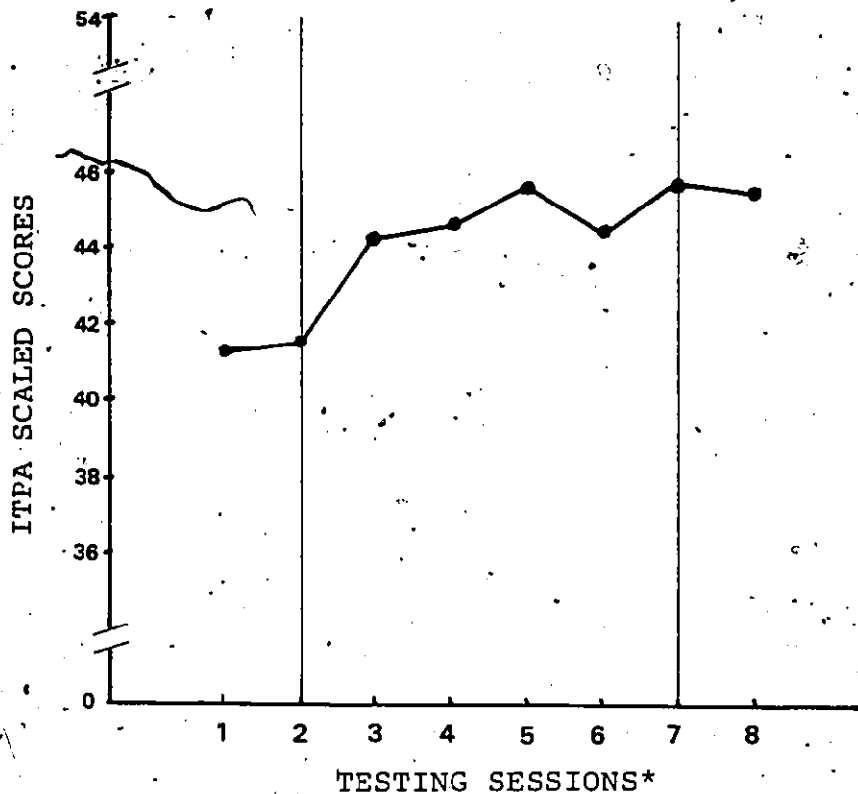
Figure 24 charts Charles' mean ITPA scaled score throughout the research project. As shown, the strongest gains were recorded during the first 6 months of the training program.

Academic Achievement Test Results

Charles' achievement test results are found in Table 10.

Baseline Period

From the first to the second set of results, Charles' overall achievement index advanced from grade 1.7 to grade 1.9. His approach to reading and spelling can best be described as slow and laboured. In sounding out letters to form words, he gave evidence of some knowledge of phonics and proper symbol-sound association. He frequently reversed letters, words and numerals. When his short attention span gave out, he tended to guess at words on the basis of beginning or ending letters. He preferred to work on Arithmetic prob-



*Code

Baseline Period

- 1 - December 1, 1975.
- 2 - February 1, 1976.

APP Remedial Training Program

- 3 - April 1, 1976.
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 24. Charles' mean ITPA scaled scores during baseline, APP training and follow-up periods.

Table 10

Charles' Achievement Test Grade Ratings for Eight Testing Sessions

Test	Subtest	Testing Sessions*							
		1	2	3	4	5	6	7	8
WRAT									
	Reading	1.7	2.0	2.3	3.1	3.2	3.6	3.8	4.1
	Spelling	1.4	1.8	2.2	2.0	2.0	2.3	2.5	2.5
	Arithmetic	1.9	2.1	2.4	2.6	2.8	3.0	3.2	3.6
Gates-MacGinitie									
	Vocabulary	2.0	2.0	2.3	2.3	2.0	3.3	2.7	2.7
	Comprehension	1.5	1.6	1.7	1.9	2.5	2.7	2.6	3.1
Achievement Index**									
		1.7	1.9	2.2	2.4	2.5	3.0	3.0	3.2

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

** Mean of all five achievement subtests.

lems but avoided multiplication or division items because he could not remember his times tables.

APP Remedial Training Period

With the third set of results, Charles' achievement index advanced from grade 1.9 to grade 2.2. The boy's slow decoding skills and error patterns remained unchanged but his concentration had improved. Consequently he attempted more subtest items within allotted time limits, sometimes successfully.

The fourth set of results indicated a rise on the achievement index from grade 2.2 to grade 2.4. On the WRAT Reading (word recognition) subtest, Charles' rating jumped ahead from grade 2.3 to grade 3.1 as a result of quicker decoding ability. The boy could now recognize a few words on sight. On the Spelling subtest, he made fewer reversal errors and spontaneously corrected some of those that did appear.

The fifth set of results saw the Comprehension subtest rating jump ahead from grade 1.9 to grade 2.5. Charles could now decode letters and recognize words fast enough to gain meaning from phrases and sentences.

By the sixth set of results, the achievement index advanced by half a grade, largely on the basis of greater success on the Reading (word recognition) and Vocabulary (word understanding) subtests. Charles now read words more quickly and only vocalized phonics on difficult words. Reversals of letters had disappeared but reversals of numbers persisted.

The boy's concentration span had improved noticeably, but beyond 15 minutes, he became restless and fidgety.

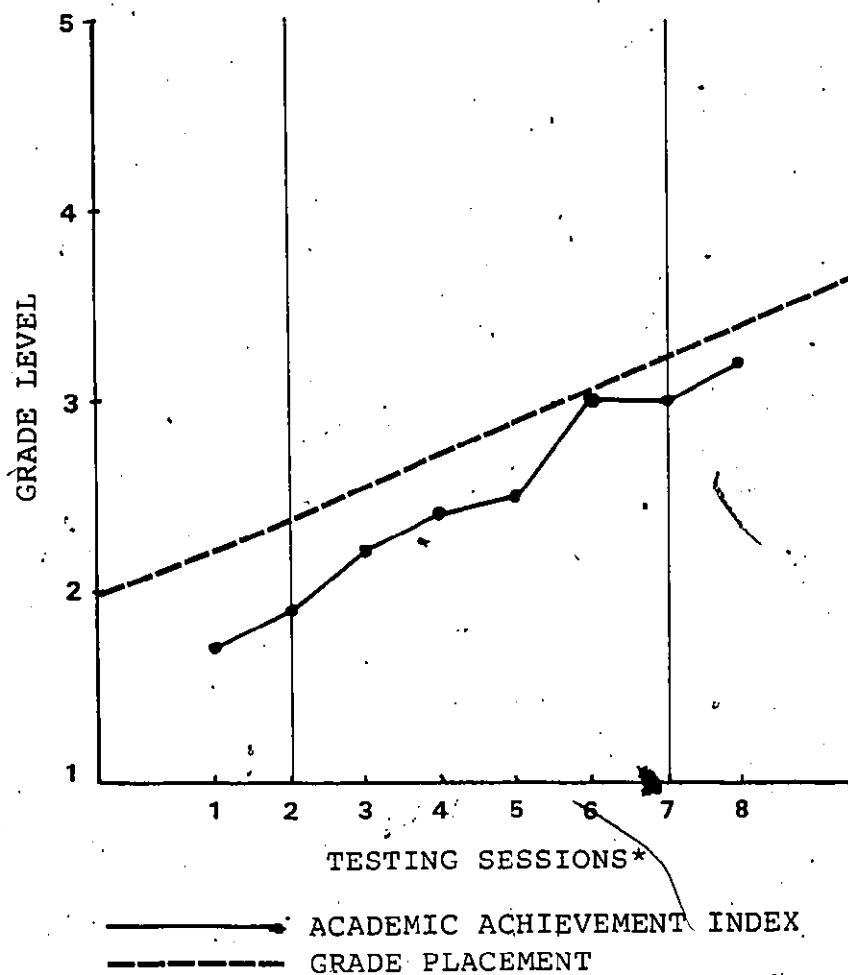
By the seventh set of results, at the close of APP training, reversals of numerals had disappeared on the Arithmetic subtest. On the Gates-MacGinitie tests, Charles read very quickly and fairly well, but in his overconfidence, he did not check over his responses as he had done before.

At the close of the 10-month training program, Charles had advanced 1.1 grades on the achievement index. On the basis of his clinical file, it can be stated that he had progressed less than half a grade in basic skills over the 10 months that preceded this research project.

Follow-Up Period

The eighth and final set of results saw the achievement index move ahead from grade 3.0 to grade 3.2, mainly because of gains on the Arithmetic and Comprehension subtests. On the latter, it was evident that Charles could read more smoothly at a conceptual level. On the former, Charles succeeded on multiplication and division items, having mastered simple times tables. He approached all subtests with enthusiasm and self-confidence.

Figure 25 represents Charles' achievement index grade ratings throughout this research project. As shown, the progressive baseline trend in achievement was accentuated slightly during the first 2 months of APP training, and generally maintained from April to August 1976. By October, a stronger



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 25. Charles' academic achievement index during baseline, APP training and follow-up periods.

progressive trend appeared, but without further gains in December. The trend line defined during the follow-up period resembles that indicated during the baseline period. Overall, the strongest gain occurred between August and October 1976.

Table 11 compares Charles' achievement test results at the start of APP training with those at the end of the follow-up period, in terms of grade ratings and percentile ranks. As indicated, within a year, Charles advanced by 1½ grades or more on the Reading, Arithmetic and Comprehension subtests. Whereas in February 1976, all subtests were ranked below the 35th percentile, a year later three subtests were ranked clearly above the 35th percentile. Spelling ability however remained weak as to both grade rating and percentile rank.

Additional Pre and Posttraining Data Comparisons

Intelligence. Prior to this research project, in late November 1975, Charles obtained a WISC-R Verbal IQ of 111, a Performance IQ of 114 and a Full Scale IQ of 114. The lowest scaled scores were obtained on the Digit Span and Coding subtests. A month after this research project, in early March 1977, Charles obtained a WISC-R Verbal IQ of 111, a Performance IQ of 121, and a Full Scale IQ of 118. The Picture Completion and Object Assembly subtests advanced by 2 and 4 scaled scores respectively.

Learning Quotient. Prior to this research project, Charles obtained a Learning Quotient of 83, a score below the recommended cut-off of 90. At the close of the research

Table 11

Comparison of Charles' Achievement Test Results
at the Onset of APP Training and at the Close of
the Follow-Up Period

Test	Subtest	February 1976*		February 1977**	
		Grade	%ile	Grade	%ile
WRAT					
	Reading	2.0	18	4.1	50
	Spelling	1.8	13	2.5	16
	Arithmetic	2.1	19	3.6	39
Gates-MacGinitie					
	Vocabulary	2.0	34	2.7	24
	Comprehension	1.6	18	3.1	38

* At the onset of APP training.

** At the close of the follow-up period.

project, he obtained a Learning Quotient of 90.

Pupil Rating Scale. Just prior to this investigation, Charles was given an overall PRS rating of 67, below the chosen cut-off score of 70. He received relatively low scores in the specific areas of Orientation to Time and Space, Motor Coordination and Personal-Social Behavior. In December 1976, at the close of APP training, he obtained a PRS rating of 73, as a result of slightly higher scores in the areas of Spoken Language, Motor Coordination and Personal-Social Behavior.

A summary of these pre and posttraining comparisons can be found in Table 12.

Case #4: Darryl

Perceptual Processing (ITPA) Test Results

Darryl's ITPA results are presented in Table 13.

Baseline Period

The first set of ITPA results revealed two borderline discrepant functions: Auditory Reception was nearly 9 scaled scores below the mean SS of 36.8, and Manual Expression was nearly 10 scaled scores above that mean SS.

Qualitatively Darryl was restless, talkative, flitting from one comment or question to the next in an attention-seeking way, often not waiting for a response to his interjections. He frequently did not fully grasp the examiner's questions or comments, responding with a "huh" or "say that

Table 12

Pre and Posttraining Data Comparisons for Charles

Source of Data	Pretraining	Posttraining
WISC-R		
Verbal IQ	111	111
Performance IQ	114	121
Full Scale IQ	114	118
Learning Quotient*	83	90
Pupil Rating Scale**	67	73

* A Learning Quotient of 89 or less indicates classification in the learning disability category.

** A PRS score of 69 or less indicates potential learning difficulties.

Table 13
Darryl's ITPA Scaled Scores for Eight Testing Sessions

ITPA Subtests	Testing Sessions*							
	1	2	3	4	5	6	7	8
Representational Level								
Auditory Reception	28	29	32	35	34	34	35	37
Visual Reception	35	35	34	34	37	38	38	38
Auditory Association	41	41	40	41	41	40	40	42
Visual Association	36	38	42	42	42	40	41	42
Verbal Expression	34	34	36	35	38	40	39	40
Manual Expression	46	46	46	47	48	48	47	46
Automatic Level								
Grammatical Closure	35	35	33	34	37	36	37	36
Auditory Seq. Memory	38	34	33	36	40	40	41	41
Visual Seq. Memory	41	40	40	41	40	43	42	42
Auditory Closure	35	36	42	44	44	44	43	42
Sound Blending	41	41	46	48	48	48	46	45
Mean Scaled Score	36.8	37.2	38.5	39.7	40.8	41	40.8	41
Standard Deviation	4.98	4.62	5.20	5.21	4.46	4.45	3.62	3.10
Total Change Between Testing Sessions		+4	+15	+13	+12	+2	-2	+2

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

again". Sometimes, after a pause of a few seconds and without the examiner having to repeat, he suddenly understood the question or comment. On the Verbal Expression subtest, he enumerated a number of possible answers, many of them irrelevant to the stimulus item. On Auditory Sequential Memory, digits from one test series carried over into his response to the next test series. His posture was poor throughout the testing session.

The second set of results did not differ appreciably in any way from the first set. This provided for a stable baseline period.

APP Remedial Training Program

The third set of results brought an overall gain of 15 scaled scores, mainly on the strength of advances on Auditory Reception, Auditory Closure and Sound Blending. These subtests depend in part or in total upon good auditory-vocal intake.

Qualitatively, Darryl remained very talkative but was more relaxed and settled as well as more serious in his attitude. He maintained his posture in the upright position. On Grammatic Closure, he listened to his replies and tried to correct them on the basis of whether they sounded right or not. Verbal Expression responses were now formulated as short statements instead of lengthy enumerations, but still contained many irrelevant ideas.

The fourth set of results also brought an overall gain

of 13 scaled scores, due largely to small gains on auditory-vocal subtests. Qualitatively, Darryl seemed able to follow conversation and understand test questions more quickly, rarely responding with a searching pause or a comment such as "say that again". On Auditory Sequential Memory, carry-over from one series of digits to another was no longer evident.

With the fifth set of results, small gains on a number of subtests provided for an overall gain of 12 scaled scores. Verbal Expression responses contained fewer irrelevant notions and were formulated in more personal and organized statements. On Visual Reception, Darryl used verbal self-direction to prevent himself from responding too quickly to the visual test stimuli. On Grammatic Closure, he successfully corrected poor responses after verbalizing them and listening to their appropriateness.

The sixth set of results showed little quantitative change from the former, save for a small gain on Visual Sequential Memory. Qualitatively, Darryl clearly used overt verbal mediation and verbal labelling strategies on the Visual Reception and Visual Sequential Memory subtests. He verbalized his thoughts as he approached Visual Reception items, and responded in a more reflective manner. On the Verbal Expression subtest, his statements were more logical and to the point.

The seventh set of results again produced little quanti-

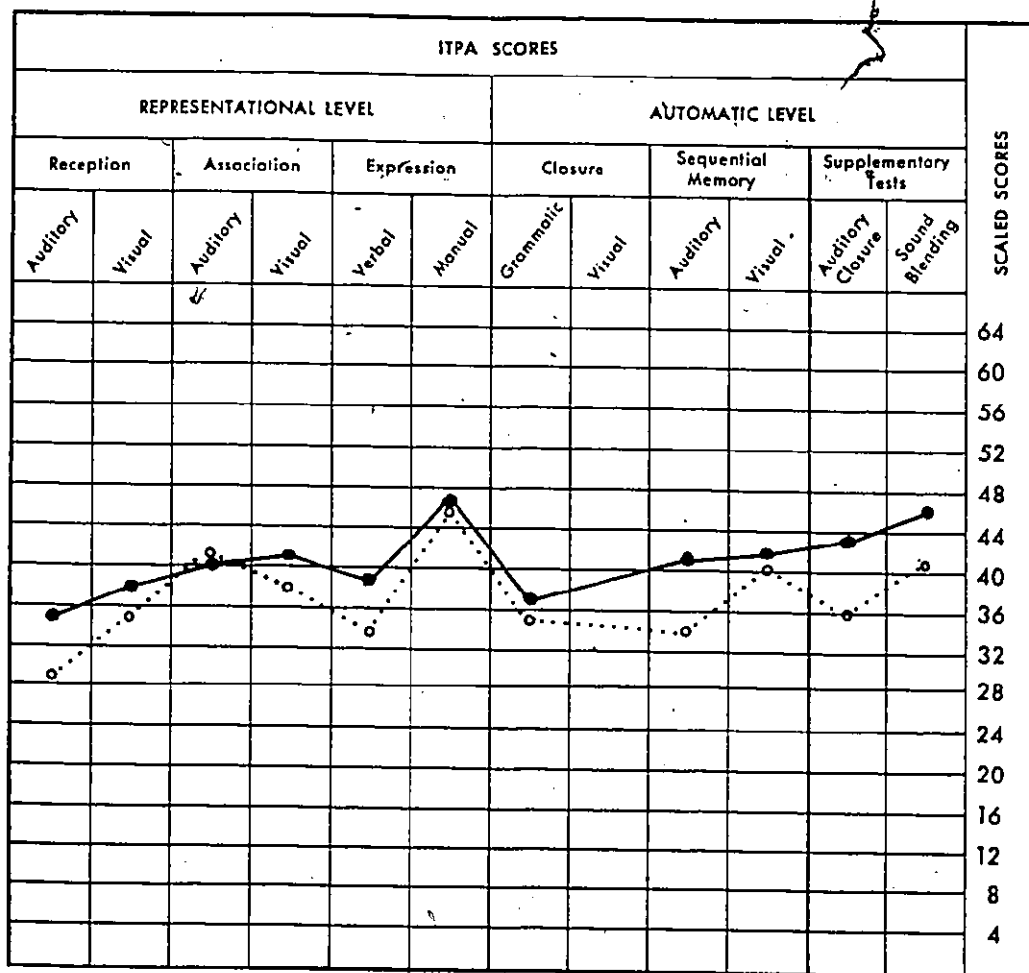
tive change except for a reduction of the standard deviation from 4.45 to 3.62. Qualitatively, Darryl continued to use verbalized mediational activity and self-direction on the Visual Reception and Visual Association subtests. Verbal Expression drew answers that were again more personal and better organized but this dimension is not considered in the ITPA scoring criteria.

Figure 26 depicts Darryl's ITPA results and subtest pattern before and after APP training. The biggest changes occurred on auditory-vocal functions, and especially at the automatic level. Auditory Reception, Auditory Sequential Memory and Auditory Closure all attained substantial gains over the training period. Verbal Expression and Sound Blending approached a substantial degree of change with an advance of 5 scaled scores each. Visual Reception and Visual Association registered small gains of 3 scaled scores each. At the close of APP training, on the basis of the mean SS of 40.8 (see Table 13), no subtest score could be considered even marginally discrepant. The postintervention ITPA profile was more evenly balanced.

Follow-Up Period

The eighth and final set of results did not change appreciably in any respect from the former set.

Table 13 also indicates that the standard deviation for the various sets of ITPA results gradually diminished from 5.20 at the start of APP training to 3.10 at the end



..... Before APP training (Feb. 1, 1976).

———— After APP training (Dec. 1, 1976).

Figure 26. Darryl's ITPA patterned scaled scores before and after APP training.

of the follow-up period. A trend towards greater homogeneity of ITPA functions was clearly defined.

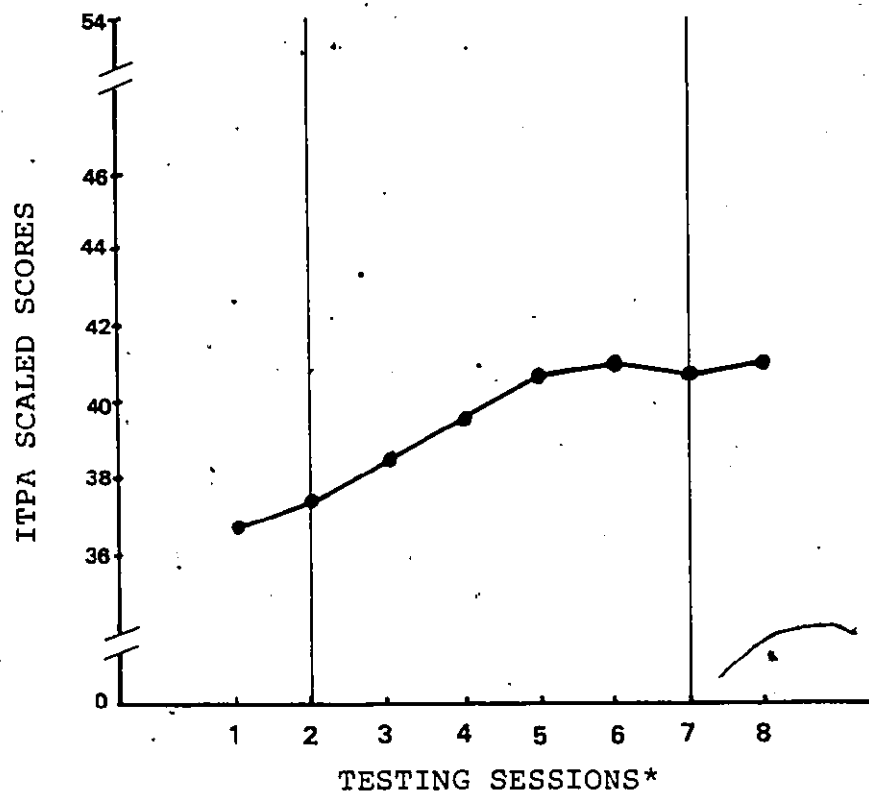
Figure 27 charts Darryl's mean ITPA scaled score throughout the investigation. As can be seen, a slight trend towards a higher mean was indicated in the baseline period. The trend was accentuated during the first 6 months of the training program during which time the largest gains were attained. No definite gains or losses were recorded as to the mean SS over the last 6 months of the research project, including the 2-month follow-up period.

Academic Achievement Test Results

Darryl's achievement test results are found in Table 14.

Baseline Period

Darryl's overall achievement index rose slightly during the 2-month baseline period from grade 2.1 to grade 2.2. Although he had been well drilled in phonics and proper symbol-sound association, his decoding skills remained very slow and labored, so slow that he often could not catch the full name or the meaning of a word. He vocalized phonics loudly as he read and spelled. In spelling, he confused vowel sounds. He reversed letters and numerals. On the Arithmetic subtest, he occasionally used his fingers very adeptly to add and subtract. Qualitatively, his attention span was short and he maintained a negative complaining attitude throughout both testing sessions.



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 27. Darryl's mean ITPA scaled scores during baseline, APP training and follow-up periods.

Table 14

Darryl's Achievement Test Grade Ratings for Eight Testing Sessions

Test	Subtest	Testing Sessions*							
		1	2	3	4	5	6	7	8
WRAT									
	Reading	1.8	2.5	2.6	3.1	3.4	3.5	4.1	4.3
	Spelling	1.8	1.6	2.2	2.2	2.3	2.2	2.6	2.9
	Arithmetic	3.6	3.0	3.9	4.5	4.2	3.9	4.2	4.5
Gates-MacGinitie									
	Vocabulary	1.9	2.3	3.2	2.8	2.5	2.9	3.1	3.5
	Comprehension	1.7	1.6	2.0	1.8	1.7	2.1	2.4	2.2
Achievement Index**									
		2.1	2.2	2.8	2.9	2.8	2.9	3.3	3.5

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

** Mean of all five achievement subtests.

APP Remedial Training Period

The third set of results indicated a gain of over half a grade on the achievement index. Darryl's attention span had improved such that he attempted more test items within the allotted time limits, and this contributed to higher grade ratings on four of the five subtests. On the Vocabulary and Comprehension subtests, he sounded out words more quickly and acceded more readily to the level of word or passage meaning. Reversal errors persisted on the Spelling and Arithmetic subtests.

From the third to the sixth testing session, the overall achievement index showed little definite gain or loss. However the WRAT Reading (word recognition) score advanced nearly a full grade during this 6-month period. Darryl could successfully sound out longer words, but in trying to read sentences or passages he often gave in to the temptation of guessing the meaning on the basis of one or two words rather than sound out all the elements of a phrase. His spelling errors were now more understandable, with fewer confusions of vowel sounds. By October, most reversal errors had disappeared with the exception of the letters "b" and "d". Qualitatively Darryl continued to sound out phonics or to read aloud on most subtests. His attitude throughout these testing sessions was friendly and positive, and he could work in a very concentrated fashion.

With the seventh set of results, Darryl's achievement

index jumped ahead by nearly half a grade on the basis of gains on all subtests. On the Spelling subtest, he succeeded on a few words that depended more on visual memory because they did not follow the regular sounds of the English language. One of the test administrators, a retired remedial teacher, noted that Darryl continued to sound out words but his synthesis was now much quicker, allowing for easier access to meaning. The same administrator felt that Darryl was suddenly using a lot of energy during the testing sessions asking himself such questions as: "what's this now" or "that can't be right".

At the close of APP training, it can be indicated that Darryl's overall achievement index moved ahead by 1.1 grades during the 10 months of training. According to his clinical file, he had advanced less than a third of a grade in basic skills over the 10 months that preceded this investigation.

Follow-Up Period

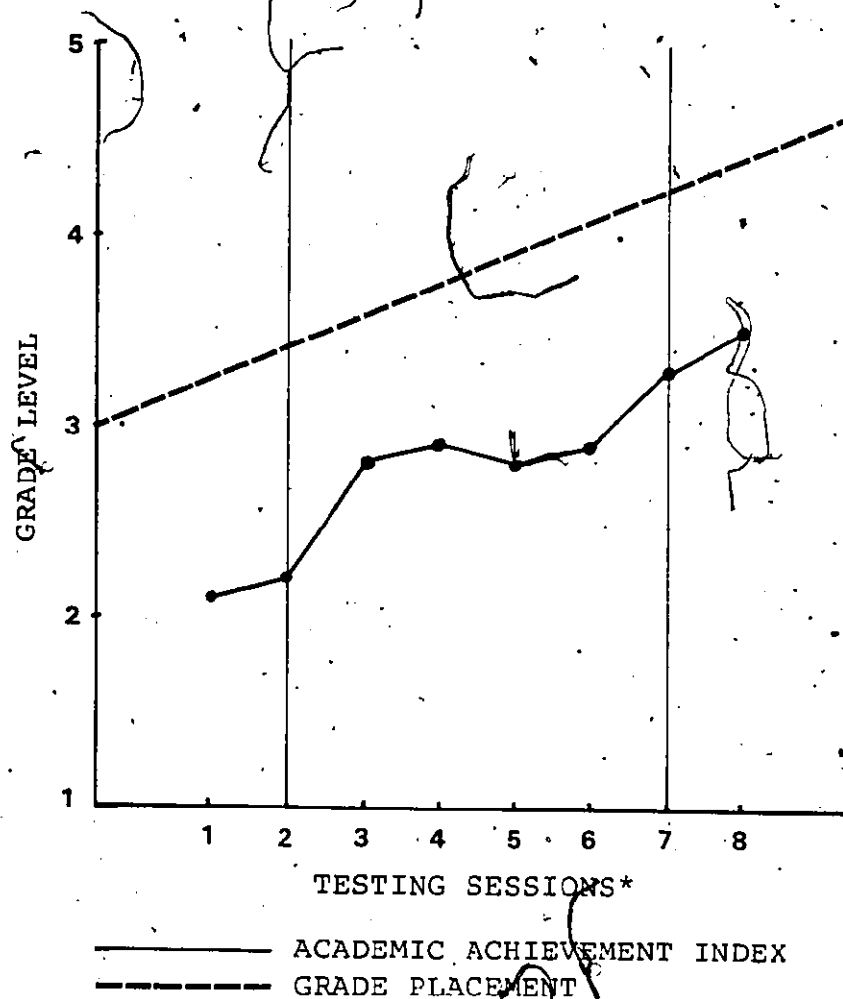
With the eighth set of results, gains on most subtests pushed the achievement index ahead by .2 of a grade. On Arithmetic, Darryl managed to cope with some difficult division and multiplication items. In his reading and spelling, he gave no evidence of reversals of the letters "b" and "d". The retired remedial teacher who administered some of the tests commented that Darryl was almost ready to read at a conceptual level, and that he now seemed to vocalize or sound out only for self-assurance.

Figure 28 charts Darryl's achievement index ratings throughout the investigation. As can be seen, a large gain in overall achievement appeared after the first 2 months of APP training, with little definite progress over the ensuing 6 months. A second and more gradual advance was shown at the end of APP training and over the follow-up period. At the start of APP training, Darryl's overall achievement was 1.2 grades behind his class placement; by the close of the research project, it was .9 grades behind.

Table 15 compares Darryl's achievement test results at the start of APP training with those at the end of the follow-up period, in terms of grade ratings and percentile ranks. As indicated, within a year, Darryl moved ahead by well over a full grade on all subtests except Comprehension. At the start of remedial training, only the Arithmetic subtest score reached the 25th percentile. At the end of the investigation, three subtests were ranked above the 35th percentile, with Vocabulary above the 45th percentile. Spelling and Comprehension remained below the 15th percentile.

Additional Pre and Posttraining Data Comparisons

Intelligence. Prior to the research project, in late November 1975, Darryl obtained a WISC-R Verbal IQ of 108, a Performance IQ of 111 and a Full Scale IQ of 110. He obtained his lowest scale score of 6 on the supplementary Digit Span subtest, and a scaled score of 9 on the Information and Coding subtests. In March 1977, a month after the



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 28. Darryl's academic achievement index during baseline, APP training and follow-up periods.

Table 15

Comparison of Darryl's Achievement Test Results
at the Onset of APP Training and at the Close of
the Follow-Up Period

Test	Subtest	February 1976* Grade	%ile	February 1977** Grade	%ile
WRAT					
	Reading	2.5	16	4.3	36
	Spelling	1.6	5	2.9	13
	Arithmetic	3.0	25	4.5	39
Gates-MacGinitie					
	Vocabulary	1.9	10	3.5	46
	Comprehension	1.7	5	2.2	4

* At the onset of APP training.

** At the close of the follow-up period.

research project, Darryl obtained a WISC-R Verbal IQ of 105, a Performance IQ of 112 and a Full Scale IQ of 109. The Digit Span subtest advanced to a scaled score of 9, and the Vocabulary subtest fell from a scaled score of 14 to 12.

Learning Quotient. Prior to the research project, Darryl obtained a Learning Quotient of 77, below the cut-off score of 90. After APP training, he merited a Learning Quotient of 83.

Pupil Rating Scale. At the start of this investigation, Darryl received an overall PRS Rating of 65, below the cut-off score of 70. He was rated relatively low in all areas except Motor Coordination. In December 1976, after APP training, his PRS rating advanced to 71 on the basis of gains in the areas of Auditory Comprehension and Motor Coordination.

A summary of these pre and posttraining comparisons is found in Table 16.

Case #5: Ernest

Perceptual Processing (ITPA) Test Results

Ernest's ITPA results are presented in Table 17. Those results from the last testing session in February 1977 are offered tentatively as Ernest had by then outgrown the ITPA norms tables by 2 months. Scaled scores were derived as if he had been within the normative age limits, and they are bracketed to underline that they should be used with caution.

Table 16
Pre and Posttraining Data Comparisons for Darryl

Source of Data	Pretraining	Posttraining
WISC-R		
Verbal IQ	108	105
Performance IQ	111	112
Full Scale IQ	110	109
Learning Quotient*	77	83
Pupil Rating Scale**	65	71

* A Learning Quotient of 89 or less indicates classification in the learning disability category.

** A PRS score of 69 or less indicates potential learning difficulties.

Table 17
Ernest's ITPA Scaled Scores for Eight Testing Sessions

ITPA Subtests	Testing Sessions*							
	1	2	3	4	5	6	7	8
Representational Level								
Auditory Reception	28	30	33	32	32	38	41	(42)
Visual Reception	43	45	48	45	44	44	47	(48)
Auditory Association	39	39	43	42	42	44	44	(43)
Visual Association	40	40	47	44	48	47	48	(47)
Verbal Expression	32	31	30	34	36	41	42	(42)
Manual Expression	46	47	47	48	48	48	48	(48)
Automatic Level								
Grammatical Closure	28	28	31	29	31	31	42	(40)
Auditory Seq. Memory	34	33	31	32	32	31	34	(37)
Visual Seq. Memory	35	35	42	46	44	48	50	(52)
Auditory Closure	37	37	42	44	41	44	44	(44)
Sound Blending	38	39	44	44	46	46	47	(47)
Mean Scaled Score	36.4	36.7	39.8	40	40.4	42.3	44.4	(44.6)
Standard Deviation	5.71	6.05	7.11	6.80	6.51	6.35	4.57	(4.30)
Total Change Between Testing Sessions		+4	+34	+2	+4	+21	+23	(+2)

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Baseline Period

The first set of ITPA results revealed three borderline discrepant functions: Manual Expression, with a SS of 46, was more than 9 points above the mean SS of 36.4, while Auditory Reception and Grammatic Closure, each with a SS of 28, were more than 8 points below the mean SS. At the representational level, Auditory Reception and Verbal Expression were particularly weak in comparison to their visual-motor channel counterparts.

Qualitatively, Ernest appeared momentarily dazed in reacting to the examiner's comments or verbal directions. He sometimes met a question with a blank stare or a comment such as "eh" or "what again". His responses on Verbal Expression consisted of short statements of impersonal nature.

The second set of results changed only slightly from the first, thereby providing a fairly stable baseline trend.

APP Remedial Training Period

The third set of results brought an overall gain of 34 scaled scores as the mean SS advanced from 36.7 to 39.8. Visual Sequential Memory and Visual Association both registered substantial gains. A number of other subtests, mainly auditory-vocal, registered smaller gains.

Qualitatively, Ernest was noticeably more alert and quicker in responding than before, and less apt to ask the examiner to repeat comments or questions. Now more talkative, he verbalized his thoughts as he approached Visual Reception,

Visual Association and Visual Sequential Memory items, using verbal labels to deal with test items. He seemed unable to refrain from passing comment on whatever caught his eye or ear, such as a pendant the examiner wore that day, or the stopwatch that had been on the table even on previous testing days, or again the sound of someone walking in the hallway. His alertness had a paradoxical quality: although able to concentrate longer on a task, he could also be distracted fairly easily. On Verbal Expression, Ernest gave more elaborate responses but his ideas were not always related to the subtest demands.

The fourth set of results essentially maintained the previous gains. Ernest remained alert and talkative but in a more relaxed and self-controlled way. He reacted to Verbal Expression items with more personal statements often prefaced with "I can" or "you might"; his more relevant responses produced a small gain on this subtest. On some visual-motor subtests, he now subvocalized his thoughts in a form of private strategy planning.

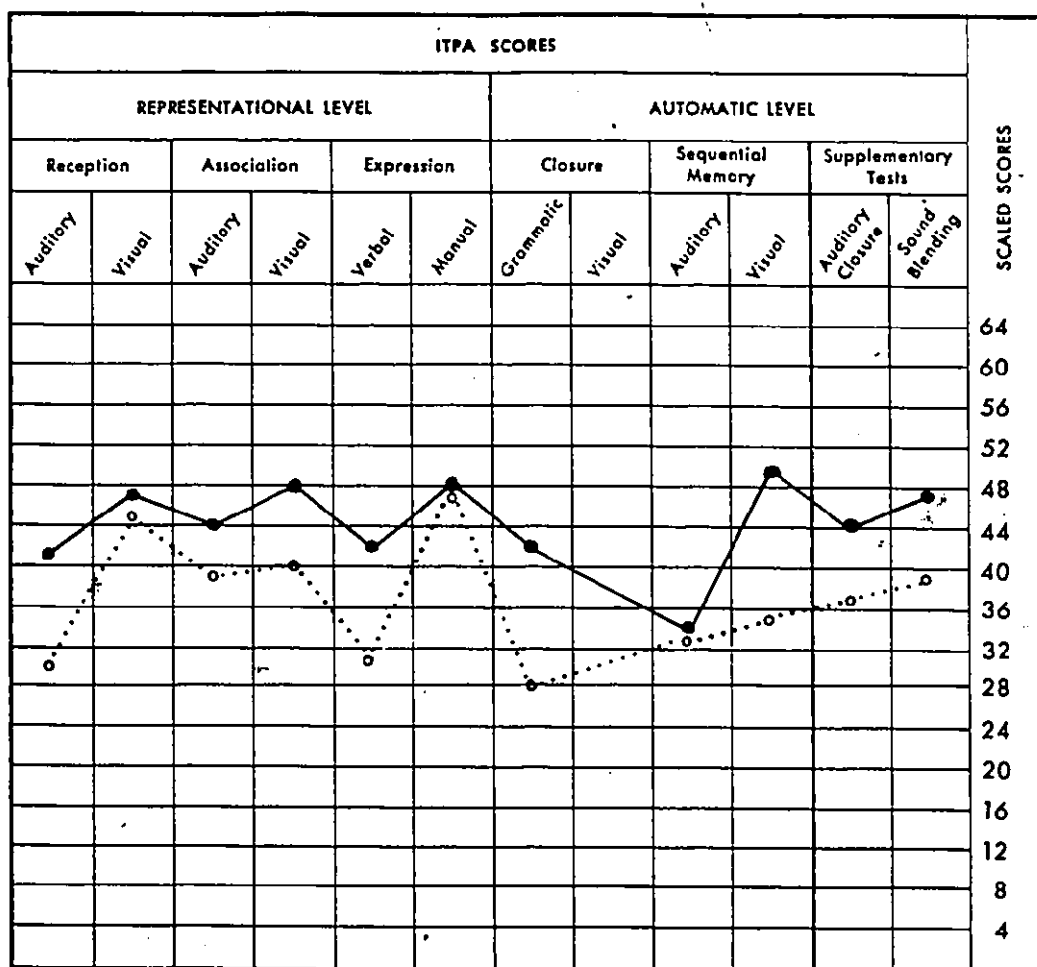
The fifth set of results brought little overall quantitative change. Ernest's responses on Verbal Expression were much better organized, but the ITPA scoring system does not credit such verbal fluency. On Grammatical Closure, Ernest now listened closely to his replies, correcting those which did not sound right. On visual-motor channel subtests, no overt verbal mediation or vocalization of thoughts could be

detected.

The sixth set of results produced an overall gain of 21 scaled scores, mainly on the strength of substantial or near-substantial gains on Auditory Reception and Verbal Expression. On the latter subtest, Ernest now offered responses at an abstract rather than just concrete or instrumental level. On Auditory Sequential Memory, he could now repeat longer series of digits but made errors in the order of recall.

The seventh set of results produced another overall gain of more than 20 scaled scores. Most gains occurred on auditory-vocal functions. Grammatic Closure in particular recorded a substantial advance of 11 scaled scores. On this subtest, Ernest continued to monitor and correct his verbal responses, succeeding at this point on many items that called for knowledge of exceptions to grammatic rules. On Auditory Sequential Memory, he made fewer serial-order errors.

Figure 29 graphically displays Ernest's ITPA scaled scores and subtest profile before and after APP training. By the close of the remedial program, seven of the 11 subtests recorded substantial gains of 6 scaled scores or more. Five of these seven subtests related related to the auditory-vocal channel. The strongest gains at the representational level involved auditory-vocal functions. Most automatic-level subtests advanced to a level more in keeping with representational-level subtests. Only Auditory Sequential Memory did not



..... Before APP training (Feb. 1, 1976).

_____ After APP training (Dec. 1, 1976).

Figure 29. Ernest's ITPA patterned scaled scores before and after APP training.

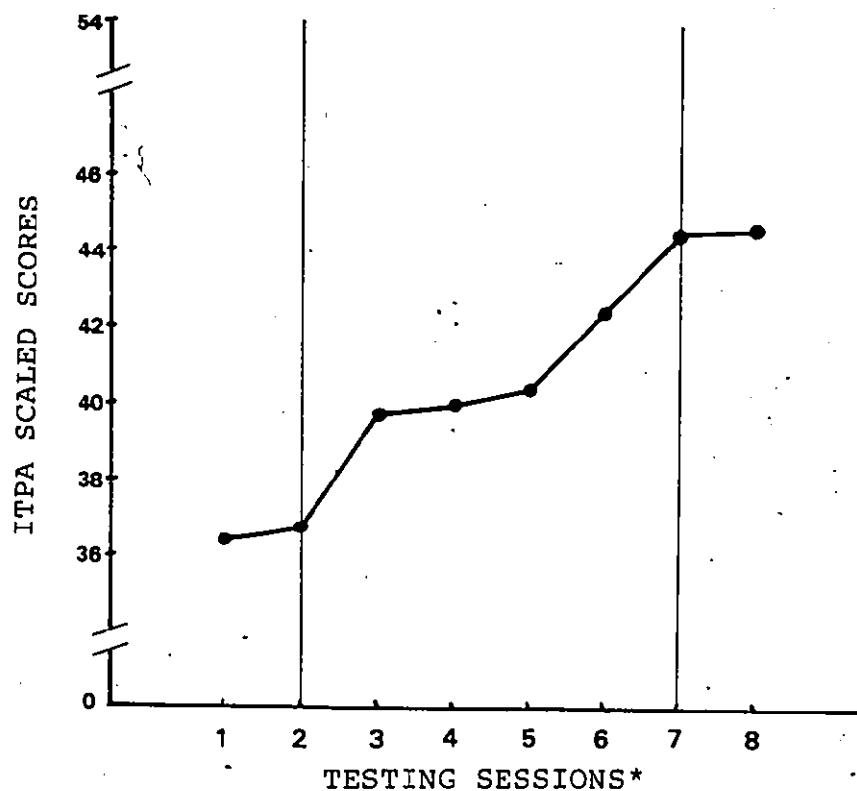
move ahead appreciably nor contribute to the generally better balanced posttraining profile. On the basis of the mean SS of 44.4 (see Table 17), this subtest could be considered as substantially discrepant.

Follow-Up Period

As indicated previously, the scaled scores for this final set of results are to be read with caution. Tentatively, little overall change occurred in relation to the seventh set of results. Only Auditory Sequential Memory produced a small gain as Ernest overcame some of his serial-order problems.

Table 17 also presents the standard deviation for the eight sets of results during the investigation. The baseline phase showed a trend towards a larger standard deviation and a more heterogeneous subtest pattern, a trend that was accentuated over the first 2 months of APP training. From the third to the last testing session, this trend was reversed towards a more balanced and homogeneous pattern of ITPA functioning.

Figure 30 graphically displays Ernest's mean ITPA scaled scores throughout the research project. As can be seen, strong gains were achieved over the first 2 months and the last 4 months of the remedial training program. The baseline and follow-up periods produced little change in the mean SS.



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 30. Ernest's mean ITPA scaled scores during baseline, APP training and follow-up periods.

Academic Achievement Test Results

Ernest's achievement test results are presented in Table 18. It should be noted that his achievement index represents the mean of six rather than five subtest grade ratings. Being somewhat more advanced in basic skills than the other boys in this project, he could be administered the Gates-MacGinitie Speed and Accuracy subtest from the start of the investigation. This subtest usually provides two scores: one for the number of reading paragraphs attempted, and one for the number correctly understood. Since the two scores were generally redundant, they were combined into one grade rating for the purposes of the present study.

Baseline Period

From the first to the second testing session, the overall achievement index rose from grade 2.9 to grade 3.1. Although he had acquired some phonetic skills, Ernest had difficulty clearly discriminating vowel sounds. He decoded letters into sounds and words slowly, often guessing at a word if it was too long. His concentration span was short and he seemed to run out of energy within ten minutes of the start of testing, making mistakes of inattention or half-hearted efforts thereafter.

APP Remedial Training Period

With the third set of results, Ernest's achievement index advanced by half a grade. He could now persist and con-

Table 18

Ernest's Achievement Test Grade Ratings for Eight Testing Sessions

Test	Subtest	Testing Sessions*							
		1	2	3	4	5	6	7	8
WRAT									
	Reading	2.8	2.7	3.0	3.8	4.1	4.6	5.6	5.7
	Spelling	2.2	2.7	2.3	2.7	3.5	3.5	3.5	3.7
	Arithmetic	3.9	3.9	4.5	5.0	5.0	4.5	4.7	4.7
Gates-MacGinitie									
	Vocabulary	3.5	3.7	4.4	4.3	4.6	3.9	4.7	5.8
	Comprehension	2.8	3.4	4.7	3.6	3.4	4.1	5.4	4.4
	Speed and Accuracy	2.2	2.2	2.6	2.5	2.6	3.3	3.3	3.4
Achievement Index**									
		2.9	3.1	3.6	3.7	3.9	4.0	4.5	4.6

*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1976

** Mean of all six achievement subtests.

concentrate more on his work. This provided for gains on the more demanding subtests such as Comprehension and Speed and Accuracy, both of which involve reading and understanding short passages. On the Arithmetic and Reading subtests, he attempted more items successfully within the allotted time limits. In addition to the increased concentration ability, Ernest seemed a bit driven and restless, making costly mistakes of impatience on the Spelling subtest.

By the fourth testing session, Ernest seemed less talkative, more settled and self-controlled. He sounded out words more clearly on the reading and spelling subtests.

With the fifth set of results, the Spelling subtest rating advanced from grade 2.7 to grade 3.5. Ernest's spelling of words had become more accurate phonetically. He no longer confused vowel sounds. He also used his recall of similar-sounding words to help him spell correctly.

The sixth set of results produced little overall change from the previous testing.

The seventh set of results indicated an advance of half a grade on the achievement index. Ernest could not synthesize sounds more quickly and read more fluently at a meaningful level. The Speed and Accuracy results moved up by half a grade. Spelling did not progress at this time: Ernest succeeded on words that followed regular sounds of the English language but encountered problems with words that required knowledge of special rules and principles.

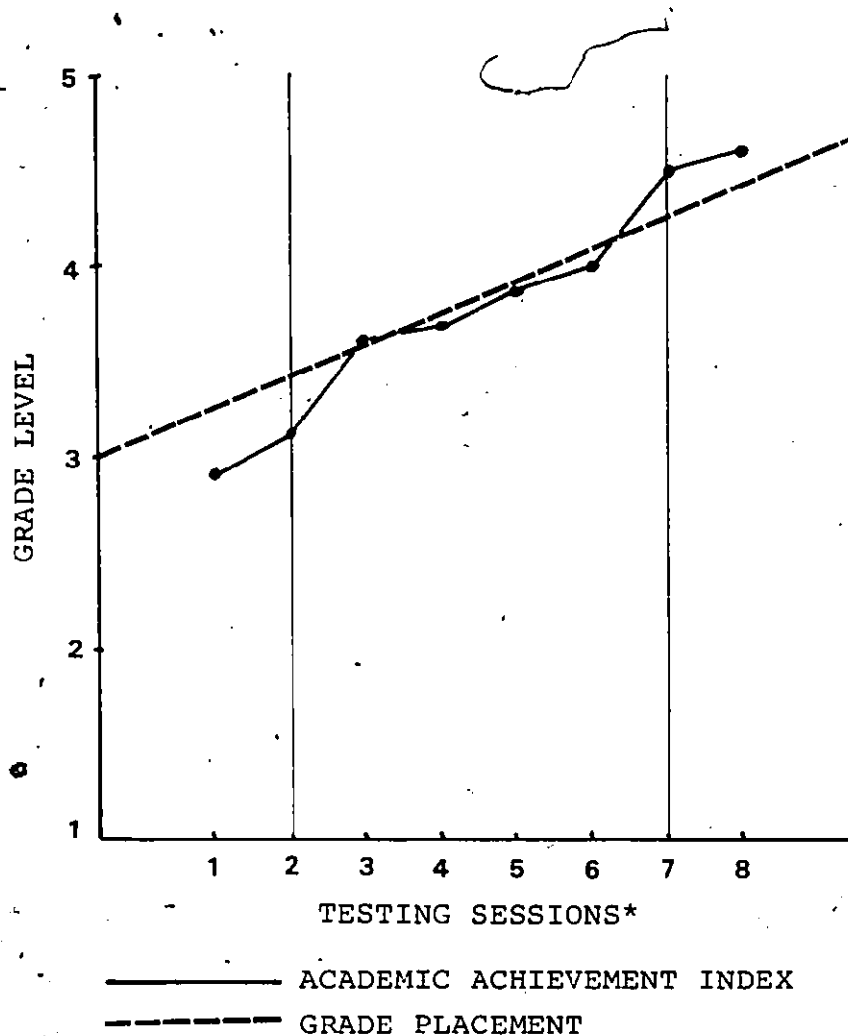
During the 10-month period of APP training, Ernest's academic achievement index advanced by 1.4 grades. According to his clinical file, in the 10 months that preceded this investigation, he gained about a full grade in basic skills.

Follow-Up Period

The final set of results showed only a slight gain on the achievement index. An advance of just over a full grade on the Vocabulary subtest was countered by a loss of a full grade on the Comprehension subtest. On the latter, Ernest seemed too self-assured, proceeding quickly without checking back on his answers.

Figure 31 graphically depicts the academic achievement index ratings throughout the research project. As can be seen, a progressive trend was established during the baseline period. Strong gains were recorded over the first 2 and last 2 months of APP training. During the middle months of the training program, and over the follow-up period, the achievement trend resembled that delineated during the baseline period. By the end of APP training, Ernest's achievement index had surpassed his grade placement.

Table 19 compares Ernest's achievement test results at the start of APP training with those at the close of the research project, in terms of grade ratings and percentile ranks. As shown, the main gains occurred in the areas of basic word recognition (WRAT Reading) and word understanding (Gates-MacGinitie Vocabulary) which were both ranked above



*Code

Baseline Period

- 1 - December 1, 1975
- 2 - February 1, 1976

APP Remedial Training Program

- 3 - April 1, 1976
- 4 - June 1, 1976
- 5 - August 1, 1976
- 6 - October 1, 1976
- 7 - December 1, 1976

Follow-Up Period

- 8 - February 1, 1977

Figure 31. Ernest's academic achievement index during baseline, APP training and follow-up periods.

Table 19

Comparison of Ernest's Achievement Test Results
at the Onset of APP Training and at the Close of
the Follow-Up Period

Test	Subtest	February 1976* Grade	%ile	February 1977** Grade	%ile
WRAT					
	Reading	2.7	19	5.7	66
	Spelling	2.7	19	3.7	23
	Arithmetic	3.9	47	4.7	45
Gates-MacGinitie					
	Vocabulary	3.7	58	5.8	76
	Comprehension	3.4	50	4.4	46
	Speed and Accuracy	2.2	12	3.4	18

* At the onset of APP training.

** At the close of the follow-up period.

the 65th percentile at the close of the research project. The Arithmetic and Comprehension subtests maintained their ranks between the 45th percentile and the 50th percentile. The Spelling as well as Speed and Accuracy subtests remained below the 25th percentile despite gains of a full grade or more.

Additional Pre and Posttraining Data Comparisons

Intelligence. Prior to the research project, in late November 1975, Ernest obtained a WISC-R Verbal IQ of 102, a Performance IQ of 131, and a Full Scale IQ of 118. In addition to the generally weaker verbal skills, the lowest scaled scores were recorded on the Arithmetic and Digit Span subtests. After the research project, in early March 1977, Ernest obtained a WISC-R Verbal IQ of 115, a Performance IQ of 136 and a Full Scale IQ of 128. Among Verbal subtests, Digit Span had advanced from a SS of 7 to 12, Arithmetic from a SS of 8 to 11, Similarities from a SS of 10 to 13, Vocabulary from a SS of 9 to 11, and Comprehension from a SS of 13 to 15. Picture Completion moved ahead from a SS of 12 to 16, in line with other Performance subtests.

Learning Quotient. Prior to this research project, Ernest's Learning Quotient of 80 fell below the recommended cut-off score of 90. In December 1976, at the close of APP training, he obtained a Learning Quotient of 87, still below the cut-off score.

Pupil Rating Scale. In December 1975, Ernest received

an overall rating of 63 on the PRS, well below the cut-off score of 70. He was given relatively low ratings in the areas of Auditory Comprehension, Spoken Language, Orientation to Time and Space, and Personal Social Behavior. In December 1976, at the close of APP training, he received a PRS rating of 72, having advanced in all the areas mentioned above.

A summary of these pre and posttraining comparisons can be found in Table 20.

The following chapter discusses the results presented here mainly in terms of research expectations, as well as in the light of the diagnostic and treatment findings presented in Chapter 3.

Table 20
Pre and Posttraining Data Comparisons for Ernest

Source of Data	Pretraining	Posttraining
WISC-R		
Verbal IQ	102	115
Performance IQ	131	136
Full Scale IQ	118	128
Learning Quotient*	80	87
Pupil Rating Scale**	63	72

* A Learning Quotient of 89 or less indicates classification in the learning disability category.

** A PRS score of 69 or less indicates potential learning difficulties.

CHAPTER V

DISCUSSION OF RESULTS

In the first section of this chapter, the writer will discuss the degree to which the research expectations advanced in the first chapter were met. Emphasis will be placed upon general findings and pertinent differences in regards to the test results, as related to APP training, among the five dyslexic boys studied. A second section will focus upon additional findings related to the APP remedial program for dyslexia. A third section will consider the strengths and weaknesses of the present research project. The fourth and final section will deal with future research directions suggested by the findings of this exploratory study.

Discussion of Research Expectations

The review of the literature in Chapter I led to the formulation of a general research expectation. This was subsequently broken down into seven specific expectations to better determine the nature of changes in perceptual processing abilities and academic skills in relation to the remedial training program. The general research expectation will be examined first, followed by the seven specific expectations.

General Research Expectation

The general research expectation, derived from APP theory

and from the review of the literature, was stated as follows: language-related perceptual processing abilities and basic academic skills will show positive gains during APP training.

Results presented in Chapter IV indicate that this expectation was met in four of the five cases. On the ITPA, chosen to assess language-related perceptual processing, four boys recorded substantial gains on various subtests and also attained a better balanced posttraining subtest profile. On the battery of achievement tests, the same four boys showed a stronger overall achievement pattern at the close of APP training than that indicated during the baseline period. In addition, their gains in achievement during the intervention period were generally stronger than those indicated for a similar period of time in their past school record.

In the case of one boy, Brian, only small gains were recorded on the ITPA, and the posttraining subtest pattern proved to be less balanced than its pretraining counterpart. Some improvement in basic decoding skills and in errors of letter omission and sequence was apparent during APP training, but the overall rate of achievement during this period was roughly similar to that over the 10 months that preceded the research project. Only in Arithmetic did he achieve a gain of a full grade during the intervention period. Brian actually seemed less confused and distressed during the 2-month follow-up period. In that short time he gained more in overall achievement than he had during the training program.

It is possible that Brian was moved ahead too quickly through the APP remedial training program and that he did not have sufficient time to consolidate some of the early gains he demonstrated on the ITPA. It is equally possible that his particular form of listening deficiency may have required a different type of training program to produce better results.

Specific Research Expectations

As explained in Chapter I, the general research expectation was subdivided into seven specific expectations to better evaluate the nature of changes in perceptual processing abilities and academic skills as remedial training progressed.

First Specific Research Expectation. This expectation deals with the relationship between perceptual processing abilities and academic skills. It was stated thus: gains in language-related perceptual processing ability should generally precede gains in academic achievement.

In four of the five cases, the main gains on the ITPA occurred over the first 2 to 8 months of APP training while improvement in academic achievement occurred from the 4th month of the training program and into the follow-up period. Although generally speaking gains on the ITPA did precede gains in achievement in these four cases, in two of the cases, Charles and Darryl, some degree of overlap occurred. In one of these four cases, Brian specifically, many early gains on

the ITPA were lost at the end of the intervention, perhaps due to the premature introduction of the last training subphase; these losses were partially recovered during the follow-up period.

It is also interesting to note that in four of the five cases, gains in achievement were more clearly related to the second active phase of APP training. The remaining youngster, Brian, manifested the most progress in academic skills after APP training, in the follow-up period.

These trends are in keeping with Tomatis' (1972a) emphasis on enhancing the preschool listening and language foundations in dyslexic children. They are also in keeping with some proponents of the biomedical and psycho-educational tradition who, in their approach to the prevention as well as to the remediation of dyslexia and learning disabilities, stress the diagnosis and development of underlying perceptual-processing weaknesses (Hagin, Silver and Kreeger, 1976; Jansky and de Hirsch, 1972; Johnson and Myklebust, 1967; Kephart, 1960; Kirk and Kirk, 1971; Silver and Hagin, 1976).

The main finding here, that in four of the five cases gains in language-related perceptual-processing preceded gains in academic achievement, requires further qualification. Over the first 2 or 4 months of APP training, all boys registered some gains on the achievement tests as a results of increased attention and concentration. However upon closer analysis, these gains were more quantitative than qualitative

in nature. More test items had been successfully attempted within allotted time limits but basic problems in decoding, reversals of letters or words, confusion of vowel sounds, and omission of letters in spelling all remained. Real improvement in basic skills emerged only from the 4th month of APP training on, as indicated previously, and generally in the active phase of training. The intriguing changes in attention span will be dealt with in the second section of this Chapter.

Ernest proved to be the exception to this main finding in that many of his gains in perceptual-processing ability coincided with improvements in academic skills rather than precede them. He showed sharp gains on the IPTA over the first 2 months of APP training, and again over the last 4 months while in the active phase of the program. The latter gains involved mainly auditory-vocal functions, and concurred with major advances on the achievement tests. Over these last 4 months, as Ernest responded to such ITPA subtests as Verbal Expression, Grammatical Closure, Auditory and Visual Sequential Memory, the writer was impressed by the boy's greater capacity for processing information in a logical, succinct and orderly fashion. Theoretically this deserves some comment, especially since both Andrew and Charles also manifested more logical and sequential type responses in the active phase of APP training, although in their case this preceded gains in academic achievement.

Luria's model of information processing may have something to offer in understanding Ernest's particular pattern of change. Luria (1966, 1973) has drawn attention to two basic forms of integrative activity of the cerebral cortex: simultaneous synthesis which involves spatial or grouping functions primarily, and successive synthesis which involves temporally organized processing. He has related simultaneous synthesis of information to parieto-occipital areas of the brain, and successive synthesis to fronto-temporal areas which form part of the motor and acoustic analyzers. Luria's model has been operationalized by Das (1973; Das, Kirby and Jarman, 1975; Das, Cummins, Kirby and Jarman, 1979) through a battery of selected tests found to fit these two modes of synthesis. Their research on the reading process would suggest that successive processing appears to be important for the development of elementary decoding skills while simultaneous processing may be important for the development of advanced skills of comprehension. Interestingly, in relation to Ernest's pattern of test results, as he manifested ITPA gains through responses of a more logical, orderly and successive nature after 8 months of APP training, he could clearly decode at a much quicker pace and was starting to read more comfortably at the comprehension level.

It is also possible to consider Ernest's pattern of change in terms of hemispheric specializations in cognitive functioning. Ornstein's (1972) review of the literature in

this area indicates that the left hemisphere is involved predominantly with language and logic: it processes information sequentially. The right hemisphere by contrast is said to be primarily responsible for our orientation in space, bodily awareness and creative talents: it processes information more diffusely than the left hemisphere does, integrating material in a simultaneous rather than linear fashion. In regards to Ernest, the attainment of the right "leading ear" during active APP sessions may have promoted a more sequential and logical cognitive style characteristic of left hemispheric functioning. Tomatis (1963, 1972a, 1974) has indicated that the right ear is more directly connected to the speech centres of the left hemisphere.

Whatever the explanation, the attainment of a more logical and successive manner of processing information, as reflected on the ITPA, seems to have had a greater and more immediate effect on academic achievement in Ernest's case than it did for the other four boys.

Second Specific Research Expectation. This research expectation focuses on the nature of language-related perceptual processing changes that might be brought about during APP training. It was stated as follows: gains in perceptual processing should occur in auditory-vocal functions, and primarily at the level of sensory-motor habits rather than at the representational or symbolic level.

In four of the five cases, this expectation proved cor-

rect, although in one of these cases, Brian specifically, the ITPA gains were not substantial. Charles recorded substantial gains mainly at the automatic level, on three auditory-vocal and one visual-motor subtest. Darryl and Ernest attained substantial gains at both the automatic and representational levels of the auditory-vocal channel, but primarily at the automatic level.

Although no two children were alike in their ITPA profiles or pattern of changes, it can be pointed out that in general the first improvements on the automatic auditory-vocal functions occurred on those subtests that required refined auditory analysis: Auditory Closure and Sound Blending. These gains appeared mainly in the first or passive phase of APP training which emphasized, in this research project, the opening of selective listening ability on the TLT. It seems logical that gains on the more receptively oriented Auditory Closure subtest preceded those on Sound Blending which leans more heavily on auditory-vocal skills. Interestingly, some improvements in reading-related decoding skills was noticeable after gains on these two ITPA subtests. Increased self-listening ability was clearly demonstrated on Grammatical Closure during the second or active phase of APP training which emphasizes right-eared self-monitoring of speech. Three of the boys improved their scores on this subtest by listening to the plausibility of their replies and correcting them if they did not "sound right". Signs of greater capacity for

successive information processing generally came late in the program as shown by improvement on the Auditory Sequential Memory subtest.

The relevance of such automatic skills to reading problems and reading ability has been underlined by Kirk and Kirk (1971) and Bannatyne (1973). Kinsbourne and Caplan (1979) point out that improvements in selective listening and auditory attention, particularly as they relate to segmentation of words and auditory analysis, are more closely related to the rate of learning to read than improvement in visual skills. Luria's (1966) hypothesis that functionally mature auditory portions of the cortex act as selective analyzers seems relevant here. Moreover Shankweiler and Liberman's (1972, 1976) proposal that dyslexic children may not be sufficiently sensitized to the phonetic structure of words they can hear and do repeat, seems equally relevant. In this writer's opinion, refined listening skills and more articulate phonation may be components of what Shankweiler and Liberman call phonetic coding ability. It seems logical to suggest that the improvement of listening skills under APP training and subsequent phonological counterreactions may make speech segments more explicit and improve phonetic coding to the advantage of basic reading skills. In addition, Tomatis (1963, 1972a) has indicated that auditory-vocal processing through the right leading ear is more rapid than through the left ear. Dionne (1974) experimentally demonstrated a right lead-

ing ear advantage for speech output in terms of its articulatory and temporal parameters.

It should be emphasized that representational level functions in the auditory-vocal channel may also have been positively affected by APP training. Auditory Reception seems to have been affected in both the passive and active phases of training, perhaps because it involves auditory discrimination as applied to actual words and phrases. Verbal Expression generally manifested gains from the start of the active phase, and generally involved more relevant as well as better formulated responses at that point. Unfortunately, as indicated in the previous chapter, neither the fluency nor the personalized nature of responses to this subtest could be credited in view of the narrow focus of the ITPA scoring criteria.

In only one case, Andrew, did APP training coincide with visual-motor rather than auditory-vocal gains, and in this case more at the representational than automatic level. Andrew demonstrated very substantial gains (18 SS) on Visual Association, and near substantial gains of 5 SS on Visual Reception and Visual Sequential Memory. However these changes appeared hand in hand with the spontaneous use, once into APP training, of overt verbal labelling, verbal mediation and verbal self-direction. These strategies gradually took on a subvocal tone and eventually disappeared, perhaps becoming covert, towards the close of the training program.

On the basis of Andrew's pretraining ITPA profile, it can be suggested that his weak visual processing only required linkage to relatively well-developed auditory-vocal abilities to improve academic skills. Orton (1937) drew attention to the importance of visual association skills for proper reading ability. He indicated that visual symbols or visual word patterns require a strong association or linkage with auditory-vocal impressions or with meaningful language symbols for proper reading to occur. Orton proposed that such integrated functioning depended upon the maturation of tertiary association levels of the dominant hemisphere. Tomatis' (1978, 1980) recently advanced theoretical model, which proposes the existence in man of three systems or levels of sensory-integrative activity, may also aid in understanding Andrew's ITPA gains. At the third and highest level, the cochlear-interpretative system is said to pull together and integrate a visual and a vestibular system through sound and personalized listening-language functions. This third level may well have come into play in Andrew's case under APP training: he manifested not only verbal strategies on visual tests, but also a more personalized form of self-expression.

Third Specific Research Expectation. This expectation, like the previous one, deals with the type of perceptual processing changes that might occur during the APP remedial training program. It was stated as follows: gains in perceptual processing of a visual or visual-motor nature can

be expected.

This expectation was met in all five cases in varying degree. Andrew achieved substantial gains on the Visual Association subtest, with small gains on Visual Reception and Visual Sequential Memory. Brian registered small gains on Visual Reception. Charles attained substantial gains on Visual Sequential Memory. Darryl showed small gains on Visual Reception and Visual Association. Ernest recorded substantial gains on Visual Association and Visual Sequential Memory, as well as small gains on Visual Reception. In all cases these gains seemed to have been attained through the aid of some form of verbal mediation or verbal self-instruction which for everyone except Darryl was triggered during initial stages of APP training. As indicated, the children were highly aroused at the onset of the training program, becoming overtalkative, often manifesting a need to verbally comment on whatever caught their attention. Such overt verbal mediation faded out by the end of the program, or perhaps became covert. In regards to Darryl, such verbal mediation was already present at the start of APP training and persisted throughout the program.

Theoretically, these spontaneous forms of verbal strategies deserve some comment. Vygotsky (1962) has pointed out that between 2 or 3 and 6 and 7 years of age, thought and language develop in a coordinated way. During this time a child may vocalize his thoughts or use external signs such

as counting on his fingers to assist in exchanges between inner and outer experiences. After 6 years of age or so, such overt verbalization or use of signs becomes more covert in the form of silent "inner speech". It would appear that in regards to at least four of the boys in this project, APP training triggered such aspects of language behavior that may have been delayed or bypassed. This lends some support to the theory that APP training promotes the normal evolution or recapitulates earlier stages of language development.

These boys employed verbal labelling, verbal mediation and verbal mnemonics predominantly in their approach to the Visual Association and Visual Sequential Memory subtests. When such strategies faded out or became covert, the gains on the above subtests were maintained. It seems relevant here to underline that many researchers such as Blank and Bridger (1966) and Vellutino (1978) have concluded that the weak visual processing skills found in many dyslexics are due to a lack of verbal mediation of some sort.

Responses to Visual Reception illustrated the use of language for purposes of self-regulation of behavior. This subtest measures the ability to gain meaning from visual symbols. After brief presentation of a stimulus picture, a child must choose the most functionally similar response picture from four response options. Incorrect options include pictures of varying degree of structural rather than functional similarity. At first sight, most of the boys in this pro-

ject were attracted to many of the structurally similar choices. Some of them came to use verbal labelling to relate more appropriately to functional aspects of the pictures. Andrew and Ernest also came to employ verbal self-directions to slow down their initial reactions and thus avoid responding impulsively to the structural features of the response options. Interestingly this ITPA subtest has some properties in common with Kagan's Matching Familiar Figures Test which has been used to demonstrate the existence of a cognitive style continuum called reflection-impulsivity (Kagan, 1965a). Moreover, Kagan (1965b) found that elementary-school children with reading problems were inclined to be more impulsive than successful readers who were more reflective and deliberate on the visual matching tasks.

Luria (1961) has suggested that between 4½ and 5½ years of age, a child can make use of self-initiated verbal self-instruction to inhibit or regulate his or her own motor behavior. After 5½ years of age, children are said to be capable of regulating their behavior by covert rather than overt speech. Luria's postulates regarding verbal self-regulation of behavior have served as a theoretical basis for the development of self-instructional training programs for impulsive children (Meichenbaum and Goodman, 1971) or hyperactive children (Douglas, 1975). Such children have often been called learning-disabled; they also manifest problems of attention and motor coordination. Training them to regu-

late their own behavior via verbal self-direction has reportedly had positive effects. From the results of the present study, it seems that APP training may stimulate language in such a fashion as to develop its normal regulating effect on behavior.

Fourth Specific Research Expectation. This research expectation attempts to evaluate the possible harmonizing or integrative action of APP training on language-related perceptual processing. It was formulated as follows: the posttraining profile of perceptual processing abilities should be more evenly balanced than the corresponding pretraining profile.

This specific expectation was met in four of the five cases in that the posttraining ITPA profile was more evenly balanced. Furthermore, in each of these four cases, the standard deviation of the successive sets of ITPA results gradually diminished in the direction of a more homogeneous subtest pattern by the end of APP training. In regards to these findings, the writer recognizes that a better balanced ITPA profile could have come about as a consequence of repeated testing and that more homogeneous subtest scores do not necessarily reflect greater integration among the subtests involved. The present results however do indicate that further investigation into the harmonizing and integrative aspects of APP training seems worthwhile.

Only in Brian's case did the posttraining ITPA profile

appear less balanced, and only in his case did the posttraining standard deviation of subtest results prove to be larger than its pretraining counterpart. It is possible that this boy was moved ahead too quickly through the various phases and subphases of the training program to properly integrate some of the changes that did occur. There was some indication to this effect when he advanced from the passive to the active phase. At that point he became confused again about certain sound-symbol associations he had initially mastered. Later, when he advanced from the first to the second active subphase of training towards the last month of the program, the dip in the speech zone on the TLT became more pronounced after it had been previously overcome at least in part. In the last testing session of the APP training period, he lost a good part of the ITPA gains registered previously during the training program. Although he functioned well on certain auditory-vocal subtests, he had become dazed and confused on certain visual-motor channel subtests. In the last testing session of the research project, at the close of the follow-up period, Brian recovered some of the aforementioned ITPA losses and functioned better on the visual-motor subtests. However at that point he had become confused and frustrated on the auditory-vocal channel subtests. One sensed that this youngster could not function in both channels simultaneously in a sharp and integrated manner.

It should be noted here that the dip that Brian presented

in the speech zone on the TLT, for both air and bone conduction, is recognized in APP circles as a pattern that is very resistive to change. This pattern sometimes requires a different form of modified feedback on the Electronic Ear for proper training of listening skills. Such a program was not attempted during this research project, and this may have contributed to Brian's poor response to the training sessions.

Fifth Specific Research Expectation. This research expectation considers the nature of changes in reading skills that might be brought about during an individualized APP training program. It was stated in this manner: gains in reading should follow a developmental pattern, with initial improvement at the perceptual level of basic decoding skills, and later improvement at the conceptual level involving the meaningful understanding of words and passages. The achievement test battery used in this project was chosen to tap these different levels of reading skills.

This expectation was met in four of the five cases, each one following a developmental pattern at his own rate. After 2 months of APP training, nearly all reading subtest grade ratings advanced, seemingly as a result of increased attention span. In a second phase that lasted anywhere from the third to the tenth month of training, depending on the child in question, basic phonetic skills and speed of decoding improved slowly. In a third phase, anywhere from the fourth month of training to the follow-up period, synthesis of

phonetic skills occurred with quicker access to meaningful reading. In the case of Brian and Darryl, this last phase became apparent only in the follow-up period, and predominantly at the level of word understanding rather than fluent passage comprehension.

This general finding is considered important in view of the recent emphasis by researchers and reviewers on understanding the normal development of language and/or reading skills to better grasp and correct the difficulties of the disabled learner (Bannatyne, 1971, 1973; Fries, 1962; Gibson and Levin, 1975; Goodman, 1972; Kavanaugh and Mattingly, 1972; Wiener and Cromer, 1967). As indicated in Chapter I, this lead to the conceptualization of at least two levels or stages in the normal evolution of the reading process: a perceptual or decoding level, followed by a conceptual or comprehension level. Many component skills, including good receptive and expressive language abilities, are involved at each level. Given the complexity of the reading process, the investigator of dyslexia has been advised to measure more than one aspect of reading achievement (Doehring, 1978; Smith, 1971; Torgeson, 1975). The use in this research project of three subtests of reading skills, in keeping with the outlined levels of the normal development of reading ability, seems to have been fully justified by the results obtained. Moreover, this developmental pattern of gains in reading skills lends support to Tomatis' (1972a) emphasis on promoting or

recapitulating the normal development of listening and language skills in the remediation of dyslexia. It should be stressed again that the APP remedial training program for dyslexia does not involve remedial teaching of basic academic skills.

Only in Andrew's case was this developmental pattern of gains in reading skills not noticeable although he progressed considerably in his reading ability. This boy seemed to advance in word recognition, word understanding and passage comprehension gradually yet simultaneously. As indicated in the discussion of a previous research expectation, it is possible that Andrew's weak visual processing skills, as shown on his pretraining ITPA profile, may have primarily required linkage to relatively well developed auditory-vocal skills for proper reading to occur. In view of the fact that he recorded his main gains on the ITPA visual-motor channel functions, it is also conceivable that Andrew's pattern of gains in reading achievement reflects a greater reliance on a whole word or sight approach rather than phonetic approach to reading.

Sixth Specific Research Expectation. This research expectation deals with the nature of changes in spelling behavior that might occur during APP training. It was stated thus: gains in spelling should occur mainly on words that follow the regular and phonetically accurate sounds of English rather than on words requiring knowledge of special rules or

individual memorization.

This research expectation was borne out in the case of four of the five boys, with improvements occurring mainly after each child had entered the active phase of auditory-vocal exercises emphasizing clear auditory discrimination and well articulated repetition of words and phrases. By the end of APP training, spelling became phonetically more accurate. Errors of letter omission and of serial order of letters gradually disappeared in two cases for whom this was a problem. Darryl and Ernest had gone beyond the correct spelling via phonetics and had started to learn some words that depended on visual memory: they could spell by ear and had started to spell by eye also. Only in Brian's case did spelling prove problematic in terms of phonetics at the close of APP training: he still confused some sounds, especially vowel sounds, and this may be related to the dip his TLT showed in the middle speech range frequencies.

It should nevertheless be underlined here that the Spelling subtest in general registered the smallest gains of all the achievement subtests through the intervention period. Four of the five boys advanced less than a full grade in their spelling behavior during the 10-month APP training program. It seems to this writer that once these children had improved sufficiently in spelling at a phonetic level, a review of rules and principles for spelling words that do not follow regular English sounds would have been advisable. This might

have helped these children advance further in this subject area.

In regards to those two boys who had learned to spell some irregular words on the basis of visual memory, Tomatis (personal communication, 1977) has indicated that memory itself involves the active intentional participation of the whole body in a sustained manner during information processing and retrieval. He states that APP training, through its action on the cochlear and vestibular systems, prepares the body as a whole, including the visual system, for effective memorization. Such a view of the components of memory is in keeping with aspects of Meacham's (1972) analysis of the memory function.

Seventh Specific Research Expectation. This last research expectation deals with visual reversal errors which have been considered in the past as key signs of dyslexia. It was formulated as follows: reversals of letters, words and numerals should disappear during the second phase APP training as it emphasizes auditory-vocal laterality and clear articulation of words.

Only three boys, Brian, Charles and Darryl, presented with such difficulties. Their reversal problems did disappear while in the active phase of APP training. For Charles, reversals of numerals disappeared after letter and word reversals had been overcome, perhaps because APP training deals more with sounds and words rather than numerals. For Brian,

only reversals of the letters "b" and "d" persisted at the close of the research project. This may reflect the fact that he was the only boy who had not attained right-eared control of speech, and whose APP program had not been at least moderately successful.

Kephart (1960) and Money (1962) suggest that visual reversal errors are related to difficulties in body schema which do not allow the child to impose proper spatial coordinates on equivocal visual signs. Shankweiler and Liberman (1972) suggest that such errors reflect inadequate sensitization to phonemic and articulatory differences in graphically similar letters and words. Tomatis (1972a) has indicated that right-eared self-listening contributes to the alignment of other lateral preferences, to better body schema, and to clearer articulation of words. It is thus understandable that APP training towards the acquisition of the right "leading ear" during the active auditory-vocal exercises may have helped overcome visual reversal errors. However since such training purportedly enhances laterality, body schema and articulation, it is difficult to determine here which factor or factors may have contributed to the disappearance of the reversal problems. Clarification of this issue awaits further research.

Overall it can be stated that the first six research expectations were met to some degree in four of the five cases. The seventh and last expectation applied to only three of the

five boys, and all three met this expectation in whole or in part. The findings related to these research expectations also indicate that four of the five boys, Andrew, Charles, Darryl and Ernest, seem to have profited appreciably from APP training. Brian however may have benefited from the program only to a limited extent.

The next section discusses additional findings that may throw more light upon the nature and extent of the effectiveness of the APP remedial training program for dyslexia.

Further Findings Related to APP Training

In addition to the results linked to the research expectations, one can indicate that all boys advanced by nearly a full grade or more on the WRAT Arithmetic subtest during the 10-month APP training period. Improved concentration and ability to memorize times tables likely contributed to these gains. Moreover, Andrew and Darryl no longer used the external sign of counting with their fingers by the end of APP training.

Sustained attention and active concentration are considered prime ingredients in successful mathematical calculation (Rapaport et al., 1945). It is interesting to note that two of the boys who seemed to profit the most from APP training, Andrew and Ernest, showed appreciable gains of 3 scaled scores on their posttraining WISC-R Arithmetic subtest.

The area of attentional mechanisms deserves special comment here. All boys showed signs of high arousal levels in

the early months of APP training, with increased attention span. It would appear that the boys had to learn to cope with and focus their increased arousal level and ability to attend in the first 2 to 4 months of APP training. Initial restlessness and overtalkativeness was replaced by a more relaxed disposition and more personally directed verbalization as the youngsters progressed in the program. In most cases, the ability to concentrate improved gradually over the full 10 months of APP training and did not falter during the follow-up period. In terms of Brian and Charles, variable mood tone and motivation impinged upon this improved concentration over the last 6 months of the research program.

Theoretically, this unexpected finding is particularly intriguing. The review of the literature underscored the fact that weak attentional mechanisms have been repeatedly linked to learning problems. Attention was recognized as a complex factor in itself, likely made up of various components. Researchers in dyslexia and learning disabilities have suggested that poor attention may be due to inadequate physiological arousal to support sustained attention (Hunter et al., 1972), to a lack of vigilance or sustained attention (Noland and Schuldt, 1971), to a lack of focussed arousal (Sheer, 1976), to distractibility (Santostefano et al., 1965) and to a lack of impulse or inhibitory control (Douglas, 1976). In view of the results of APP training in these five case studies, one may wonder if all of these aspects may not

be attributed to a listening disorder as understood by Tomatis, or if they may not all be fitted into an explanatory framework dealing with excitatory-inhibitory processes (cf. Luria, 1961). This area seems rich in research possibilities.

As indicated in the previous section, a more evenly balanced ITPA subtest pattern was found in four of the five cases after APP training. It was recognized that a more harmonious pattern could have resulted from repeated testing rather than from APP training, and that more homogeneous ITPA scores do not necessarily reflect integration among the subtest functions involved. However the fact that the repeat WISC-R profiles for these four boys, obtained at an interval of over a year, were in general more evenly balanced after APP training does suggest a possible harmonizing action coinciding with APP exercises. Moreover, it was observed that two of the boys, Andrew and Ernest, came to speak, gesticulate and maintain posture as well as eye contact in a more coordinated and synchronized way over the course of the training program. In view of these additional bits of evidence, future research into a possible harmonizing and integrative action of APP training seems further justified.

The sleep patterns of Darryl and Ernest, the two boys who lived in the CSC residence, were reported to have improved after a month or two of APP training. They had apparently acquired sounder sleep with less restlessness, and they apparently awoke more easily in the mornings in a refreshed

state. This area was not investigated or reported upon in terms of the other three boys who lived at home.

Again, it is interesting to note that improvements in mood tone, concentration, self-expression and social interaction, and in motivation to learn all preceded actual improvements in basic academic skills for all boys except Brian.

In the case of four boys, a need for physical closeness and skin contact was apparent in the early passive stage of APP training. These youngsters seem in good spirits, not depressed or regressed, when they made their bids for closeness. Andrew, Brian and Charles made advances for closeness towards the Program Assistant while Ernest approached his mother. Three of these four boys had been described by teachers or parents as "warmer". Tomatis (1974) maintains that the ear itself is a highly specialized piece of skin and that changing the way the ear listens also affects the cutaneous response of the body. Von Békésy (1957) has drawn attention to skin sensations similar to directional hearing, beats and harmonics of the ear. This area may be worth investigating in terms of physiological arousal aspects of skin conductance and in terms of the "skin hunger" aspect of affectional needs.

All five boys improved to some degree in verbal self-expression. Generally, they came to express themselves with less effort and in a more personal genuine way. In three cases, Andrew, Charles and Ernest, it was observed by parents

and/or teachers as well as by the writer that the boys' expression of thoughts had become more organized, logical and succinct. This occurred after they had entered the active phase of APP training. These three boys attained the strongest degree of right-eared control of speech according to the ALM.

All boys improved to some degree in social interaction over the period of APP training. Andrew, Charles and Ernest seemed to have acquired a greater awareness of the needs of others and of the appropriateness of relating on a give and take basis. This more other-centered level of awareness came about in the active stage of APP training. Again, these three boys attained the highest degree of right "leading ear" control of speech on the ALM.

The above indications of greater awareness of self and others, and of more logically organized verbalizations, fit into what Tomatis (1972b) calls socialized communication. He states that this is attained through right-eared self-monitoring of speech, and that such communication is a prerequisite to true reading. Wepman (1962), drawing upon Piaget's insightful observations on children's cognitive development, has remarked how the evolution of reading skills roughly coincides with an increased seeking of external sources of satisfaction and with the transition from an egocentric to a socio-centric cognitive orientation. Wepman suggests that the dyslexic child may fail to attain the level of a socialized

cognitive orientation or maturation, and that this may predispose such a child to delinquent behavior at the same time. In view of these points, it would be interesting to relate Tomatis' ALM measures to Piaget's egocentric-social framework as well as to reading ability.

The reactions of two parents seems worth underlining. Charles' mother and Darryl's adoptive mother were both distressed with signs of improvement and independence in their children. It appeared as if they wanted their boys to grow up but without letting go of them. Tomatis (1972a, 1972b) states that many dyslexic children are still sitting, psychologically speaking, in their mother's lap. Further to this, the reaction of two other parents also deserves comment. Brian's father had serious language and learning problems and was advised to participate in APP training with his son as is often recommended in such cases by Tomatis. However this man's busy work schedule did not allow him to become involved in the program. Charles' father, once diagnosed as dyslexic, and still struggling as an adult with communication problems, accepted the invitation to join his son in the training program. However this father did not persist in this venture beyond 10 sessions. Both fathers provided poor models of socialized language as understood by Tomatis. This may have limited the degree of progress their sons made in the research project. The area of family dynamics as it affects dyslexia may contain subtle but powerful

factors that have been overlooked in the past in trying to fathom this complex phenomenon.

Finally, one should look at the possible effectiveness of APP training on the five dyslexic boys in terms of the diagnostic methods used initially to select these subjects: the APP criteria and the composite operational definition of dyslexia. Overall, in terms of APP criteria, three children could be described as having overcome their dyslexia: Andrew, Charles and Ernest. In terms of the criteria related to the composite definition of dyslexia, Andrew might still be considered dyslexic in view of his Learning Quotient of 87, however this could be overlooked in view of his academic achievement which was generally at grade level, and in view of his high Performance IQ which may have inflated his degree of learning disability according to the Learning Quotient formula. In general, it can then be said that APP treatment seemed successful in terms of Andrew, Charles and Ernest, and that they could no longer be considered dyslexic.

Darryl's APP program can be qualified as moderately successful and he would have to be considered as mildly dyslexic at the close of APP training. According to the Learning Quotient of 83 after the training program, a large discrepancy still existed between his overall achievement grade and his expectancy level. Despite improvements in basic word recognition and word understanding, Darryl had not progressed sufficiently in his spelling and passage comprehension.

sion. Consequently, Darryl could still be considered dyslexic according to the composite definition of dyslexia although some beneficial gains did appear during the APP training program.

According to both the APP criteria and the composite definition of dyslexia, Brian remained severely dyslexic after APP training. He had improved mildly as a result of the training program.

Strengths and Weaknesses of the Present Research Project

The case study design had definite advantages in this research project despite some weaknesses. Although all five boys were diagnosed as dyslexic, each differed noticeably in terms of diagnostic indicators, perceptual processing and achievement test results. Each boy's APP program was applied in an individualized way that respected his progress. Where most of the research expectations were met in four of the five cases, each case still presented interesting individual features. For example, although in four cases the main ITPA gains occurred in the auditory-vocal channel and at the automatic level, in no two cases were the initial profiles and pattern of changes similar.

The time-series strategy had the particular merit of highlighting the process of change. For example it would appear that APP training has an initial arousal or excitation action that manifests itself in restlessness, overtalkativeness and increased though poorly channelled attentional ability. This would appear to be followed by increasing ability to

focus one's attention and better direct one's energies. One is tempted to think in terms of an early excitatory action followed by increasing inhibitory control. This pattern, which seemed to emerge in the first two to four months of APP training, during the passive "filtered sounds" phase, would not have emerged in a simple pre-post design.

The time-series strategy also underlined the possibility that some poorly developed visual processing abilities and some impulsive response patterns may well have been overcome through the use of overt verbal mediation or self-statements that emerged during the early stages of APP training and disappeared, becoming perhaps internalized, towards the end of the program. The contribution of such overt verbal behavior may well have passed unnoticed in a simple before and after design. Such indications and process variables seem all the more important in view of recent research in the field of learning disabilities that has focussed on the complexities of poor attentional mechanisms (Douglas, 1976; Dykman et al., 1971; Harris, 1976; Hunter et al., 1972; Santostefano et al., 1965) and on the benefits of verbal self-directions in the control of impulsive responding or in the maintaining of attention (Douglas, 1975; Meichenbaum and Goodman, 1969).

The time-series strategy seemed to indicate that gains in ITPA performance generally preceded improvement in academic skills, a finding in keeping with Tomatis' emphasis on pre-reading auditory-vocal skills and with the tenets of the per--

ceptual processing school. More striking yet are the indications that major gains in activity level, motivation, talkativeness and social encounters preceded academic gains in four out of five cases. These indications suggest that need to take a fresh new look at the nature of learning problems in keeping with Tomatis' tenet that relational difficulties may be at the root of the auditory-vocal and learning problems. The time-series design used here also supports the use of more than one form or level of reading test in dyslexia-related research since gains in reading did follow a developmental pattern. All in all, the time-series design allowed the investigator to take account of the pattern and process of change throughout the research project. The manner in which results were obtained proved to be as important and revealing as the final results in themselves.

Beyond these tentative findings, the present design contained certain weaknesses. Longer baseline and follow-up periods would have been desirable. Longer baseline trends in perceptual processing ability and academic achievement would have been especially helpful in providing more definite control factors against which to compare changes that occurred in these areas during the APP training program. Practical time limits and heavy testing schedules were considerations that led to the adoption of the present research format despite its acknowledged weaknesses. In future investigations using a similar time-series strategy, the APP training pro-

gram could be speeded up considerably. This would shorten the intervention period and allow for longer baseline and follow-up periods. Tomatis (personal communication, 1977) has indicated that a dyslexic child can comfortably endure up to six half-hour training sessions a day in a more intensive APP program over a shorter period of time or over intervals that interfere less with school attendance.

The fact that no control cases were used in this intense case study design does limit the degree to which the gains and findings can be attributed to APP training. The changes and improvements noted in perceptual processing ability and academic skills can at best be described as coinciding with or paralleling APP training: these changes and gains cannot be interpreted within a cause-effect framework. Even with the provision of a longer baseline, the contribution of such factors as maturation or human attention could not be readily ruled out. Consequently future research in this area using the case study design would do well to include control cases or a control group. The control subject(s) should be carefully matched to the experimental subject(s), taking account of some of the previously mentioned subtype classifications for dyslexia.

The possibility comes to mind that the ITPA and achievement test results may have been inflated because of repeated testing and a learning effect. However the writer actually suspects an underinflation of the results because of a boredom effect manifested by most of the boys over the last two

or three testing sessions. One must admire the endurance of the youngsters in cooperating with all the assessments involved in this project.

The observations gathered throughout the investigation proved helpful in discussing and interpreting some of the test findings. However these observations were gathered in a relatively unstructured manner. It seems to the writer that more systematic behavioral data gathering would have enriched the present findings even further.

The manner in which the present case studies were conducted could be improved upon further by employing a "multiple baseline across subjects" design using a "time-lagged control", as illustrated by Gottman (1973) as well as by Hersen and Barlow (1976). With such a design, baseline data are gathered until stable trends are attained, and the treatment is introduced in only one case at a time until baseline changes are obtained for the case in question before proceeding to the next case. Such a time-lagged condition helps control for external threats to validity such as historical or seasonal change. The time-lagged design would have lent the experimenter more confidence in interpreting the results that coincided with the intervention.

Future Research Directions

In keeping with findings and indications discussed in the previous sections, further single-case time-series studies of the effectiveness of APP training on dyslexia could focus

on the areas of attentional mechanisms, vigilance and concentration. Autonomic or physiological measures such as the EEG, evoked potentials or orienting responses may be used to this end. Less costly and perhaps more reliable behavioral data may also be employed, as suggested by Douglas (1976). For example, Bryan and Wheeler (1972) and Bryan (1974) have found that the amount of time spent on non-task-oriented behaviors, as determined by observational means, is related to learning disabilities. A third alternative involves the use of simple tools such as the Continuous Performance Task (CPT) (Rosvold, 1965) and the Matching Familiar Figures Test of Reflection-Impulsivity (Kagan, 1965). Meichenbaum (1976) has indicated how such simple tasks can be analyzed into their cognitive-functional components for greater pay-off in terms of process variables rather than performance outcome alone.

Other areas worthy of similar forms of investigation are those of verbal behavior, with particular attention to clarity of self-expression, the personalized nature of self-expression, and the use of private speech of a self-informing or self-regulating nature. Changes in posture, in motor coordination and sleep pattern may be studied in this way. Changes in the quality and quantity of social interactions during APP training also merit closer study.

The study of adolescent or adult dyslexics might prove fruitful since they could report on felt changes throughout

the period of investigation: this might yield further clues as to the nature of changes under APP training.

The area of spelling seems worthy of special investigation in terms of what type of gains might be expected from APP training and how APP might be used to better advantage for words that do not follow the regular sounds of the English language. Furthermore, there is some suggestion that reversal problems might yield more to the active auditory-vocal exercises with emphasis on right-eared self-monitoring of speech rather than to just the passive listening exercises.

Traditional multisubject research designs might be used to study the perceptual integration aspect of APP training. A pre-post research design with a control group, using a battery of sensory and perceptual tests, might indicate whether APP training does exercise a harmonizing effect as seen in subtest profiles, as well as an integrating effect as seen perhaps in the intercorrelation matrix of subtest scores. Guthrie (1973) found learning-disabled children characterized not so much by a lower level of reading subskills as by a lack of interfacilitation among subskills whereas normal readers showed evidence of a higher degree of integration between subskills. Myklebust et al. (1971) have shown, on the basis of the intercorrelation matrix of a battery of tests, that the mental abilities of learning-disabled children are structured differently. Given Tomatis' (1978, 1980) recent emphasis on the supposed integrative nature of APP

training, an investigation into the integrative effects of the APP program on dyslexic children seems indicated. Tests of vestibular functioning, proprioceptive functioning and motor coordination along with the ITPA, in the manner adopted by Ayres (1969, 1972, 1978), would seem appropriate in such a study.

Further group comparison research could be conducted on the diagnostic dimensions of APP such as the Tomatis Listening Test (TLT) and the Audiolaterometry technique (ALM). Both methods are complex and require some experience in their use. Statistical evidence of the reliability and validity of these instruments seems desirable, as does the provision of some developmental norms. In regards to the TLT, the availability of clear interpretative criteria and guidelines would facilitate the investigation of APP programs. In looking over the few guidelines and TLT profiles presented in this thesis alone, it would appear that dyslexic children can manifest defective listening ability in more than one way, such as closed selectivity or weakness in speech related frequencies. Perhaps a scoring method could be developed to consider the various dimensions of the test, and to perhaps provide an overall global score capable of clearly differentiating between dyslexic and non-dyslexic groups. Such a scoring system could be used for diagnostic purposes as well the more systematic monitoring of the effects of APP training. Future research could also contrast the TLT to a standard audiometric hearing test to

verify to what degree the TLT actually does constitute an advantage over recognized psychophysical methods. The ALM, which measures auditory laterality in the act of speech, could be contrasted to the currently employed dichotic techniques. In addition, there is some suggestion in the present research findings that right-eared control of speech might be related to clearer expression of one's thoughts as well as to a more socialized or less egocentric form of interpersonal relationships. The ALM technique thus seems rich in research possibilities.

The case study format was employed in the present study in the hope that it might also point out which type of dyslexic child might profit the most from APP training. However the effects of the training program on the five boys were too diverse to attempt to clarify this issue here. Nevertheless the writer suggests that the effects of APP training might be studied with certain subtypes of dyslexic children such as those whose perceptual problems are predominantly auditory or mainly visual in nature. Or again dyslexic children with or without a familial pattern might be studied. It would be particularly interesting to study two groups of dyslexic children with a high familial incidence of the disorder: in one group, APP training could be given to the child alone, and the results here could be contrasted to the second group where dyslexic family members joined the child in the remedial program. Such an approach might throw light on the question

of to the degree to which familial or socio-linguistic factors affect the dyslexic child.

In the final analysis the present project, exploratory in its intent, has brought forth tentative findings and indicators that point to a number of areas worthy of further investigation, both in terms of intensive case study and multi-subject research designs. The present intensive case studies, despite inherent weaknesses, have been fruitful in providing a number of research leads and a better understanding of the nature of APP training.

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APPENDIX A

THE THREE INTEGRATORS

The Three Integrators¹

The nervous system as a whole is intricately linked, via a functional complex composed of three dominant sensomotor and sensorimotor tracts, to the auditory apparatus. In the course of our research on the ear we have been able to identify these three tracts as follows:

- 1) the vestibular (or somatic) integrator
- 2) the visual (or spatial) integrator
- 3) the cochlear (or linguistic) integrator

The Vestibular Integrator

It has been amply demonstrated, both phylogenetically and ontogenetically, that the sensory apparatus we know as the ear is simply an external attribute of the cerebral cortex. The cerebral cortex itself is merely a concentration of vestibular nuclei located in the medulla oblongata zone of the nerve axis.

It is through the area of its vestibule that the ear monitors the relationship of the organism with its environment, whether static or dynamic. The vestibular zone provides the necessary stimulation so that the cortex will be bombarded with sufficient informational "bits" to ensure optimal development of the organism within its species. In other words, the labyrinth acts as a generator, supplying the nervous system with the energy it requires.

¹ A.A. Tomatis. Audio-Psycho-Phonology: A New Challenge. Paper presented at the Symposium on Audio-Psycho-Phonology, Potchefstroom University for Christian Higher Education, Potchefstroom, South Africa, April 30, 1980, 20-26.

At the embryonic stage of foetal life, the cortex, and the labyrinth attached to it, induce structuralization of the entire nervous system. This ontogenetic sequence, whose evolutionary development is also clearly traceable phylogenetically, brings us irresistably to the concept of intra-uterine listening aptitude. In our research, once we had understood the nature of pre-natal auditory perception, we were then able to develop numerous therapeutic strategies based on it.

The development of direct and overlapping efferent vestibulospinal nerve fibers and, with the evolution of the archeo and paleocerebellum, the development of the afferent tracts of Fleschig and Gowers, combined to create the vestibular complex that enables the organism to relate to its environment. Two final acquisitions, secondary and hence more recent than the vestibular nuclei, are the emboliform nucleus and the central portion of the red nucleus, including, of course, their olivospinal and rubrospinal tracts. Together, this grouping forms what we have called the "vestibular (or somatic) integrator". Both pre- and post-natally, it controls body image impression reinforcement and also kinesthesia, or the sensation of bodily movement in space. From the foregoing it will be clear how this structure, the vestibular integrator, prepares the human body for its ultimate task as the instrument of language.

The Visual (or spatial) Integrator

Phylogenetically, the next evolution occurring in this

neuronic nucleus was the addition to it of the visual, or spatial integrator. For millions of years -- a relatively short span in terms of eternity -- this visual integrator superceded and dominated the vestibular integrator, obliging living creatures to circulate in space solely under visual guidance. With the advent of the mammalian species, however, the labyrinth regained its former dominance, forcing the visual analyser into a subordinate role. Simultaneous control is now exerted at the anterior roots of both medulla and medulla oblongata through the vestibulo-mesencephalic tract, which is then, in turn, able to assume control over the motor nuclei of the VI, IV and II cranial nerve pairs, source of motor nerve function for the eye. This development resulted in increased eyeball mobility and in anthropoids, eventually resulted in binocular vision. The catalyst for this evolutionary step was the powerful action exerted by the vestibular labyrinth on the visual integrator, reinforcing body image impression and enabling the organism to orient itself in the environment and perceive the environment's characteristics.

The Cochlear (or linguistic) Integrator

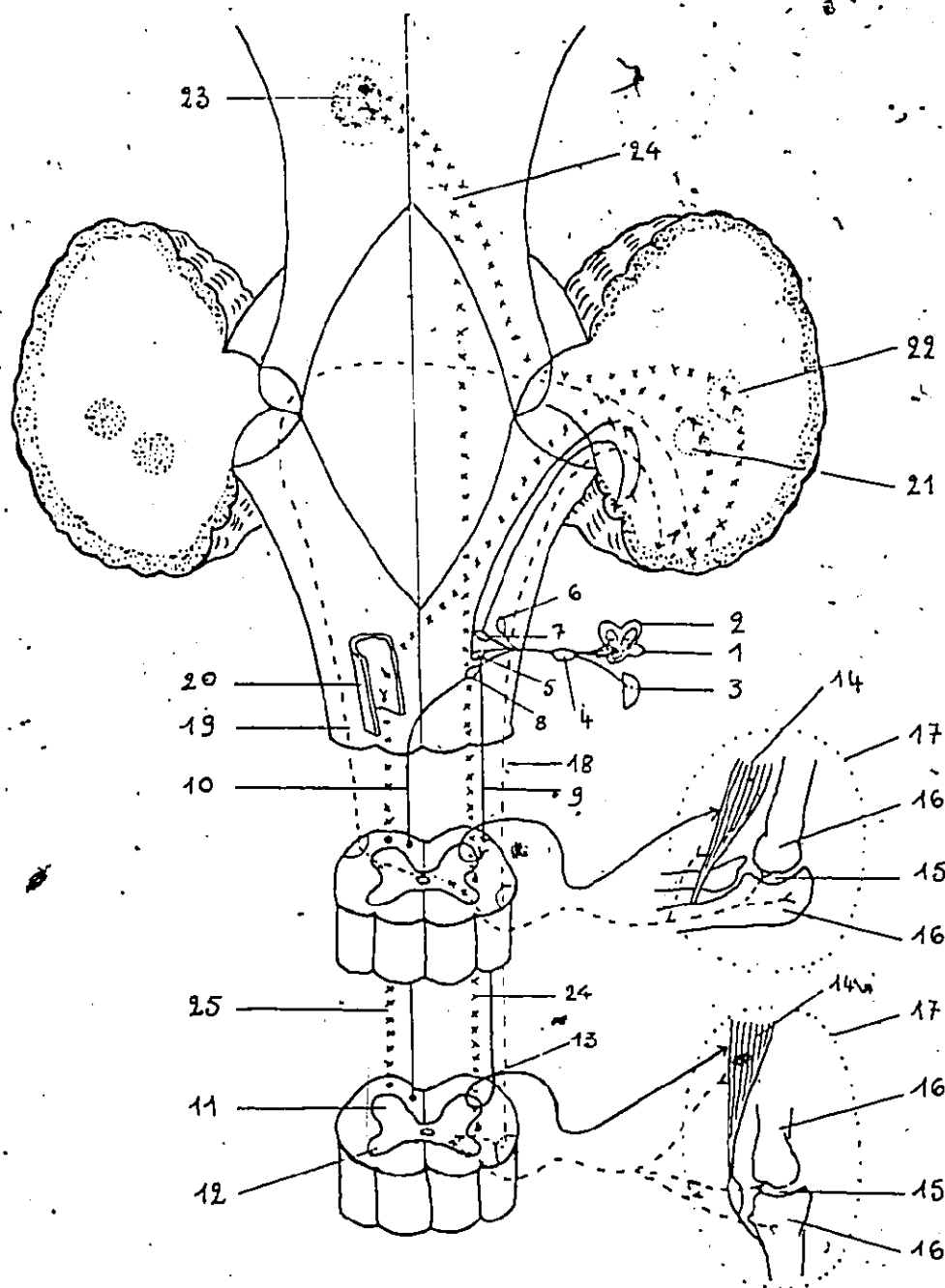
The last stage in the integrative sequence is purely inductive rather than evolutionary, a product of that highly sophisticated structure unique to man: language function. Stimulated by language potential, the vestibular labyrinth

-- that is, the utricle, its semicircular canals and the saccule -- which operates like a gyroscope for controlling the organism's spatial equilibrium, acquired a new addition to its physical panoply. This was the cochlea. To the gyroscope was added a sextant; to the monitor of equilibrium, a monitor for navigation. Now, while the labyrinth maintains the organism's equilibrium in the environment, the cochlea navigates the organism through the environment. And with this added ability to navigate came vertical posture: when man acquired the ability to sense where he was going, he was then able to stand upright. No longer a prisoner of physical and visual contact with the ground, he became an antenna, a neurological radarscope able to send and receive messages, to relate to the environment without necessarily either touching or seeing it. Standing upright, maintaining his equilibrium, navigating successfully by means of an innate control center designed to receive, send and monitor messages, man then became capable of the most sophisticated, most abstract performance of all: the reception and transmission of speech. Language function's ultimate induction -- vertical posture -- provided the physical fields necessary for the analog transposition from language potential to the speech act itself. The body must assimilate language in terms of both motor and sensory function in order for human speech to materialize. When man speaks, he speaks with his entire body; and it is his entire body which acquires, absorbs and memorizes the

structures and information necessary for speech to occur -- in fact, memory itself is no more than the product of a psycho-sensorimotor process.

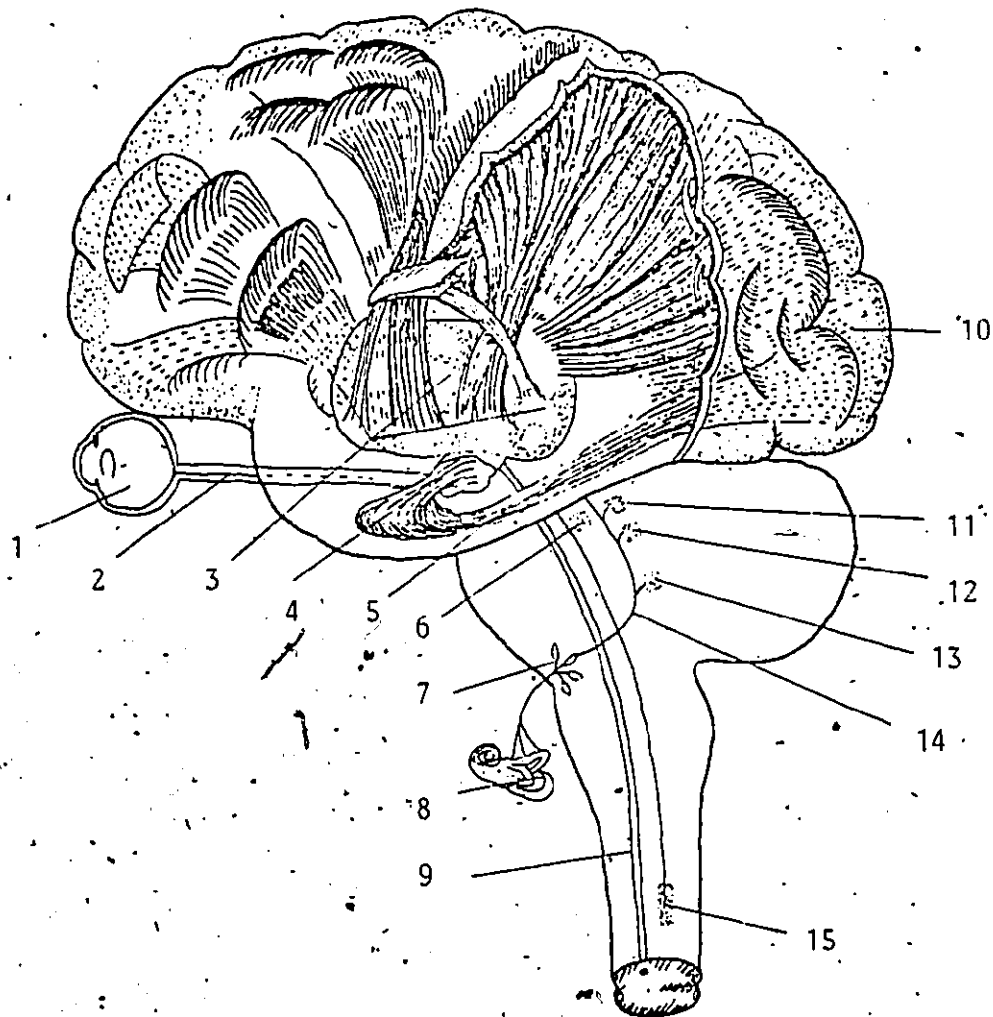
Embyrologically speaking, it is the development of the cochlea that determines expanded cerebral function in the organism. The extra-pyramidal zones increase in size, projecting motor feedback of greater complexity to the cerebellum via the temporo-pontine tract, the ponto-cerebellar tract, the parieto-pontine tract and, recursively, via the cerebellar-dentato-rubro-thalamo-cortical tracts, with sensory feedback travelling via the spino-thalamic tracts and the tracts of Goll and Burdach. It is this functional ensemble that we have chosen to call the "cochlear integrator".

The cochlear integrator links the cortex to the cerebellum, relaying somatic messages to the labyrinth either directly or after they have been previously processed by the cortex. Assimilation of these signals enables the labyrinth, through the pyramidal nerve cluster groupings it dominates, to coordinate and exert cybernetic control over the entire range of bodily posture and gesture, both spontaneous and voluntary.



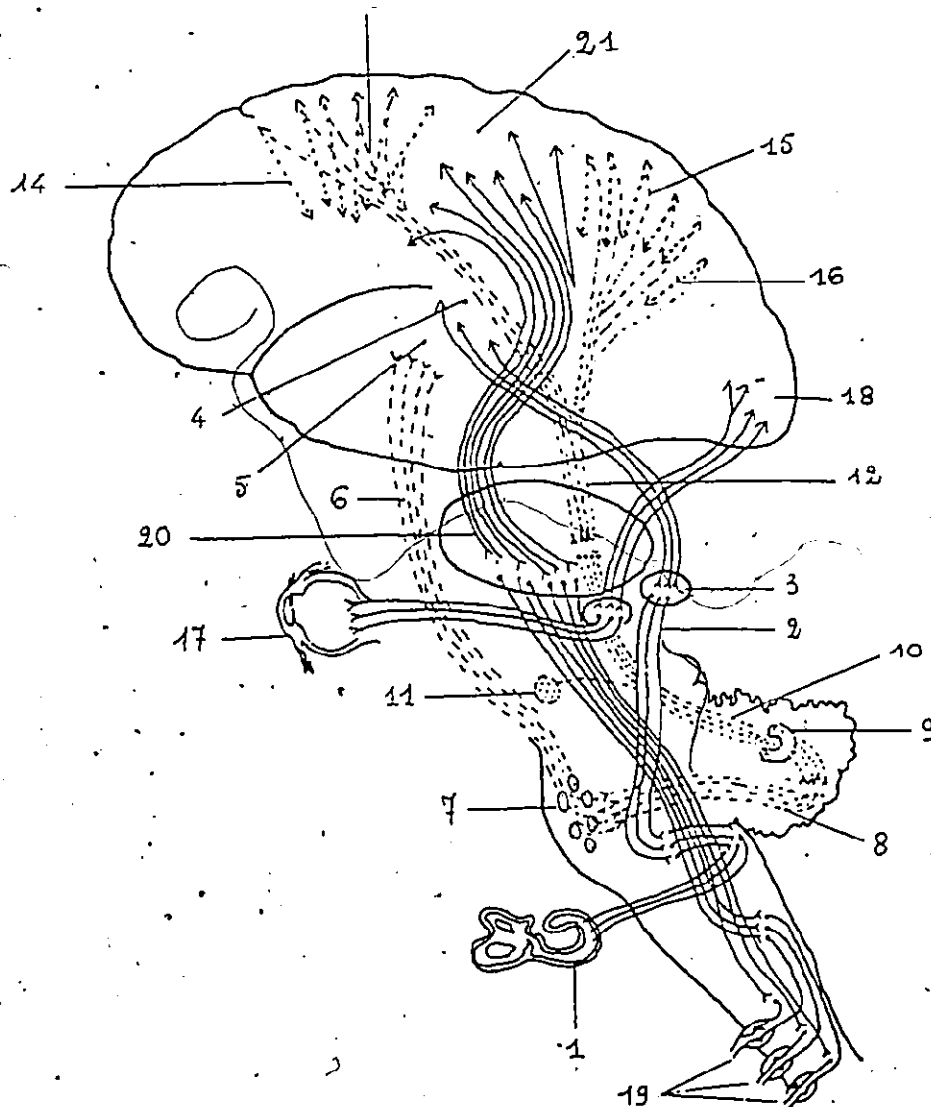
- | | |
|---|-------------------------------|
| 1 : utricle | 14 : muscles |
| 2 : semicircular canals | 15 : joints |
| 3 : saccule | 16 : bones |
| 4 : ganglion of Scarpa | 17 : skin |
| 5 : nucleus of Deiters | 18 : tract of Fleschig |
| 6 : nucleus of Beichelew | 19 : tract of Gowers |
| 7 : nucleus of Schwalbe | 20 : inferior olivary nucleus |
| 8 : nucleus of Roller | 21 : globose nuclei |
| 9 : homolateral vestibulo-spinal tract | 22 : emboliform nucleus |
| 10 : controlateral vestibulo-spinal tract | 23 : red nucleus |
| 11 : anterior horn | 24 : rubrospinal tract |
| 12 : posterior horn | 25 : olivospinal tract |
| 13 : anterior root | |

Figure A. The vestibular (or somatic) integrator.



- 1 : eye
- 2 : optic nerve
- 3 : thalamus
- 4 : lateral geniculate body
- 5 : optic radiation
- 6 : pupil nucleus of the III nerve
- 7 : vestibular nucleus
- 8 : vestibule
- 9 : tectospinal tract
- 10 : optic zone
- 11 : nucleus of III nerve
- 12 : nucleus of IV nerve
- 13 : nucleus of VI nerve
- 14 : vestibulo-mesencephalic tract
- 15 : ciliospinal centre of Budge

Figure B. The visual (or spatial) integrator.



- 1 : cochlea
- 2 : lateral tract of Reil
- 3 : medial geniculate body
- 4 : auditory zone
- 5 : sub-auditory extrapyramidal zone
- 6 : temporo-pontine tract of Turk-Meynert
- 7 : Nuclei of Pons
- 8 : ponto-cerebellar tract
- 9 : dentate nucleus
- 10 : dentato-rubro-thalamic tract
- 11 : red nucleus
- 12 : thalamo-cortical tracts
- 13 : thalamo-frontal tract
- 14 : thalamo-pontine tract
- 15 : thalamo-parietal tract
- 16 : parieto-pontine tract
- 17 : eye
- 18 : optic zone
- 19 : sensory fibres
- 20 : thalamo-parietal sensory tract
- 21 : parietal zone

Figure C. The cochlear (or linguistic) integrator.

APPENDIX B

THE APPROXIMATE MEAN AGE-GRADE TABLE
STATED IN YEARS AND MONTHS

Table A.
The Approximate Mean Age-Grade Table
Stated in Years and Months

	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APR.	MAY	JUNE
GRADE	1	2	3	4	5	6	7	8	9	10
K	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	6-0
1	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	7-0	7-1
2	7-4	7-5	7-6	7-7	7-8	7-9	7-10	7-11	8-0	8-1
3	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-0	9-1	9-2
4	9-5	9-6	9-7	9-8	9-9	9-10	9-11	10-0	10-1	10-2
5	10-6	10-7	10-8	10-9	10-10	10-11	11-0	11-1	11-2	11-3
6	11-5	11-6	11-7	11-8	11-9	11-10	11-11	12-0	12-1	12-2
7	12-5	12-6	12-7	12-8	12-9	12-10	12-11	13-0	13-1	13-2
8	13-5	13-6	13-7	13-8	13-9	13-10	13-11	14-0	14-1	14-2
9	14-4	14-5	14-6	14-7	14-8	14-9	14-10	14-11	15-0	15-1
10	15-4	15-5	15-6	15-7	15-8	15-9	15-10	15-11	16-0	16-1

Form A.C. 7
Auxiliary Education Services Division
Special Educational Services Branch.

APPENDIX C

PROCEDURES FOR THE EVALUATION OF THE
DOMINANT EAR - AUDIOLATEROMETRY

Procedures for the Evaluation of the
Dominant Ear - Audiolaterometry¹

General Notions

This part of the APP assessment is carried out with the help of the audiolaterometer, an apparatus designed to reveal a subject's dominant ear, that is to say the ear that controls vocal output. The audiolaterometry test (ALM) therefore indicates how the subject uses his listening skills during verbal expression. This important test completes the three main dimensions of the administration of the Tomatis Listening Test (TLT): specifically, establishing listening thresholds, spatialization and selectivity.

The audiolaterometer allows the diagnostician to obtain measurable results in terms of scores. The apparatus itself should not be confused with the simple balance system of a stereophonic amplifier: the latter brings into play a single amplification channel using a central potentiometer to divide the energy load into two parts, distributing this load to one part or side in proportion to the energy withdrawn from the other. The total energy travelling across the potentiometer always remains identical: the same energy charge can be collected at the output level, in this case from the ear-phones or speakers. Such a set-up cannot provide a proper estimate of auditory laterality because it does not take into

¹ Translated and adapted from La Passation du Test d' Ecoute,
Centre du Language, Paris, 1978, 21-26.

account the dynamics of the ear. It is important to be able to determine how audition functions under conditions that correspond best to the organism as it adapts to the language task.

In regards to the audiometer, it consists of an electronic device used with a two-channel amplifier, or with two identical amplifiers, or again with the amplification system built into the Electronic Ear (EE) apparatus. The essential operative fact here is that the two outputs from these amplifiers must be matched for impedance as they enter the two outputs of the audiometer, and they must also be balanced, that is to say they must each carry the same energy charge. When this energy load is introduced into the audiometer, it is distributed to two earphones via identical control potentiometers, one for each earphone. The quantity of energy received depends on the opening of the potentiometers. If both potentiometers are regulated to a setting of 5, for example, the energy load will be identical for both earphones. A galvanometer controls the energy at the audiometer input level so that the exact quantity of energy being received and distributed is always known. At a setting of 5 on both potentiometers, outputs to both earphones will be 50 decibels, an intensity easily perceived by normal subjects and corresponding to the dynamic qualities of the ear.

At the beginning of the ALM test, the subject is asked

to speak into a microphone and receives balanced feedback through the earphones since both control potentiometers, that for the left ear and that for the right ear, are set at 5.

Maintaining this value for the right ear only, the examiner starts to modify the sound intensity introduced into the left ear via its corresponding potentiometer: left ear intensity is gradually decreased to 4, and then to 3 and afterwards to 2, until noteworthy changes are perceived in terms of the subject's vocal expression, facial features, posture and motions. One should look for a more mobile yet relaxed facial expression, a lighter and better modulated voice, a relaxed yet upright posture. In reducing the feedback intensity of the subject's voice to his left ear, while maintaining the right ear feedback at the initial level of 5, it can thus be proven that the left ear was used predominantly up till this modification to control speech: three units of energy (5-2) or 30 decibels had to be withdrawn from the left ear to allow the right ear to assume its leading role in the control of speech and to trigger a series of desirable expressional correlates.

The audiolaterometer thus permits the examiner to recognize and document in scores a subject's self-listening capability in the act of speech. According to APP theory, it also allows the examiner to evaluate the subject's desire to be involved in the world of communication and close encounters since right-eared self-listening is considered the most

direct and efficient route to verbal contacts with others.

Instrumentation

As suggested above, to give the ALM test, the examiner must have the following equipment at his or her disposal:

- 1 microphone
- 1 Electronic Ear (or a two-channel amplifier; or two identical amplifiers).
- 1 audiometer
- 1 headset (two earphones)

The Electronic Ear apparatus and the audiometer are only available from the International Association of Audio-Psycho-Phonology, 68, Boulevard de Courcelles, 75017 Paris, France.

Regulating the Equipment

Before proceeding to the evaluation of auditory dominance, the examiner must carry out a number of operations to check and regulate the equipment involved. Towards this end, the subject is asked to be seated in front of the examiner while the examiner verifies that the potentiometers of the EE and of the audiometer are properly positioned.

a) Regulating the Electronic Ear

Since only the amplification system of the EE is being used, all other input or modification systems are turned down completely.

- Tape recorder input: 0

- Gating switch : 0

- Delay switch : 0
- Upper Channel bass : 0
- Upper channel treble: 0
- Lower channel bass : 0
- Lower channel treble: 0

Regulation of the microphone input and of the output volume is carried out at the beginning of the ALM procedures per se.

b) Regulating the Audiometer

- Potentiometer, right ear: 5
- Potentiometer, left ear : 5

Administration of the audiometer Test

A close-up illustration of the audiometer is presented in Figure D. A depiction of the proper setup for administering the ALM test, using the EE apparatus as an amplifier, is found in Figure E.

At the outset, the examiner starts a conversation with the subject in order to properly adjust the microphone - input and volume-output potentiometers of the Electronic Ear.

a) Setting the microphone-input level

This is done in consideration of the total input intensity, including the noise of the surroundings, the examiner's voice and the subject's voice. This intensity can be estimated visually on the basis of the oscillating needle on the VU-Meter which should dis-

place itself in the middle range of the calibrated dial.

b) Setting the volume

This concerns the output volume switch of the EE apparatus: the proper setting takes account of the subject's auditory sensitivity. The subject should be able to comfortably perceive sound without the loudness being disturbing. To this end, the examiner regulates the volume until the subject indicates that he or she hears well.

Following these preparatory steps, the ALM test proper can be given: this will require sharp perceptual skills on the part of the examiner who must listen carefully to the subject's voice while watching closely for facial, postural, gestural and other bodily changes. Often only one of these dimensions, for example changes in voice fluency, will allow the examiner to clearly determine the test results.

The subject is asked to talk to the examiner or to answer questions given by the examiner, while the latter increases or diminishes the subject's left ear feedback intensity via the appropriate potentiometer on the audiolaterometer. The examiner must carefully follow changes in the subject's voice and bodily features as changes in auditory control are brought about gradually. Such an evaluation presupposes that the examiner possesses refined listening skills sensitive to tonal and rate differences that will indicate at what point

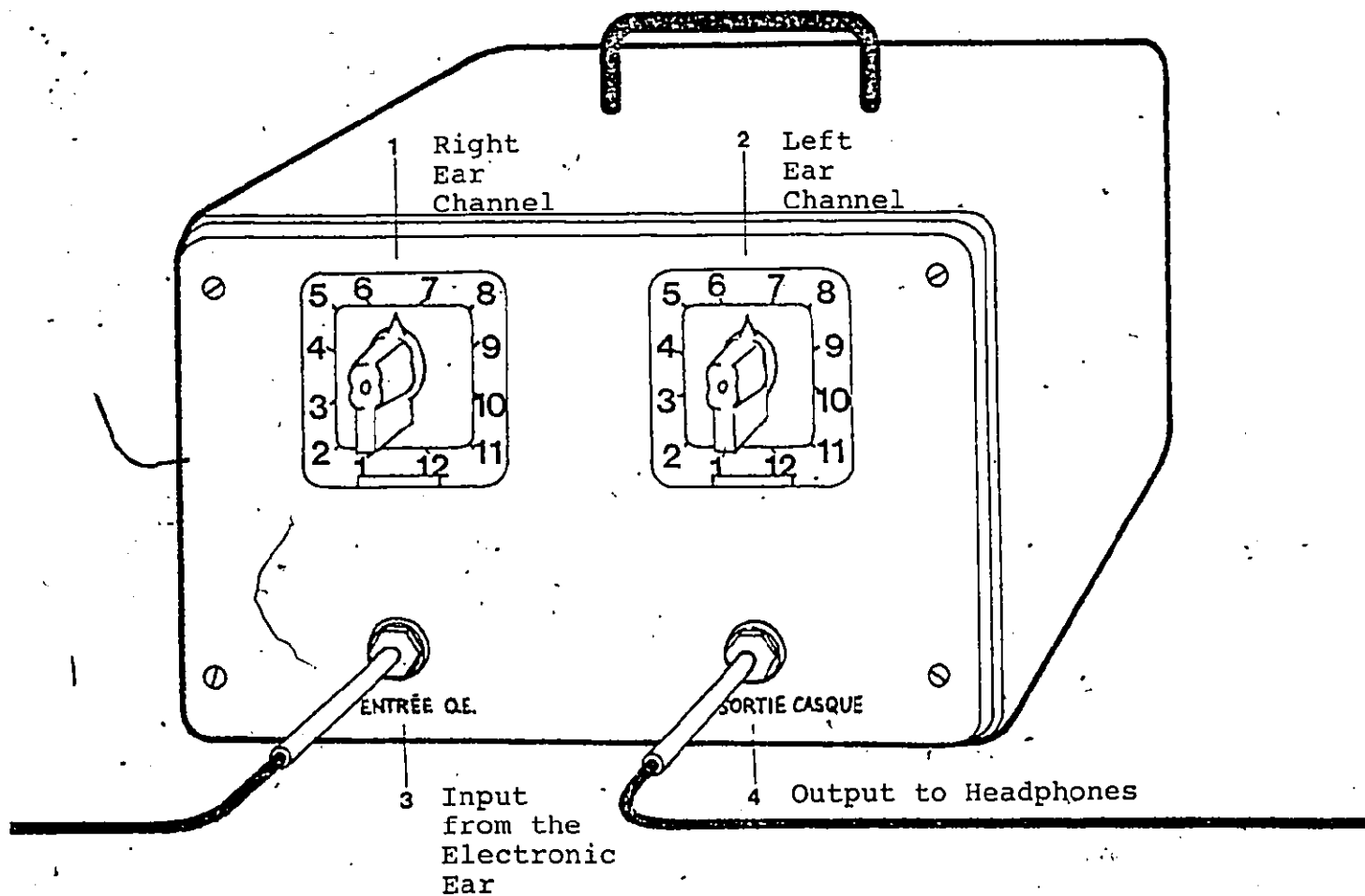


Figure D. Illustration of Audiometer.

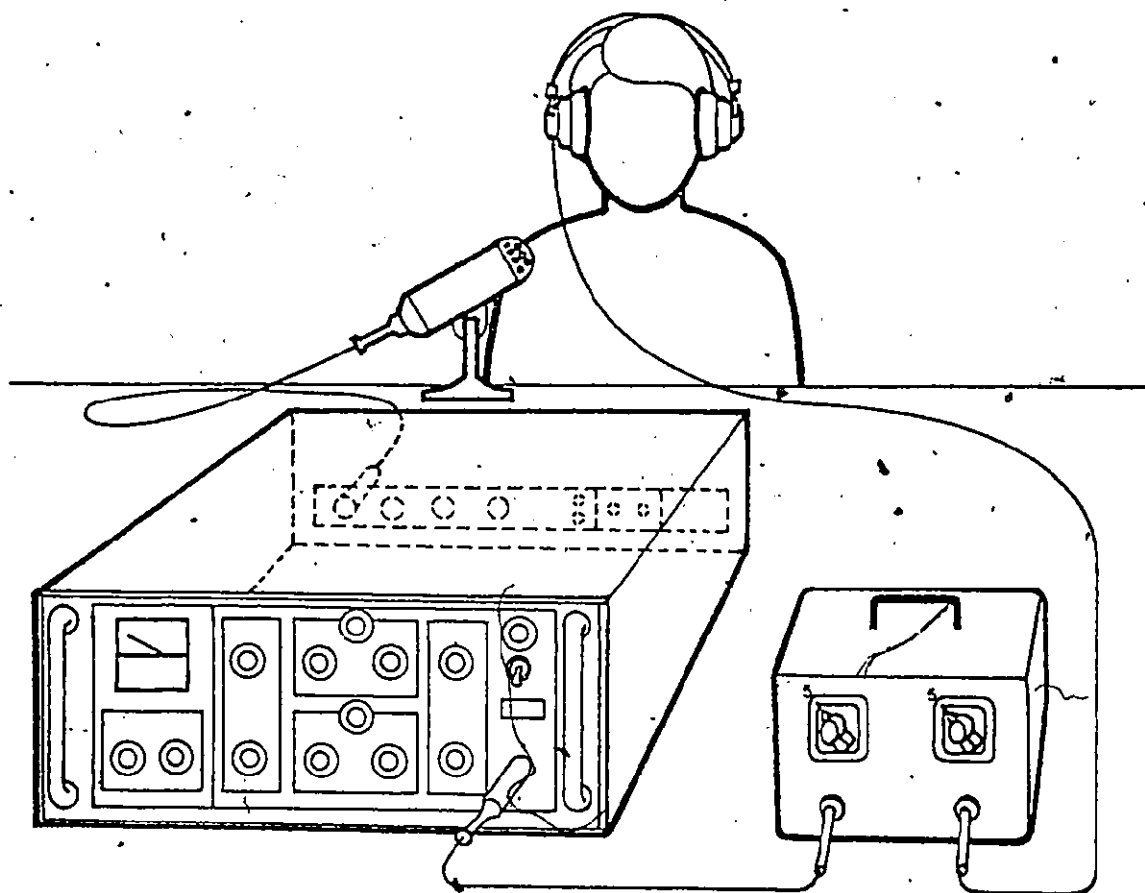


Figure E. Setup for administration of the Audiometer test in conjunction with the Electronic Ear.

the subject's voice and bodily characteristics reveal acquisition or loss of the leading ear dominance for speech.

Often the examiner must rely heavily on modifications that occur on the subject's face, and more specifically on changes around the mouth, to determine the sought-after transition point. Tomatis has indicated that there exists a right mouth and a left mouth, and that one or the other is usually dominant in regards to its mobility during speech: thus it can be said that the subject "talks to the right" or "talks to the left". If the subject alternately speaks to the right and to the left, one can usually find a rhythm problem somewhat akin to stuttering. This diagnostic approach therefore requires that the examiner look closely at the subject who is speaking to see how this person's face and mouth behave during vocal emission and as left ear feedback is varied: it is important for the examiner to note at what setting on the audiolaterometer the most distinct changes in vocal and facial expression occur.

Generally the examiner will have to deal with two types of individuals while giving the ALM test: these two types will be examined more closely for illustrative purposes.

a) The left-eared and left-mouthed subject

This subject presents himself or herself with some or all of the following characteristics:

- a low, flat and monotone voice;
- slow and hesitant verbal flow;

- brief exchanges, difficult dialogue, vague or fuzzy thoughts;
- facial musculature active on the left side and inert on the right side.

These characteristics are those of a person whose left ear is dominant in regards to language activities. The examiner, upon noticing these telltale signs, will diminish the intensity of left ear feedback using the audiolaterometer until the subject can control speech by his or her right ear. The changeover point manifests itself in changes in the voice which becomes clearer with more timbre and modulation, in mobilization of the right side of the face which becomes quite animated, occasionally in an improvement in posture which becomes more upright and relaxed. The setting on the audiolaterometer's left ear potentiometer that triggers this changeover indicates the degree to which the left ear is habitually dominant in comparison to the right. This is indicated in the boxes to the right and to the left of the listening test grid as illustrated below in Figure F: this shows that the left ear input had to be diminished by 3 units ($5-3=2$) of intensity, or 30 decibels, before the right ear could assume its leading role in controlling language.

b) The right-eared and right-mouthed subject

If, on the other hand, a subject presents the following:

- a clear voice, well timbred and well modulated,

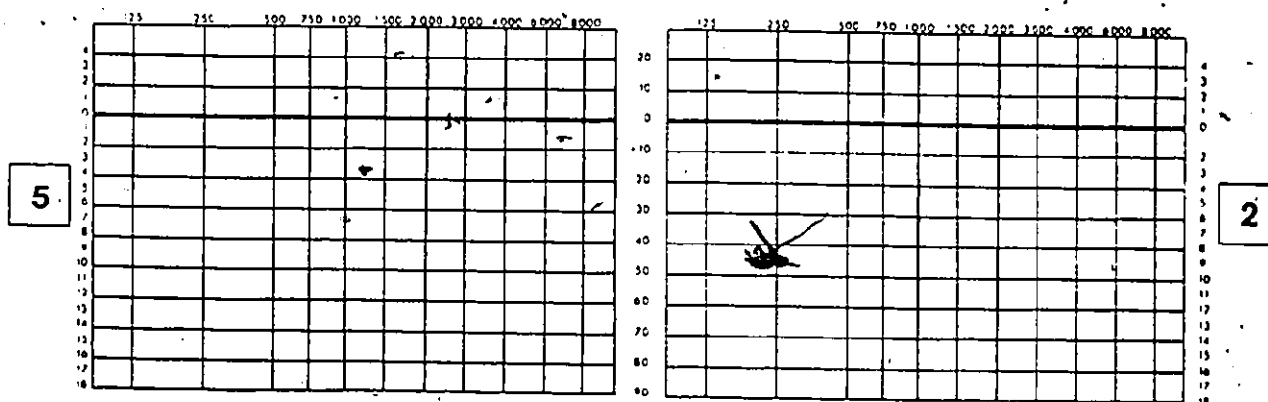


Figure F. Audiolaterometry results for left ear dominance of 3.0 in the control of speech.

rich in harmonics;

- quick, precise and effortless verbal outflow;
- constructive verbal exchange and easily engaged dialogue;
- a mouth and facial musculature mobilized to the right during speech;

then these are the characteristics of right-sided language.

The examiner, always maintaining the right ear potentiometer at a setting of 5, will play on the left ear potentiometer to discover how much energy must be added to the left ear feedback in order to dissolve the right ear control of speech. The setting or number corresponding to the change-over to left-sided speech with its typical correlates, will give an indication of the subject's auditory-vocal dextrality. For example, in the hypothetical case illustrated in Figure G, the examiner had to increase the intensity of left ear feedback by 2 units ($5+2=7$) or 20 decibels before upsetting right ear dominance of speech and language.

The importance of the ALM in the APP assessment battery cannot be overstressed. At the same time one must recognize that this test requires a good deal of skill and experience for proper administration and accurate results.

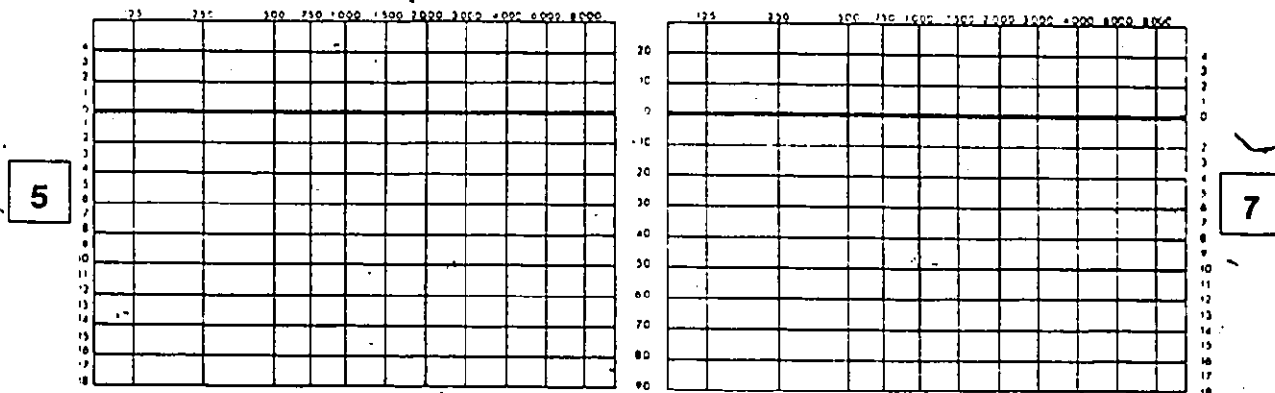


Figure 6. Audiometer results for right ear dominance of 2.0 in the control of speech.