thing, they usually know it. Similarly, if they feel that they do not possess the information the probability is great that they do not possess it. When an individual fails to remember, he must then determine whether or not the item is possibly stored but not retrieved in his memory bank. A monitoring process is used to make judgments as to whether or not the subject has the information and should make an attempt to retrieve the information. Inefficient memory monitoring can result either in futile attempts to retrieve information which is not stored or in failure to attempt the retrieval of items which are in storage.

The memory monitoring process may have implications for remediation in a number of different areas. Children who do not have confidence in whether or not the information for a specific item is in their storage banks could be given confidence in a concrete way through training in memory monitoring. It may be possible to adapt the memory monitoring process for specific content areas such as reading, writing, arithmetic, or spelling. Research should be conducted to determine whether different sensory modalities play prominent roles in memory monitoring systems. One individual, for example, may rely upon auditory recall or recognition; whereas, another individual might rely entirely or almost entirely upon visual recall or recognition. It may be necessary, therefore, to train a memory monitoring process for each specific modality. The basic concept provides an interesting approach to the problem of improving memory.

Biochemistry

There is little information about relationships between the biochemical makeup of the brain and memory. Hilgard and Bower (1966) discuss the importance of cellular neurochemistry to learning. Recent studies have investigated the effect of drugs upon performance in learning tasks. The effect of the drug Thiopental upon learning and retention of pictures and pairs of letters and words by normal subjects was explored by Osborn (1967). Both recognition of letters and recall of words and letters was decreased by amounts correlated with the concentration of Thiopental in venous blood at the time of learning. Talland and McGuire (1967) investigated the effect of the drug Cylert upon learning and retention. The drug did not improve new learning but it did improve maze relearning and reproduction of a line drawing. The area of biochemistry may prove to be one of the most important areas for developing techniques to modify learning processes.

Directions for Future Research

Little is known about the neurophysiological, biochemical, and psychological basis for memory. There is need for the medical, psychological, and educational disciplines to clarify the conceptual distinctions which have been made about memory, such as: the physiological and psychological basis for memory; the global and molecular aspects of memory; sensory versus intellectual memory; memory process and memory product; and storage, scanning, and retrieval.

There are several theories which attempt to explain the storage and retrieval process but there are only a few studies which have attempted to observe events in the nervous system. There is need to conduct basic research with both animals and humans to determine the neural basis for memory. Drugs, surgery, electroconvulsive shock, and cellular chemistry should be used to study the memory process in different areas of the brain, as well as their interrelationships. Any statement about the relative value of this kind of basic research for the educator should probably be reserved until data have been gathered and educators have had the opportunity to relate their application in the teaching situation.

The few procedures which have been developed for assessing memory rely upon recall and reproduction tasks, afterimage and memory span, delayed response, the effect of aspiration level and the application of learning strategies to facilitate remembering. Assessment procedures are needed which take into account the nature and quantity of the material to be learned, the meaningfulness of the material, the specific steps necessary to learn the material, the amount of time necessary to learn the material, activities which are introduced during the retention period, and the duration of retention. Instead of relying upon digit or word span, perhaps educators should begin thinking of assessing memory in terms of specific school tasks where recall and recognition are required for achievement.

There is need to obtain detailed descriptions of memory disorders in children. If a child has a specific, rather than a general memory problem, it might be helpful for planning purposes to obtain descriptions of memory performance in the areas which are not affected. Another issue which should be explored is whether or not memory disorders in children represent the same kind of memory disorders which have been described in adults. A child may function normally at a concrete, sensory level but as the same child grows older he may experience great difficulty in acquiring, retaining, recalling, or recognizing spoken or

written symbols. When a child has been diagnosed as having organic brain damage, the behavioral manifestations should be described. Remedial efforts should also be described and the child's progress carefully recorded. Through careful description of organic involvement, behavioral symptoms, and remedial intervention, it may be possible to make statements about etiology, prognosis, and treatment. At the present time, however, the status of description of memory disorders remains at a gross conceptual level.

The research which has been conducted on the remediation of memory dysfunction is limited. The facilitating effects of practice usually disappear when practice is discontinued. Several attempts to improve memory through organization and the application of rules have met with limited success. The application of learning principles in programmed presentation has made retention more efficient. Improving the memory monitoring process is another intervention technique which may have some value. Although memory appears to develop along with physical growth, there is no evidence that memory can be improved through outside intervention. Improvement through biochemistry may be possible at some future time. Until then, educators must pinpoint the specific memory problem with which they are concerned and intervene with specific techniques designed to improve initial learning (Pribram, 1968).

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DYSFUNCTIONS IN SYMBOLIC OPERATIONS

CHAPTER 7

AUDITORY LANGUAGE

This chapter reviews the problems in assessing and treating central processing dysfunctions which interfere with the acquisition and use of a first language. Major issues are discussed and future research needs identified. Also included in this chapter is a preliminary task analysis that describes, in behavioral terms, the various subtasks which must be attained in order to develop facility in understanding and using auditory language.

Because of the wide scope of language study, it is not possible to comprehensively treat all aspects of language in this chapter. The chapter, therefore, has several limitations. First, only a minimal description of the linguist's conception of language as a system will be included. Theory concerning the acquisition of language in children is in a state of controversy. In the absence of research studies to support various theoretical positions, particularly with respect to children with brain dysfunctions, it is not possible to make definitive statements about the many aspects of language study which have been or are being raised by Skinner (1957); Carroll (1964); Chomsky (1959, 1965); McNeill (1966); Osgood (1966); and Lenneberg (1967). A second limitation is reporting research which focuses on disorders in children, excluding the adult population. Third, the psychologists' and philosophers' concern with "thought" is not treated here. A fourth limitation is the deemphasis on language dysfunctions which have occurred after language has been attained.

There are several reasons for the focus on dysfunctions which have been found to interfere with the initial acquisition of a first language. Although definitive epidemiological studies have not been conducted, it is generally agreed that there are more children who do not develop language by age 4 than there are children who develop and then lose language performance. Since more is known about the etiology and treatment of conditions relating to loss of language performance, the reader can find adequate discussions on loss of language elsewhere (Head, 1926; Weisenburg and McBride, 1935; Goldstein, 1948; Nielsen, 1946; Wepman, 1951; Schuell, 1953; Myklebust, 1954; Berry and Eisenson, 1956; Wepman, Jones, Bock, and Pelt, 1960; Wood, 1960; Luria, 1963; Osgood and Miron, 1963; Van Riper, 1963; Mecham, Berko, Berko, and Palmer, 1966; Carterette, 1966). Multiplicity of terms applied to children who do not develop language such as asphasic, childhood aphasic, word-deaf, receptive or expressive aphasic, autistic, mentally or socially retarded, and dysacoustic, indicates a need for clarification in description of behavior and diagnosis. Finally, the prediction of language rehabilitation after language loss depends not so much upon the extent of the loss, or the extent of the lesion as upon the age of the child and the degree of his language acquisition at the time of loss (Lenneberg, 1967). Thus, even in cases of language loss it is necessary to have information concerning the initial acquisition of language. For these reasons, the focus of this chapter will be directed toward central dysfunctions which interfere with the acquisition of the auditory language code.

Acquiring the Auditory Language Code

It is generally agreed that in acquiring auditory language, the child acquires an auditory-vocal communication system, a code used by his speech community (Carroll, 1964; Chomsky, 1965). The terminal behavior of the child is agreed to be the comprehension and production of complex and highly structured utterances which conform to the code, the content and form of which are relatively well known (Jakobson, Fant, and Halle, 1963).

Menyuk (1967) summarizes the current state of thinking about the universal components of language:

> The syntactic component contains rules for defining the classes of the language and their functional relationships. The semantic component contains rules for interpreting the meaning of lexical items and the underlying syntactic structures of the sentence. The phonological component contains rules for defining the classes of sounds of the language and translating the underlying structure of the sentence into a sequence of sounds (p. 313).

Menyuk (1967) is conducting a series of investigations to ascertain the sequence in which the universals in the general American language code are acquired. Several studies present descriptions of children's utterances which show that they appear to come closer and closer to adult production with advancing age (Brown and Bellugi, 1964; Weir, 1962, 1966). Also, there seem to be obvious regional variations in pronunciations as well as regional differences in meaning for the same word.

What is not generally agreed upon is the manner in which children acquire the code. The technique of linguistic analysis has been applied recently, with mixed results (Ervin and Miller, 1963). The linguist in the field employs a procedure involving the use of "native informants" who are asked to judge the appropriateness of certain utterances in his own language. The use of native informants presupposes the prior acquisition and retention of the language elements about which judgments are sought. This technique has obvious limitations when the native informant is a young child or infant, not given to making judgments and responding to judgmental tasks. Therefore, the appropriateness of the informant technique is open to serious criticism when dealing with the acquisition of a first language in a young child, or with a child who has not acquired language to the extent that is expected, and a person of any age who has acquired language but lost the facility.

How then is the acquisition of a first language investigated? Myklebust (1954, 1960) discusses a developmental sequence for language acquisition consisting of inner language or meaningfulness, receptive language, and expressive language. Rarely does a child acquire the total performance of one language task before demonstrating acquisition of any part of another language task (Fraser, Bellugi, and Brown, 1963). It is more consonant with the data on language acquisition to postulate that there is a spiral effect, in which some aspects of reception are learned before any aspect of expression is learned. Lenneberg (1967) points out that it is possible to acquire the receptive aspects without any vocal-motor behavior. Without adequate motor control of the delicately balanced sequential system of the speech motor mechanism, however, the acquisition of expressive vocal language may be greatly impeded. The usual order is random vocal-motor behavior, receptive, and then expressive language.

It should be noted that some aspects of phonology may not be acquired in an expressive way until several years after receptive learning has occurred. Some persons have difficulty in producing sounds in their native language of English, especially the consonants /r/ and /s/. Many persons report difficulty in acquiring new phonemes in a second language (Fries, 1963), but young children under 4 apparently have a plastic phonological system which acquires new phonemes easily. Whether there is an upper age limit to the acquisition of a first language is still open to question.

Many discussions of language acquisition are confusing because little distinction has been made between the three major aspects of language performance: Receptive auditory language, expressive auditory language, and vocal-motor production. Few attempts have been made to identify the various central processing functions which are required in the attainment of receptive language or expressive language (Myklebust, 1954). A large body of literature exists, however, concerning the acquisition of vocal-motor production (Travis, 1957; Van Riper, 1963; West, Kennedy, and Carr, 1947; and Berry and Eisenson, 1956).

Gagne (1965) presents a theoretical hierarchy of learning tasks for acquiring language skills. These include: (1) signal learning; (2) stimulus-response learning; (3) chaining; (4) verbal association; (5) multiple discrimination; (6) concept learning; (7) principle learning; and (8) problem solving. There is need to investigate the ways in which these eight different types of learning are employed by normal children as they develop language skills. There is need, also, to study the ways in which central processing dysfunctions affect the employment of these learning strategies and interfere with the acquisition of language.

For purposes of organization, this chapter includes task analyses of the subtasks which may be involved in the decoding, encoding, and production of auditory language. These task analyses represent a very arbitrary distinction between the auditory, motor, and cognitive aspects of langauge acquisition. Language typically develops as an integrated pattern involving the sounds, the motor act of moving the vocal organs, and the kinesthetic concomitants of those movements. As mentioned in table 11, the act of babbling is one of the earliest elements in language acquisition, which must be quite closely related to the acquisition of auditory receptive language outlined in table 9. It should be emphasized that these functions proceed concomitantly, and what is much more important, interact with each other.

It is very difficult to discuss, at the same time, the many interrelated facets of auditory, motor, and cognitive aspects of language acquisition. For this reason,

and for purposes of organization, this chapter includes three admittedly primitive task analyses, which are intended to help make several important distinctions and emphasize the major concepts related to auditory language dysfunctions among children. Although the acquisition of receptive auditory language, vocal-motor production, and expressive auditory lanaguage is generally believed to be interrelated and may occur at the same time, there is little research as to how much vocal-motor behavior and receptive language is necessary for adequate expressive functioning. This is a fertile area for future research. For purposes of organization and clarity, the decoding, encoding, and production of auditory language will be discussed separately.

The acquisition of receptive auditory language behavior is analyzed in table 9. The child first attends to vocally produced sound units, then must discriminate between them. A reciprocal association is formed between the sound unit and an experience. This association allows the child to interpret the vocal sound unit as a meaningful language signal which is stored for retrieval at a future time. The child improves his receptive langauge by analyzing more complex signals and by increasing the speed and accuracy of interpretation. Finally, with sufficient practice the child can shift attention from the vocal-language signal to the meaning carried by the signal sequence. Thus, he will be able to respond appropriately to verbal commands, instructions, explanations, and questions.

Table 10 presents a task analysis for acquiring expressive auditory language. First, the child must possess the need to communicate, and make the decision to send the message. Second, he must formulate the message by retrieving and sequencing the appropriate language signals. The third stage consists of organizing the vocal-motor sequences for producing the desired auditory-vocal signal and producing that vocal-language signal. (See table 11.) Simple vocal-language signals are combined to form more complex vocal-language signals. In time, the child gradually increases the accuracy, length, number, and types of vocal-language sequences to the point of automatic production. Finally, the child shifts attention from the mechanical aspects of sound production to the content of the message to be sent. This enables him to produce appropriate verbal instructions, commands, explanations, descriptions, and questions.

The acquisition of vocal-motor production has been analyzed in table 11. First, random movements of the vocal-motor apparatus produce random vocal-sound units. The child attends to the kinesthetic stimulation of the vocal-motor movements and the audi-

Table 9.—Acquiring Auditory Receptive Language: A Task Analysis

I. Attention: Attend to vocally produced auditory sound units, i.e., noises, speech sounds, words, phrases, sentences.
II. Discrimination: Discriminate between auditory-vocal sound units.
III. Establishing correspondences: Establish reciprocal associations between the auditory-vocal sound units and objects or events:
  A. Store and identify auditory-vocal sound units as meaningful auditory-language signals. Substitute auditory-language signals for actual objects and/or events.
  B. Establish word order sequences and sentence patterns.
IV. Automatic auditory-vocal decoding:
  A. Improve interpretation by analyzing increasingly more complex auditory-language signals.
  B. Increase the speed and accuracy of the reception of auditory-language signals through variation, practice, and repetition to the point of automatic interpretation.
  C. Shift attention from the auditory-language signals to the total meaning that is carried by the signal sequence.
V. Terminal behavior: Respond appropriately to verbal commands, instructions, explanations, questions, and statements.

Table 10.—Acquiring Expressive Auditory Language: A Task Analysis

I. Intention:
  A. Possess the need to communicate.
  B. Decide to send message vocally.
II. Formulate message by retrieving and sequencing the appropriate vocal-language signals.
III. Organize the vocal-motor sequence:
  A. Retrieve the vocal-motor sequence for producing the selected vocal-language signals.
  B. Execute the vocal-motor sequence for producing the vocal-language signal.
IV. Automatic vocal encoding:
  A. Combine simple vocal-language signals to form more complex vocal-language signal sequences.
  B. Increase the rate, accuracy, length, total number, and types of vocal-language signal sequences to the point of automatic production.
  C. Shift attention from the mechanics of producing vocal-language signal sequences to the contents of the message to be sent.
V. Terminal behavior: To produce appropriate verbal instructions, commands, explanations, descriptions, and questions.

tory stimulation of the vocal sounds produced by himself and by others. As the child begins to repeat vocal-motor movements, vocal-sound units are reproduced. He also begins to discriminate between different sounds and movements and to associate vocal-sound units with the appropriate vocal-motor movements which produce them. The correspondences which are established between vocal-motor movements and the vocal-sound units are stored for retrieval at a later time. The speed and accuracy of vocal-sound production is increased until the child can automatically produce the appropriate vocal-sound unit. A complete treatment of the complex and finely tuned mechanism for vocal-sound production may be found in Lenneberg (1967).

Methods of assessing children's performance on various subtasks of acquiring auditory language have been developed through the years. A comprehensive review of representative measures can be found in Spradlin (1967). Analysis of these published test batteries show that they have been developed, with few exceptions, from existing tests, and not from a task analytic approach such as is espoused in this chapter. There is need to conduct future research on the specific subtasks involved in decoding, encoding, and producing auditory language among the normal preschool population. Also, there is need to task-analyze the conditions of acquisition in cases of dysfunction in processing auditory language.

Perhaps the most effective procedure for studying the acquisition of language in children with auditory language dysfunction is to adopt an idiographic (N=1) research design. The behavioral symptoms and etiological factors of auditory language dysfunctions are so diverse, it may be necessary to approach the problem by studying one case at a time (Dukes, 1965). Such a procedure would require longitudinal research on individual children for periods of time up to 6 or 12 years. Data would be recorded including comprehensive case histories and physiological and psychological information. Standardized data-gathering procedures would enable a number of researchers to collaborate and place data in a data bank. The use of computers will make it possible to process the data in a comparatively short time, and identify behavioral syndromes as well as the psychological and neurological correlates to these syndromes.

Brain Mechanisms Underlying the Language Function

Most of the research focused on auditory language dysfunctions has been conducted with adult aphasics and not with children. Masland (1967) has reviewed and summarized a number of experiments which have contributed to our understanding of how language functions are related to the structures and activities of the brain.

Table 11.—Acquiring Vocal-Motor Production: A Task Analysis

I. Motion: Random movements of the vocal-motor apparatus produce random vocal-sound units.
II. Attention:
  A. Attends to kinesthetic stimuli produced by movement of the child's own vocal-motor apparatus.
  B. Attends to vocal-sound units produced by himself and by others.
III. Repetition: Begins to repeat vocal-motor movements which result in the repetition of vocal-sound units.
IV. Discrimination: Discriminate between different vocal-sound units and between different motor movements.
V. Establishing correspondences:
  A. Establish a reciprocal association between a vocal-sound unit and the motor movement which produces that sound unit.
  B. Store and retrieve vocal-sound units and motor movements.
VI. Automatic vocal production: Increase the speed and accuracy of vocal-sound production through variation, practice, and repetition, to the point of automatic reproduction.
Terminal behavior: To deliberately reproduce the appropriate vocal-sound unit.

The research literature suggests that the left cerebral hemisphere plays an important role in the language function (Masland, 1967). The superior temporal divisions of the left hemisphere, which is responsible for the analysis and synthesis of auditory stimuli seem to be closely related to the sensorimotor divisions which are responsible for articulation. Because these two systems interact a deficiency in one may cause effects in the other. It is pointed out that adults often suffer severe and permanent loss of language due to injury of the left cerebral hemisphere. In children, however, cases have been reported in which the left hemisphere has been removed, but language functioning remains normal (Lenneberg, 1967). Masland offers three alternative explanations for the presence of language dysfunctions in children. First, the damage might be bilateral. Second, the defect may be located in the brain stem or basal ganglion through which information is relayed to the higher cortical centers. Third, there may be genetically or constitutionally determined organizational defects or peculiarities of the brain which

interfere with the associations necessary for language acquisition.

According to Zangwill (1960), partial left-handedness or ambidexterity are more frequent than is supposed. Evidence of overt dominance may be obtained by observing the subject perform tasks requiring both hands. Clapping, interlocking the fingers, crossing the arms over the chest, pressing the hands together, width of the nails on the little finger, kneeling, jumping, listening, sighting with one eye can be used to determine handedness, eyedness, and footedness. The hand or arm in the uppermost position has the greatest strength, is the most active, or takes the lead, and is a reflection of dominance.

In studying the age of lateralization of speech functions in the brain, Basser (1962) found that there is a period of infancy when the hemispheres have equipotential. In approximately half the children with brain lesions sustained during the first few years of life, the onset of speech development was delayed. The other half of the subjects began to speak at the usual time. The distribution was the same for children with either left or right hemispheric lesions. This study suggests that cerebral dominance is not yet well established during the first 2 years of life. Lenneberg (1967) points out that both hemispheres seemed to be involved in the initial acquisition of language, and dominance seems to evolve through a progressive decrease in the involvement of the right hemisphere. In the event the left hemisphere is impaired before dominance is established, the right hemisphere persists in its function.

Another topic under current investigation is the question of cerebral dominance or localization of function. The left hemisphere has been found to be most often dominant for language functioning, even for left-handed or left-preferring individuals. Penfield and Roberts (1959), for example, found that surgery of the left hemisphere produced aphasia in 115 of 157 right-preferring persons, and in 13 of 15 left-preferring persons.

The significance of the dominant and subordinate hemispheres for auditory-vocal language functioning is not clear. For example, recent research on left-handed individuals has indicated that lesions in the left cerebral hemisphere (supposedly the subordinate hemisphere) has also produced auditory language disturbances (Chester, 1936; Luria, 1947; Humphrey and Zangwill, 1952; Ettlinger, Jackson, and Zangwill, 1955; Ajuriaguerra and Hecaen, 1960; Zangwill, 1960). Many individuals have left dominance for one task and right dominance for other tasks. It is necessary to determine the significance of dominance and the importance of the left hemisphere.

The general consensus at this time is that the speech centers are in the left hemisphere in the vast majority of individuals. This is true even in left-handed individuals, although in left-handed individuals there are more individuals who are right-brained (possibly up to 30 percent) than is the case with the right-handed. The other point is that there appears to be a greater degree of bilateral representation of language in most left-handed individuals (Carterette, 1966; Mountcastle, 1962).

Wernicke (1874) and Broca (1861 a and b) pointed out that the two cerebral hemispheres were not of equal importance. Their research led them to the conclusion that in right-handed individuals, the left cerebral hemisphere is the dominant hemisphere and is the most important for auditory-vocal language functioning. Jackson's (1867) work, however, suggested that both hemispheres were involved in auditory-vocal language. Jackson believed the dominant hemisphere was responsible for complex language acts and that the subordinate one was responsible for simple actions.

Masland (1967) identifies two possible explanations for the consistency with which the left hemisphere subserves the language function. First, research findings suggest that the left hemisphere seems to be more effective in processing auditory stimuli in temporal sequence. In contrast, the right hemisphere seems to be related to spatial rather than temporal relationships. Second, the left hemisphere may be related to differences between the recognition of learned symbols as opposed to nonmeaningful objects.

Penfield and Roberts (1959) hypothesize that the three cortical speech areas, Broca's, Wernicke's, and the supplementary motor-speech area are coordinated by projections of each part to the thalamus. This hypothesis is supported by the behavioral defects which result from both superficial and deep trauma. Permanent aphasia does not result from superficial excisions of the cortex, but deep trauma or cerebrovascular accidents affect the subcortical structures and do cause aphasia. The precise relationships between the cortex and the thalamus have not been identified (Walker, 1938; Feremutsch, 1963). Much of the research has been done with adult subjects, monkeys and apes, but not with children.

The role of the central nervous system in the development of auditory language, while generally agreed to be extensive, is the subject of much controversy. There is need for further research to clarify the issues and to provide a more accurate understanding

of the brain mechanisms which serve as the basis for language functioning. At present there is little information which relates the scope, direction, and sequence of treatment procedures to demonstrable or suspected brain dysfunction. In order to relate the treatment of language functions to brain dysfunctions, educators and members of the medical profession must collaborate and attempt to relate the contributions from both professions.

Description, Assessment, and Treatment of Auditory Language Dysfunctions

Receptive Auditory Language

Many terms have been used to describe disorders of auditory receptive language. Failure to comprehend the spoken word has been called "word deafness," "sensory aphasia," "receptive aphasia," and "auditory verbal agnosia" (Orton, 1937; Goldstein, 1948; Wepman, 1951; Myklebust, 1954; and McGinnis, 1963). The terms "childhood aphasia" and "developmental aphasia" perhaps need to be defined and differentiated (Rappaport, 1964). According to Osgood and Miron (1963):

> Aphasia in children often does not resemble adult aphasia either in symptoms or treatment. By developmental aphasia (sometimes called congenital aphasia) one refers to a condition in which either poor endowment or brain injury occurring before, during, or after birth prevents the child from acquiring language. By childhood aphasia one refers to language impairment occurring after language has been acquired in the normal manner (p. 21).

Wood (1958), in Osgood and Miron, raises the question of whether aphasia in the usual adult sense actually exists in childhood in children who have never developed language. Difficulty in translating experience into spoken words has also been called "a deficiency in inner language" (Werner and Kaplan, 1963). The concept of inner language is not clearly understood and needs further investigation (Myklebust, 1954; Johnson and Myklebust, 1967). The work of Penfield and Roberts (1959), Russell and Espir (1961) and Geschwind (1967), however, has contributed to the understanding of the central processing functions which may be related to inner language. This section will summarize the research needs in acquiring auditory receptive language.

1. *Attending to Auditory Language:* The reception of auditory language requires that a person have sufficient auditory acuity to attend to speech sounds (see chapter 4). Assessment of auditory acuity for school-age children typically includes an audiometric evaluation, tests of speech-sound discrimination, psychological tests, a case history of medical and social development, and informal observations (Berry and Eisenson, 1956; O'Neill, 1964). Fry (1966) presents evidence that infants failing to respond to sensitivity tests and fitted with powerful amplification, especially if the condition is ascertained while under 1 year of age, do then begin to respond to sound. Preschool children and children with language problems, however, may not perform reliably on such measures, perhaps because of failure to attend to the appropriate auditory stimuli. The psychogalvanic skin-reflex test may be of value in testing these children. The children who are not deaf but who do not seem to attend to auditory stimuli, particularly speech sounds, may benefit from auditory training (Berry and Eisenson, 1956; Van Riper, 1963; Mecham, 1966). Reinforcement techniques have been successfully employed to train "attending behavior" (Sloane and McAulay, 1968). As described by Bijou and Baer (1965), observable "attending behaviors" may be regarded as "* * * operant responses whose only function is to either maximize or minimize stimulus input to the child" (p. 144).

Mecham, Berko, Berko, and Palmer (1966) believe that the amelioration of problems in attention is a prerequisite to all habilitative programs. After observing several thousand cases, Berko's staff noted that many "signs" of "brain damage," such as "abstracting problems" and some so-called "perceptual difficulties" seemed to disappear once stable patterns of action were established.

Future research should determine the effectiveness of various intervention techniques for improving attention to auditory stimuli. This would require investigations of both organic and functional disorders and include behavioral intervention as well as drug therapy. There is need, also to develop diagnostic procedures for differentiating between organic and nonorganic problems in attending to auditory stimuli.

2. *Distinguishing Between Auditory-Vocal Units:* In learning the auditory language code, the child must distinguish between sounds, words, and groups of words. There are, of course, many other cues from the physical environment to let the child know which word is being signaled. In the presence of a table set for a meal, the sound c-u-b /kub/ may be interpreted by the child as signalling the word "cup." Likewise, when looking at a picture of a bear family with three small bears at the mother's feet, the child may hear /kup/ c-u-p but interpret the meaning as "cub." Failure to discriminate differences between rhythm patterns, pitch and melody also may interfere with the discrimination

of different sounds and sound patterns, particularly in rhythmic patterns (Kleist, 1934).

Difficulty can also be experienced in selecting the relevant from the irrelevant auditory stimuli. Distractibility due to competitive auditory stimuli may interfere with performance in sound discrimination. Differentiating speech sounds, distinguishing phonemic signs and separating them from insignificant auditory-vocal sound units requires systematized hearing.

Luria (1966) states that the auditory cortex of the left hemisphere is responsible for the "* * * analysis and integration of the sound flow by identification of the phonemic signs of the objective system of the language" (p. 103). Damage to the auditory cortex will not result in the loss of auditory acuity, but may disrupt the analysis and synthesis of auditory sound units. Damage to the superior temporal region of the left hemisphere may result in both phonetic and conceptual disturbances of discriminative hearing. Lesions of the superior temporal region may interfere with identifying sounds from complex sound units, differentiating phonemes, and maintaining sound order. A more detailed discussion of the auditory processing mechanism may be found in chapter 2.

According to Luria (1966), the analysis and synthesis of speech sounds in the superior temporal divisions of the left hemisphere is closely related to the sensorimotor divisions, which are responsible for articulation. A dysfunction in one of these two areas, therefore, will affect the functioning of the other. The interrelatedness of these two areas complicates the task of identifying the primary and secondary cause of a disturbance in receptive or expressive language or in speech production.

The assessment of sound discrimination performance must be preceded by an assessment of auditory processing as a whole (see chapter 2). This includes a test of hearing acuity. Tests such as repeating simple sounds, distinguishing between similar and dissimilar sound pairs should be supplemented by testing the retention of sound sequences. First, the subject is asked to repeat isolated sounds, then dissimilar sounds (o-t), and finally similar sounds are introduced (p-b). The task is made even more difficult by increasing the number of sounds which are presented.

If the vocal-motor response system is impaired, the examiner must substitute an alternative nonvocal mode of response. Older children who can read and write might be asked to write the letters, print the letters, raise one hand or the other, or respond with "same" or "different," "yes" or "no" by a nod of the head. Chapter 2 discusses the various acoustic dimensions along which performance in auditory discrimination can be assessed.

According to Van Riper (1963), auditory discrimination, or the comparison and contrast of sounds, is the final step in training children to analyze speech sounds. This is to be preceded by presenting the sound in isolation, providing stimulation, and helping the child to identify the sound in his own speech by familiarizing him with the auditory and mechanical characteristics of the sound. Utley (1950), Miller (1951), Berry and Eisenson (1956), Mecham (1960), Mecham et al. (1966), and Luria (1966) describe various approaches for training auditory discrimination performance. In the event the subject is able to analyze and synthesize visual information, these functions may be used to help the subject compensate for his deficiency in processing auditory stimuli (Luria, 1966).

Research is needed to evaluate the efficacy of remedial approches for ameliorating auditory dysfunctions as well as for developing compensatory mechanisms for deficits in these problem areas.

3. *Establishing Correspondences:* The process of linking auditory language signals to objects, actions, or experiences is a complex intersensory task. The child must integrate certain auditory information (the sequences and patterns of sounds, and his knowledge of the recurrence of these sequences and patterns) with objects and events in the world about him. These events and objects can be observed by him through any of his sensory information pickup systems. He must relate and recombine the information together with the vocal sounds produced by another person. The vocal sounds do not have to be produced by a person who is physically present with the child. The sounds can come from many sources: Television, phonographs, telephone, from another room.

The child must establish a correspondence between the recurring patterns of sounds and the object or event. In order to learn that the word name "apple" stands for a specific object (an apple), the auditory language signal must be linked with the stimulus qualities of the object.

Auditory language provides a means for naming or labeling objects and actions, distinguishing between their properties, and describing their interrelationships. Words can stand for an object when the object is not present. Research has demonstrated that certain learning principles, such as frequency and contiguity, are important for learning, but the physiological process by which auditory and visual information is integrated

has not been clarified (Hilgard and Bower, 1966.) There is need for research to determine how these correspondences are established and stored. Research needs which are related to intersensory integration are presented in chapters 5 and 6.

Future research should be directed toward the syntactical or automatic sequential aspects of receptive language. For example, comprehension of syntax and morphology was investigated in normal preschool children by Fraser, Bellugi, and Brown (1963). Pairs of pictures were shown to children, illustrating a contrast such as "the sheep is jumping" and "the sheep are jumping." One sentence was spoken aloud, and the child pointed to one picture. Templin (1966) used their procedures to collect normative data on children.

Failure to develop correspondences is often reported in case studies of children. Ajuriaguerra (1966) reports the results of clinically training 40 children who had failed to acquire speech in spite of sufficient intelligence and adequate hearing. At first the children were classified either as group I "expressive audimutes" (seriously deficient linguistic expression) or group II "congenital word deaf" (failure to understand speech and disordered verbal expression). This twofold classification had to be dropped, because it did not correspond with the observed facts about the children and their performances. Mainly, for children in group II, noncomprehension of speech took many different forms. Two main forms were finally distinguished: (1) children with normal auditory perception but with serious difficulties in the organization and performance of complex motor tasks such as vocal-motor production, and (2) children presenting complex problems of auditory perception.

Ajuriaguerra reports that all 40 subjects improved, regardless of the degree of intensity of reeducation, but that some of the symptoms remained. The majority of the children showed progress in auditory reception of language, in the comprehension of words, the expression of narratives, and syntax. Those children who were classified as "audio-verbal perception" problems showed little improvement.

Understanding simple sentences requires knowledge of grammatical structures, short-term auditory storage, and the control necessary to postpone premature conclusions about what is being said until the communication has been completed. Lesions in the temporal cortex may limit the number of auditory-vocal signals which can be processed and thus reduce understanding of what is said. If the processing of the sound structure of speech is disrupted, then the more complex auditory language signals, words, phrases, and sentences will probably be disrupted as well. Lesions of the left temporal lobe also may result in failure to establish word name associations with objects, actions, qualities, and events. In these cases, the series of words are not retained. As the length of the series increases word meaning is lost.

Damage to the middle portions of the left temporal region has been associated with the inability to obtain meaning from a word after it has been repeated. An inhibition seems to occur with repeated presentations. Comprehension of complex grammatical units such as sentences may be assessed by asking questions or giving a series of verbal instructions. In cases of temporal lobe damage, the sentence may not be perceived as a whole and the subject might react to only one aspect of the sentence. Impulsive responses are sometimes noted.

The effect of temporal lobe lesions upon abstract intellectual activity is not clear. Goldstein (1948) stated that sensory aphasics are unable to classify objects or carry out abstract operations. However, others have found the opposite. Studies by Luria (1947) and Bein (1957) found that sensory aphasics can grasp ideas, understand the proper meaning of metaphors and allegories, and that the conceptual substitutions often have an abstract basis. This would appear to refute the position that the most abstract concepts, which were last to develop, are the most seriously affected. Prepositions, conjunctions, and connecting words constitute a large portion of the residual speech of the sensory aphasic (Lotmar, 1919, 1935; Ombredane, 1951).

Dysfunctions in the middle segments of the temporal region do not disrupt phonemic hearing, but do result in failure to reproduce a series of words or phrases which have been given orally. The subject's response is often confused and the last segment is frequently forgotten. Difficulty is often encountered in reproducing the sequence in the proper order. Luria (1966) cites cases in which word meaning is retained for one or two words, but in which the patient is unable to retain word meanings when he is presented with several words at the same time.

In another type of temporal lobe involvement, pronunciation of words may remain adequate, while the subject is unable to remember word meaning. Luria (1966) believes that this reflects a dysfunction in establishing auditory-visual correspondences between objects and their word names. This integrative disorder may be due to interrelated temporal and occipital involvement.

Occipital-parietal damage has been shown to affect simultaneous synthesis and orientation in space, and is closely related to difficulty in naming objects or actions (Head, 1926; Conrad, 1932; and Luria, 1947). Occipital-parietal lesions often affect the use of words connoting time, direction, position, and the relationship of objects in space, including adverbs and prepositions such as "up, down, on, under, above, after, beside, right, and left" (Bubnova, 1946).

The problem, however, is not that the subject has failed to attach labels or word names to objects or events which are spatially related. The basic problem is the reasons why the subject fails to grasp these spatial relationships because once they have been grasped, the corresponding label can be attached in a relatively short time.

Complex word constructions which can be reversed, or transformed, such as active and passive voice, may also be affected (Luria, 1945, 1947, 1948). There is little information about the specific cause of these problems. They may represent integrative dysfunctions of the parieto-occipital systems. This kind of dysfunction may interfere with the integration of visual information into a single whole, which can be labeled or related to a specific auditory-vocal language signal. For purposes of training, explanation of the meaning of these words, development of grammatical rules, and use of external aids may help the subject establish functional use of spatial concepts (Bubnova, 1946; Luria, 1948).

Subjects with lesions in either the frontal lobes or the frontal-temporal area may understand the meaning of words which are presented in isolation, but have difficulty understanding the meaning of several words. The degree to which comprehension is affected varies widely from slight to severe. Metaphorical and allegorical meanings may not be understood and cases have been reported where the meaning of words is narrow and rigid (Zeigarnik, 1961; Kogan, 1947, 1961). Disorders of memory may interfere with the selectivity of auditory images. These disorders may be associated with auditory, occipital, parietal, and frontal lobe regions. In cases of frontal lobe involvement, voluntary memorization is involved (Luria, 1966). Disorders of memory are discussed in chapter 6. Impulsivity for premature response also has been found to result from frontal or fronto-temporal disturbances, or generalized brain damage.

Dysfunctions of any of the lower levels of analysis and synthesis will probably disrupt the rapid and automatic decoding of auditory information. There is need to identify the psycho-neurophysiological correlates to establishing correspondences between auditory-vocal language signals (words, phrases, sentences, etc.) and experiences. The assessment of whether the meaning of a word is understood requires either a verbal or motor response. The subject may be asked to describe or to point to the object named. If two or three words are presented sequentially, the subject may respond by referring to previous words. This behavior has been associated with frontal lobe and fronto-temporal lesions (Luria, 1966).

There is need to investigate the application of learning theories, such as Gagné's (1965) eight stages, to establishing correspondences between auditory-vocal signals and experiences. The field of behavior modification and reinforcement theory offers an exciting approach to teaching. The use of operant procedures in remedial speech and language training by Sloane and MacAulay (1968) is an example of putting theory into practice.

4. *Increasing the Speed and Accuracy of Decoding:* In order to understand sentences, it is necessary to become familiar with the fundamental grammatical structures. As the speed and accuracy of processing complex auditory language signals is increased through repetition and variation, attention may be directed toward the content of a vocal message. At present, there is little information about the development of the automatic-sequential aspects of receptive language. The transformations of basic assertions (active-passive, positive-negative, question-statement) seem to be acquired by age 4 (Lenneberg, 1967).

It is necessary to understand the meaning of individual words, but it is even more important to relate the meaning of one word to another. The individual who has acquired logical grammatical units for various combinations of individual words has fewer discrete auditory-language units to process. Future research should investigate the kinds of combinations which are most troublesome for atypical children.

A common procedure for testing the understanding of complex grammatical structures is to present the subject with a series of vocal requests which require a response by pointing, naming objects, or following increasingly complicated directions. Lesions in the temporal lobe or the parieto-occipital systems of the left cerebral hemisphere, and the anterior divisions of the brain have been related to difficulty in understanding logical grammatical structures (Luria, 1966). Behavioral symptoms include the inability to understand the meaning of object words, action words, words which represent spatial orientation or temporal-spatial relationships, difficulty in following complex directions,

and a lack of awareness of the implications of changes in word order resulting in perseverative responses.

There is need to investigate the automatic-sequential aspects of language. How is it developed? What are the behavioral characteristics of disorders of automatic-sequential receptive language? How can these disorders be assessed? What kinds of developmental, instructional, or remedial procedures are needed to ameliorate dysfunctions in automatic-sequential receptive language? Little research has been done in this problem area.

Expressive Auditory Language

There are children who have no difficulty understanding what is said to them, but who are unable to use spoken language as a means of communication. Johnson and Myklebust (1967) point out that combinations of deficits may cause disorders of auditory expressive language. But they identify three kinds of disorders which seem to be most prevalent. First, children who have difficulty in reauditorization and word selection typically experience problems in remembering or retrieving words for spontaneous usage. Yet, these same children are often able to understand and recognize words. The second problem consists of failure to execute motor patterns for speaking. Failure to voluntarily initiate movements of the articulators in the absence of paralysis is called apraxia. The third problem is failure to acquire syntax. This is characterized by difficulty in organizing words in their proper word order, using appropriate verb tenses, and making other grammatical errors. For purposes of organization, these three kinds of disorders will be discussed in the framework of the analysis of tasks thought to be related to the acquisition of auditory expressive language.

1. *Deciding to Communicate:* The first step in using expressive auditory language is the intention to communicate. The child must have sufficient motivation to produce vocal instructions, commands, explanations, descriptions, or questions. Without this motivation, no deliberate effort is made to send information through expressive speech. The child must also make the decision to communicate. Despite the felt need to communicate with another person, the child may decide not to send a message. Because this report is concerned with central processing dysfunctions which interfere with expressive auditory language, problems related to motivation are only mentioned here.

It should be noted, however, that the clinical assessment of a child who demonstrates no expressive language typically begins with ascertaining the possibility that the child may not need to talk. It is helpful to set up a situation in which some desirable event is made contingent upon the performance of an expressive language act by the child (Schiefelbusch, Copeland, and Smith, 1967). While this situation may be only an approximation of the terminal behavior desired by the therapist (the spontaneous decision by the child to send a message), it does represent a link in a behavioral chain.

2. *Retrieving Vocal-Language Signals:* In some cases, children can understand and recognize the words that they hear, but experience difficulty in retrieving or remembering these words during spontaneous speech. Johnson and Myklebust (1967) refer to this retrieval process as "reauditorization." Berry and Eisenson (1956) refer to failure in evoking words as an "amnesic" type of aphasia. Children who are unable to retrieve words may convey an idea by using sound effects; gesture or pantomime; delaying their responses; describing the word by use or by definition; or substituting words within the same general category (Johnson and Myklebust, 1967).

Designating objects, actions, and experiences by spoken words is a complex process. A word or words stand for each of the individual stimulus qualities of an object (red, hard, moist). A word used as a name (apple) also stands for the combined stimulus qualities of an object. During the speaking act, a child may fail to retrieve the appropriate word. Instead, he may retrieve a word which is closely associated with the desired word. During the retrieval process, a large number of associations may come to mind (apple, fruit, red, moist, hard, good, pear), and the child must scan and select the most appropriate alternative (apple). A child may retrieve an inappropriate word because it sounds like the desired word (phonological similarity), or it may have a similar meaning (semantic similarity).

Disturbances of the nominative (naming) function have been found to accompany lesions of the auditory divisions of the left temporal lobe, parieto-occipital systems, tempero-occipital systems, the frontal lobes, the fronto-temporal area, and from lesions affecting the brain as a whole (Luria, 1966; Lenneberg, 1967; Salzinger and Salzinger, 1967; Carterette, 1966.) Lesions of the anterior temporal lobe in the left hemisphere have been found to interfere with the organization of a long series of auditory-vocal signals.

Subjects with frontal dynamic aphasia, resulting from lesions of the anterior divisions of the left hemisphere, can repeat individual words and phrases, name objects, pronounce speech stereotypes, but experience difficulty in sequencing elements of a series, or in com-

posing their own scheme of expression for spontaneous speech. Vocal responses are short, passive, and echolalic. They can give a response if it is embedded in questions, but have difficulty initiating a system of speech connections (Kleist, 1934).

Children may be able to recite a well established automatic series, such as numbers or the alphabet, but have great difficulty altering the established order. Luria (1966) describes several direct approaches to the assessment of nominative functions, such as asking the subject to name single objects, pictures, or parts of the body. Several objects may be presented at the same time which may inhibit the retrieval of a word name in the presence of other word name alternatives. The subjects's ability to categorize can be tested by presenting a series of objects or procedures and asking the subject to say a single word which is appropriate or is characteristic of all the objects.

Naming an object from its description is a more complex task because the object is not physically present, and the subject must store the verbal description while attempting to retrieve the desired name. Prompting the subject by saying the first few sounds of the word may elicit the correct word. In cases where the retrieval problem is due to auditory disturbances of phonetic structure, prompting will not help the subject retrieve the appropriate word. Occipital involvement may be suspected if retrieval is facilitated by presenting more obvious pictures of the object or actual tactile contact with objects. Subjects who can name concrete objects but have difficulty in spontaneous-speech production of sentences may be affected by lesions of the frontal lobes. In these cases there is some difficulty inhibiting irrelevant words.

Luria (1966) discusses the investigation of narrative speech. Disturbances in narrative speech are characterized by lack of intention, extinction of word meaning, and loss of the higher automatisms. An important question to answer is whether the subject can produce automatized series of numbers, alphabet letters, days of the week, and months of the year. Failure in producing automatized series and the perseverative reproduction of a part of a series has been related to lesions of the anterior divisions of the brain. The subject is frequently requested to repeat the series forward and backward. Failure to reproduce a series in reverse order has been related to lesions of the frontal lobes (Luria, 1966.) Response to simple questions can be used to study the speed of response, repetition of the question, and flexibility of response. Describing pictures or telling stories is another widely used procedure for studying narrative speech. Substituting stereotyped expressions and phrases is a common mode of compensation for difficulty in composing spontaneous speech.

Instructional procedures in expressive language training are usually designed to cause a desirable event to occur when the child produces a vocal request. The supposition is that the reward received by granting the request will increase the probability of the child formulating a similar spontaneous message on future occasions. Prompting may be necessary if the child indicates that he wishes to say something but does not remember the way to say it. Ambiguous messages are sometimes sent because word order in English determines the meaning of many messages. A young child may retrieve the appropriate words for a message, but produce the words of the message in a nongrammatical manner. The task of the language therapist becomes that of re-forming the message to determine whether or not he is interpreting it correctly and to teach the subject how to formulate messages. This entire subtask merits intensive research effort, on both the content and form of messages, word meaning, and sentence and phrase structure.

Many tests have been developed to measure aspects of expressive language. In contrast, there are comparatively few tests for measuring receptive language. Similar observations can be made about training programs. The expressive "cart" has been put before the receptive "horse." As a result many children may have been trained to imitate or echo spoken language. According to Peterson (1968), imitative behavior is an important step but certainly not the last step in training.

Programs intended to train expressive language usually take the form of building upon whatever performance the child exhibits in receptive language and vocal-motor production. If a child demonstrates no vocal-motor production, the instructor must teach the necessary vocal-motor skills. If the child demonstrates imitation, the emphasis should shift to building intentional speech. Risley and Wolf (1968) present a detailed plan using operant procedures for establishing functional speech in children who imitate inappropriately. McGinnis (1963) and Barry (1961) have developed systematic training procedures for use with deaf, hard of hearing, and aphasic children which may have wider application for children with language dysfunctions.

Research is needed to: (*a*) determine the causes of dysfunctions in retrieving and formulating auditory messages, (*b*) develop assessment procedures, and (*c*) formulate instructional techniques.

3. *Executing the Vocal-Motor Sequence:* Vocal-motor behavior depends upon a certain degree of control over the mechanisms of the body which work together to produce vocal sounds. The mechanism which produces sounds is commonly termed the "speech apparatus," and is generally considered to include the musculature of the diaphragm; lungs; throat; and oral cavity, including the tongue, lips, and cheeks. One should also include the central processing mechanism which regulates and directs the sequences of events in the musculature (Lenneberg, 1967). Before phonation occurs, muscles in the abdominal and thoracic wall and in the larynx have to assume certain positions. Further, the laryngeal muscles have to be coordinated with the oral muscles. Hundreds of muscular adjustments are made every second. The complex ordering and timing of these articulatory events can be disrupted in a number of ways.

This report is concerned with central disorders in which there is difficulty organizing the motor acts necessary for speech and in receiving kinesthetic feedback from the speech mechanism.

For example, efferent or kinetic motor aphasia is chracterized by difficulty in articulating words and coherent speech. While subjects may be able to repeat separate sounds or words which have been overlearned, difficulty may be encountered in inhibiting a preceding speech movement and making the transition from one phoneme to another, repeating a series of words or phrases, reproducing melodies, or changing the order of word sequences. Speech is often characterized by a slow, arhythmical, telegraphic style in which only the key words are spoken. These disorders have been related to lesions in both the superior and inferior divisions of the premotor areas of the left hemisphere (Luria, 1943, 1947). Lesions in the inferior divisions have been found to be associated with the more pronounced disturbances.

Failure to analyze and integrate kinesthetic feedback from the speech mechanism contributes to problems in speech as a means of communication. Articulatory defects arising from lesions of the inferior divisions of the postcentral region of the left hemsiphere have been found to result in a disturbance of the kinesthetic organization of motor acts necessary for articulation (Luria, 1966). Difficulty is typically encountered in attempting to place the tongue and lips in the proper position for producing speech sounds. In kinesthetic motor aphasia, the speech sounds are not slurred or characterized by monotonous patterns as in dysarthria. Speech sounds tend to be clear, but many sound substitutions occur during speech. Sounds which are similar tend to be substituted for one another (t/d, l/r, b/p). Repetition of words or phrases is disturbed, but vocal sound units which have been overlearned can be produced correctly. The most prominent behavioral symptom of kinesthetic motor aphasia is the difficulty in seeking and producing the appropriate speech sounds. While entire phrases may be produced easily, it is difficult to produce individual sounds.

There are several simple procedures for identifying disturbances affecting the lips and tongue: "* * * protracted extrusion of the tongue and observation for signs of tremor, deviation, or general inability to maintain this position; protrusion of the lips and consideration of the tone of the appropriate muscles; etc." (Luria 1966, p. 336). Tremor of the lips, paralysis of the facial muscles, and salivation are other symptoms which should be noted.

Defective innervation to the lips, tongue, and cheeks may be determined by asking the subject to bare the teeth, puff the cheeks, wrinkle the brow, frown, squint, and place the tongue in different positions and maintain a single position with the tongue. The examiner should observe for evidence of tension, mobility, asymmetry of movement such as diminished ranges of movement, deviations to one side, and difficulty in imitating movement. The subject is then asked to repeat specific motor acts several times in succession to demonstrate the smoothness of movement and to see if he is able to inhibit other facial muscles during repetitive movement. A slight paralysis of the soft palate results in excessive nasal resonance because of the flow of air through the nose. A poorly modulated and weak voice results from paralysis which involves the larynx.

A comparison should be made of the natural performance of a motor action with performance upon request. For example, a child may be able to move his tongue quickly to lick honey placed on his upper lip. This same child, however, may find it difficult to place the tip of his tongue on his upper lip upon command, even if he is sitting before a mirror. Children should be examined for the presence of apraxia or the inability to organize and perform voluntary motor acts with the articulators.

Because this report focuses on central processing dysfunctions, the treatment of vocal-motor disturbances of speech production will not be discussed here. Detailed descriptions of training procedures for vocal-motor dysfunctions are described by Van Riper (1963); West, Kennedy, and Carr (1947); Berry and Eisenson (1956); Travis (1957); and Goldstein (1948).

4. *Automatized Vocal Encoding:* In table 10 three subtasks have been tentatively identified as part of the automatization process: (1) combining simple vocal-language signals to form more complex signals; (2) increasing the range, rate, and accuracy of production; and (3) shifting attention entirely away from the mechanics of decision on production aspects of the message to the mechanics of decision on the content of the message. Automatization enables the person to participate in conversation, in which he alternates between listening and speaking, and in which he is simultaneously processing the other person's message and formulating his own reply.

The central nervous system structures involved in the development of automatic language expression have not been identified, nor is there agreement concerning the processes by which sentences are generated and produced. Lashley (1951) demonstrated the inability of a stimulus-response behavior chain to account for sentence and phrase production. Chomsky (1957) and Lenneberg (1967) also dispute the possibility of chaining simple word structures into complex syntactic structures. Not even the sequence of automatization of certain structures is known. Investigations such as research on the development of the negative construction in English will add to the store of knowledge. Normative data has been collected on a cross-sectional basis, but there is need for longitudinal data on the acquisition of language patterns for both normal and atypical children.

Mere parroting or reproduction of adequately formed sentences is not the aim of instruction at the level of automatization. What is desired is the spontaneous production of relevant statements, questions, and requests.

There is need to develop and test procedures for facilitating automatic functioning in children. The literature on second language acquisition might provide some useful models for determining the optimum procedures for presenting and eliciting combinations of words, phrases, and sentences. The use of electronic reproduction equipment, such as magnetic tape recorders, may be beneficial in providing auditory feedback to the learner, as well as preserving the ordinarily transient speech signal for later examination and pretraining and posttraining comparisons. Instruction should be accomplished by the careful collection of data so that the efficacy of various training procedures can be evaluated.

Menyuk (1967) points out that the child who is in the process of acquiring language often hear nongrammatical language signals, sometimes mixed with half-sentences, and heard against much background noise. The child who successfully performs acquisition tasks evidently makes sense out of the "jumble." For the deviant child who fails some of the acquisition tasks, the sounds may have remained a "jumble." The linguistically significant contrasts must be identified and defined for this child. Menyuk describes four aspects of language which can be considered as variables to be investigated: structural description (syntax, semantics, and phonology); input/output (grammatical, nongrammatical, and agrammatical); grammatical capacity (addition, deletion, and permutation); and embedding and general capacity (perception, discrimination, identification, memory, and induction). The last aspect, general capacity, includes many of the factors which have been included in the task analysis of receptive language which is presented in table 9.

A major research question is: What are the principles and guidelines for programming the systematic instruction of a first language? This question can only be answered by research in the clinic and classroom—by controlled evaluation of educational techniques.

Directions for Future Research

At present, the status of knowledge with respect to dysfunctions of auditory language is, for the most part, based on work with adults who have acquired language and lost it. There is need to conduct basic research with children to determine how a first language is acquired. There is need, also, to determine how central processing dysfunctions can affect the acquisition of a first language in children. In order to accomplish these research objectives it will be necessary to devise more effective methods for investigating language acquisition in children. Longitudinal study of individual children provides a clinical approach to the problem. Detailed descriptions of specific language behaviors are needed and an attempt should be made to determine if these behaviors are correlated with other observable problems.

Research is needed to clarify the role of different areas of the brain and their interrelationships with respect to language acquisition. What is the difference in hemispheric functioning? What are the implications for language functioning when dominance is not established at an early age? What is the comparative impact of brain damage on language acquisition when it occurs at different age levels? What kinds of procedures are available for assessing brain dysfunction? Research which attempts to link behavior to brain mechanisms should be conducted by interdisciplinary teams.

Future research areas include investigation of inner language, receptive language, and expressive language. Problems in vocal-motor production arising from central dysfunctions should also be studied. There is need to develop clear behavioral descriptions of receptive language dysfunctions and to refine the terms which are intended to represent these behavioral syndromes. Research should systematically develop procedures for assessing and ameliorating dysfunctions in attention, discrimination, establishing correspondences, and increasing the speed and accuracy of decoding auditory language units.

Research is needed in describing expressive language disorders as related to central dysfunctions. Procedures and techniques for assessing and ameliorating problems in initiating expressive language, retrieving vocal-language signals, executing vocal-motor sequences, and developing automatic aspects of language represent future research areas.

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CHAPTER 8

DECODING WRITTEN LANGUAGE

Three children are sitting at a library table. One child is blind. A book rests on the table and he is feeling the embossed dots of the braille code with his fingertips. The second child is deaf. He has his eyes focused on the page of a book. There is ordinary English print in this book. Despite the fact that the second child has never heard spoken language, he is looking at the graphic representations of spoken words. The third child is also focusing his eyes on the pages of a book. This child is neither blind nor deaf. He sees the print in the book and he has heard spoken language throughout his life. One might say that all three children are reading, but are they? What constitutes the reading process? What must a child do in order to read?

Two basic approaches have been taken to answer these questions. Theoretical definitions have been proposed to describe or define the reading process. Harris (1961) has defined the reading process as "* * * the meaningful interpretation of verbal symbols" (p. 8.). Myklebust and Johnson (1962) have defined reading as "* * * a visual symbol system superimposed upon a previously acquired language system" (p. 15). Fries (1963) defined reading as "* * * a type of linguistic performance depending first of all upon the language control achieved by each individual reader" (p. 186).

More recently the theoretical approach for describing the reading process has been supplemented by operational definitions. Fries (1963), for example, presents several operational definitions such as:

> Responding to language signals represented by patterns of graphic shapes (p. 119).
>
> Developing a range of habitual responses to a specific set of patterns of graphic shapes (p. 121).
>
> Responding to contrastive spelling patterns (p. 187).
>
> Developing habits of hi-speed recognition responses to the identification features of the spelling patterns that represent the word patterns that he knows (p. 183).

It is interesting to note that theoretical definitions best fit the reading of the adult or practiced reader, while operational definitions represent the processes which operate in the individual who is learning to read, as well as in the individual who knows how to read.

To answer the question, "What is reading?", this chapter will attempt to provide an organized structure to which the signficant research on reading and reading disorders can be related. The specific kinds of tasks which are involved in the reading process will be analyzed and the correlates to reading will be discussed. A discussion of assessment procedures for reading disorders will be followed by suggestions for training procedures to ameliorate these problems.

The Reading Act

Although the act of reading has been defined, the component aspects of the reading process have not been clearly identified. A thorough analysis of the reading act should: (*a*) describe the terminal behavior and the conditions under which it occurs; (*b*) identify the specific subtasks which are necessary to achieve the terminal behavior; and (c) arrange the substasks in sequential order.

In discussing the act of reading, it is important to distinguish between beginning and advanced reading. Beginning readers must learn a new code of graphic representations for the previously learned code of auditory language signals. According to Fries (1963), the first stage in learning to read is the transfer stage. The child learns to transfer from auditory language signals, which he has already learned, to a set of graphic language symbols. Beginning readers generally may be expected to learn to decode graphic language symbols as well as they have learned to decode auditory language signals. While beginning reading focuses on the problem of decoding, advanced reading is primarily concerned with comprehension and reading rate.

A task analysis of beginning reading is complicated further by the fact that two methods for teaching reading may require two different sets of substasks. Thus, different methods of teaching reading make different demands on the beginning reader. In order to provide

a framework for this chapter, task analysis of two representative approaches to beginning reading have been included. The first emphasizes "meaning" and the second stresses "code breaking."

Table 12 represents an attempt to task analyze a whole-word system of reading. The first subtask requires the reader to attend to the visual stimuli, then the visual stimuli must be identified as a graphic word unit. Finally, the reader must then be able to retrieve the auditory language signal for the graphic word unit and respond by saying the word name.

Table 13 represents a task analysis of a sound-symbol system of reading. The first step in this system of reading requires the reader to attend to the visual stimuli as a graphic word unit. Second, the visual stimuli are identified as discrete letters in a sequence. The reader must then retrieve a phoneme(s) for each grapheme and place these phonemes in a temporal sequence. Last, the reader must blend the phonemes into a familiar auditory language signal and respond by saying the word name. Research is needed to provide a more thorough analysis of both beginning and advanced reading tasks.

Table 12.—A Whole-Word System of Reading: A Task Analysis

I.	Attends to visual stimuli.....		cat
II.	Identifies visual stimuli as graphic word unit.....		*cat*
III.	Retrieves auditory language signal for graphic word unit.....	*cat* →	(/kaet/)
IV.	Responds by saying /kaet/.....		/kaet/

Terminal behavior: Given a graphic word unit such as "cat," the reader says the word name "/kaet/" within 5 seconds.

Legend:

cat.....	Visual stimulus.
cat.....	Graphic word unit perceived as a whole visual image.
→.....	Association in the direction indicated.
(/kaet/)..	Recalled auditory language signal.
/kaet/...	Spoken word or auditory language signal.

Table 13.—A Sound-Symbol System of Reading: A Task Analysis

I.	Attends to visual stimuli.....			cat		
II.	Recognizes stimuli as graphic word unit.....			cat		
III.	Identified stimuli as sequence of discreet letters.....	1st	–	2d	–	3d
		c	–	a	–	t
IV.	Retrives phoneme for each grapheme.	c	⟶	(/k/)		
		a	⟶	(/ae/)		
		t	⟶	(/t/)		
V.	Recalls phonemes in temporal sequence corresponding to graphic sequence in step III.....	1st		2d		3d
		(/k/)	–	(/ae/)	–	(/t/)
VI.	Blends phonemes into familiar auditory language signal..			(/kaet/)		
VII.	Responds by saying /kaet/.....			/kaet/		

Terminal behavior: Given a graphic word unit such as "cat," the reader says the word name, /kaet/, within 5 seconds.

Legend:

cat.....	Visual stimulus.
c – a – t..	Discrete letters in sequence (graphemes).
(/k/).....	Recalled auditory sound signal (phoneme).
⟶.....	Association or correspondence in the direction indicated.
(/kaet/).....	Discrete sounds blended into word.
/kaet/.....	Spoken word or auditory language signal.

The Elements of the Graphic Code

Various codes, using visual representation, have been developed to record speech. Not all languages, however, have been reduced to graphic codes. According to Fries (1963), writing systems or codes have been developed for approximately one-half of the world's languages. Furthermore, not all the elements of speech are represented by any system of writing, whether by pictures, words, syllables, or letters. Historically, writing began with a picture to represent a situation; then a picture or sign was used to represent each word. Next, a picture or sign was used for each syllable. Finally, the separate phonetic units of syllables were symbolized by signs. A list of such signs is called an alphabet.

Unfortunately, many teachers and basal reading series intentionally emphasize only the alphabet letters and punctuation marks, along with an emphasis on the meaning of the word or words. Acquisition of the entire code is not stressed or taught. When this happens, instruction is often inefficient and ineffectual, and may cause children to experience unnecessary difficulty in learning the code. While considerable attention has been given to children's performance on standardized silent reading tests, comparatively little attention has been directed toward the fundamental elements which compose the graphic language code. For many people, the graphic language code consists of two elements: alphabet letters and punctuation. It should be noted, however, that there are other significant elements which make up the graphic language code. With the recent emphasis on acquiring the "code" (Chall, 1967), future research should be directed toward

studying the significance of all the fundamental elements of the graphic language code. This would include the graphic shapes of individual alphabet letters and nonalphabetic signs; the space-direction sequence; and English spelling patterns.

Graphic Shapes.—The beginning reader of English must learn to identify and distinguish to types of graphic shapes, the English alphabet and nonalphabet signs. The graphic shapes called the English alphabet consist of a set of 26 letters. Each letter has an upper-case form and a lower-case form. Any letter can be printed in typographic, manuscript, or cursive style. Thus, there are at least six possible graphic forms for each letter, depending on the style.

All letters are made from curved and straight lines. Depending on the style, some letters are all curved (*O, C*) others are all straight (*T, E, N*) and still others are partly curved and partly straight (*D, G, P*). Capital letters have distinctive features by which they can be differentiated: The number of strokes; the position of the strokes, horizontal, vertical, or slanting; the left-right position of the stroke; the relative size of the curved portions and position as combined with the strokes.

The beginning reader must learn that some aspects of the letters are not distinctive features. Size is not distinctive: An *A* can be a half-inch high, an inch high, or in the case of a billboard, 4 feet high; yet its signal is the same regardless of its size. Color is not distinctive, nor is material. The child must learn the distinguishing characteristics. For example, what distinguishes the letter *H* from the letter *A*? This is the kind of question the child must learn to answer. The differences between letter *H* and *A* (in the capitals) are that in the *H* the two vertical lines are perpendicular to the base reference line and the two lines do not meet at the top. The *A* on the other hand must have the two vertical lines meeting at the top of the letter. In the letter *A* some portion of the vertical lines must be nonparallel, that is, the portions of the lines that are to meet at the top can never be parallel. Note that visual discrimination, visual auditory integration, and memory are involved.

The nonalphabetic signs consist of three types: Word signs, abbreviations, and punctuation marks. One set of word signs comprise what we call numerals. These shapes are not alphabetic signs, but rather word signs. For each numeral or word sign in the Arabic system (0, 1, 2) there is a corresponding word which can be spelled (zero, one, two). The other set of word signs are those signs for mathematical processes. The + represents "plus or add." The − represents "minus, subtract, or less." The = represents "equals or are." The × represents "times or multiply." The ÷ represents "divided by." The second type of signs the child must learn are the abbreviations of various sorts, acronyms such as "U.S.S.R." and short forms of words such as "Mr." The third type of nonalphabetic graphic marks do not appear in vocal-auditory language signals. Punctuation marks such as capital letters, periods, exclamation marks, question marks, colons, semicolons, commas, and quotation marks exist in auditory language only as pauses or as vocal inflections. However, some linguists consider these pauses as supra-segmental phonemes.

Space-Direction Sequence.—Vocal-auditory language signals are produced in a sequence with a time dimension. Writing systems must represent this sequence by means of a directional sequence in space. In the English writing system, the space-direction sequence is a horizontal sequence of graphic shapes in parallel lines, read from left to right. Vertical or right-to-left sequences are used in some Eastern and Middle Eastern language systems.

In the transfer from a succession of sound patterns in a time dimension, to a succession of graphic patterns in space direction, there are many arbitrary features that must be specifically and thoroughly learned. This orientation toward sequence (in English, left-to-right) is significant not only for word order (*John loves Mary—Mary loves John*), but also for words (*saw—was*) and for individual letters (*b—d*), some of which have a definite directionality. In many instances a change in word order or direction changes the meaning with the exception of the letter *O*, which can be on the horizontal line in any rotation. The other 25 letters all have constraints of left-right, top-bottom, and vertical-horizontal which must be observed. Some lowercase letters have structurally significant constraints. If the left-right direction is changed, another letter is formed: *b—d, g—p*. If the top-bottom direction is changed, another letter is formed *u—n, b—p, d—g*.

Spelling.—Although the English alphabet is phonemically based, the individual letters have never stood in a one-for-one correspondence with the separate phonemes of the English language. Consequently, it is impossible to match an English phoneme with each letter of the alphabet as they occur in the graphic representation of English word patterns.

Modern English is not hopelessly chaotic. Most of the spelling is patterned. It is basically phonemic in its representation. Patterns of letters, rather than single letters, may serve as the functioning units of the rep-

resentation. Patterns of letter sequences have represented those patterns of contrastive differences of sound that identify word patterns. For example, it is the total sequence of all the letters in the spelling pattern that signals "hat" or "hate." Reading must rest upon automatic, well-practiced identification responses to the visual stimuli.

> Just as the process of talking rests essentially upon responding to the significant bundles of contrastive sound features, so the process of reading rests essentially upon responding to the significant bundles of contrastive graphic features that represent those contrastive bundles of sound features. (Fries, 1963, p. 125)

Some language signals are not represented in writing, but must be added to the printed word or words in order to convey the proper meaning or the intended meaning. In most graphic representations of language there are left out such language signals as intonation, stress, and pause. With continued practice, the responses to visual patterns become habitual. Accumulative comprehension of the meanings which are signaled enable the reader to supply those portions of the signals which are not in the graphic representation themselves. In oral reading this process of supplying the omitted signals and meanings is what has been called reading with expression. It will be noted that this stage of reading corresponds to the highest stage of receptive and expressive auditory language.

If children are to be taught the effective use of the graphic English code in reading and writing tasks, it is important that (a) the code be analyzed carefully; (b) the elements of the code be included in reading programs; and (c) that teachers and children are taught the subtleties which are found in the English code.

Correlates to Reading Failure

Failure in reading has been attributed to a number of different physical and psychological factors including: sensory deficiencies; low intelligence; low verbal ability; auditory, visual, and kinesthetic perceptual dysfunctions; memory disorders; integrative dysfunction; poorly developed laterality; biochemical imbalance; emotional disturbance; and genetic factors. Early researchers such as Dejerine (1892), Hinshelwood (1917), and Orton (1937) were among the first to investigate correlates to reading failure.

It should be noted that in some cases observable behavioral symptoms which have been related to failure in reading may result from either functional or organic causes. Also, several correlates may be affected at the same time. In some cases, however, more obvious behavioral symptoms of one correlate may mask or conceal the involvement of other correlates whose symptoms are less obvious. For the purpose of this report, this section will attempt to identify and discuss those correlates which are believed to arise from within the child and are thought to have something to do with failure in reading.

Sensory Deficiencies

There seems to be a difference of opinion concerning the extent to which visual and hearing deficiencies affect the acquisition of reading skill. Bateman (1963) found that legally blind children with 20/200 vision after correction were reading up to grade level. Despite the lack of evidence for a cause and effect relationship between visual acuity and reading proficiency, the visual correlates having implications for reading may be more subtle than suspected. Tests such as the Snellen Chart, the Massachusetts Vision Test (MVT) and other screening devices are not designed to identify specific visual disorders such as in eye coordination, depth perception, visual fusion, or lateral and vertical eye-muscle imbalance. Research attempting to correlate ocular factors to reading retardation has shown conflicting results and currently, the role of ocular factors is refuted by scientific interdisciplinary studies (Lawson, 1968).

Most of the research which has attempted to correlate hearing loss with reading disorders has found that retarded readers have a high incidence of hearing loss. The presence of a hearing loss, however, does not necessarily result in a reading problem (Vernon, 1957).

A study by Reynolds (1953) found the relationship between hearing acuity and reading to be reduced when allowance was made for intelligence which was correlated with both the auditory and reading test. Caution should be used, however, in interpreting experimental findings which are based on the statistical partialling out of variables such as mental age, auditory memory span and word discrimination.

There is a need to conduct detailed studies of both normal and retarded readers who have certain types of hearing losses. A careful study of individuals may reveal the critical variables which compensate for low hearing acuity, and thereby enable an individual with a hearing loss to function as a normal reader. The age of onset, the severity of the hearing loss and language involvement are only a few of the variables which should be studied with respect to success or failure in reading. Hearing loss may be significantly related to reading only if it has interfered with language acquisition.

Intelligence

There is some evidence that a positive correlation exists between measured intelligence and reading, particularly with younger children (Roebeck, 1964; McDonald, 1964; Lovell, Shapton, and Warren, 1964; Belmond and Birch, 1966). Children who obtain high scores on intelligence tests usually, but not always, learn to read earlier and make greater progress than do children of lesser intelligence. As chronological age increases, there seems to be a decline in the correlations between measured intelligence and reading. Bond and Tinker (1967) also cite studies which show higher correlations between reading and intelligence at the elementary level (0.80 to 0.84) than at the ninth grade level (0.69). The magnitude of the correlation, however, may depend in part upon the content of the intelligence test which is administered.

Luria (1966) cites several case studies which describe how lesions of the frontal lobes can affect understanding of printed tests. The resultant intellectual dysfunction seems to be "* * * an inability to remain within the limits of the selective system of connections, and an inability to inhibit these irrelevant connections." (p. 286)

Rather than study intelligence as a global correlate to reading, it might be more productive to study the individual factors which are thought to constitute intelligence, and try to determine the extent each factor or various combinations of factors are related to reading.

Verbal Ability

Since written or printed language is a graphic reproduction of the spoken language system, many of the same disorders which cause difficulty with spoken language might also be expected to contribute to disorders in reading. A review of the research revealed only one highly speculative report by Burroughs (1912) where a child learned to read prior to the acquisition of a verbal language system. In order to understand the significance of verbal ability as a correlative to reading, it will be necessary to direct research toward those disorders which limit verbal functioning. A more detailed discussion of receptive and expressive disorders of auditory language can be found in chapter 7.

Visual Perception

According to Goldstein (1948), primary reading disturbances are related to the analysis and synthesis of visual stimuli. While damage to the occipital lobes may cause visual disorders which interfere with reading, the resulting behavioral disturbances are varied and complex. Luria (1966), for example, describes several kinds of optic alexias which might occur as a result of occipital lobe damage.

> In cases of literal (printed letters) alexia, the integrated perception of graphemes and the visual differentiation of those of their signs with cue value are so disrupted that either the letters lose their meaning altogether, or their identification becomes highly unstable (p. 426).

The child with literal alexia confuses letters which have similar shapes or outlines. He may be able to recognize printed letters, for example, but if the letter is crossed out or written in an elaborate way, the child is unable to analyze it.

In contrast, individuals with verbal alexia may be able to recognize individual letters, but are unable to recognize whole words. Their word attack system for identifying words consists of putting a word together letter by letter. Difficulty is experienced in identifying familiar as well as unfamiliar words. According to Luria (1966) this disorder is based "* * * on the unique phenomenon of a pathological narrowing of visual perception, in which the capacity of the weakened visual cortex becomes so limited that it can deal with one point of excitation at a time." (p. 427) Another characteristic of verbal alexia is difficulty in selecting elements from a word and in controlling the gaze so the subject remains on the appropriate line.

In the condition of left hemianopsia, the child may not be aware that he has lost the use of the left field of vision and, therefore, makes no attempt to compensate for this loss. In these cases, children completely ignore the left-hand side of the text. If, however, the child has no difficulty reading a word printed vertically, the presence of hemianopsia is confirmed. This disorder is usually associated with lesions of the parieto-occipital or the temporal-parietal-occipital divisions of the brain, particularly when both hemispheres are implicated.

There is a difference of opinion concerning the nature of visual perception and its significance for success in reading. One point of view maintains that visual perceptual skills are specific, while a second point of view believes word perception to be a factor that is quite different from the ability to perceive numbers or geometric figures. The question of whether or not there is a common visual perceptual factor or several factors remains unresolved.

Attempts to study this question are complicated by the fact that the perception of printed words, individual numbers, groups of digits or geometric forms represent different visual perceptual tasks which make slightly different demands upon the processing mechanism for visual stimuli. There is also a difference in

the response required. Perceiving a visual geometric form is typically measured by naming it, drawing it, or finding it. Perceiving a printed word is typically measured by saying the spoken word it represents. There is some evidence that children tend to see visual forms as vague wholes and then in increasing detail. Goins (1958), for example, found that children tend to focus on significant physical aspects of a word more than do adults who have developed perceptual ability for dealing with print and who know how to read.

Tests of visual perception were found to correlate with reading ability (Goins, 1958). Goins found visual closure and perceptual speed or the ability to perceive visual stimuli rapidly to be the most significant factors. It should be noted, however, that a wide range of differences existed between the average ability of the children used in the two schools under investigation. It should be noted that comparatively little information exists with respect to the development of visual perceptual skills. If visual perception is a factor in learning how to read, then failure to develop visual processing abilities by school age could cause difficulty.

A study by Kass (1962) found that children with reading disabilities differed from the normal in certain psycholinguistic abilities. They had greater difficulty: (*a*) reproducing a series of symbols presented visually; (*b*) predicting a whole from a part; (*c*) manually representing a visual image from memory; and (*d*) visually comparing detailed figures rapidly. The research needs for this area are discussed in detail in chapter 3.

Auditory Perception

Difficulty in phonetic analysis and synthesis may result from lesions in the auditory cortex (Luria, 1966). Literate adults with damage to this area of the brain may have no difficulty perceiving or recognizing the meaning of familiar words but will have problems in perceiving or recognizing printed words which are unfamiliar. In other cases, the subject may be able to recognize individual words but is unable to read whole sentences or deal with the phonetic content of the word. The discrepancy between true reading ability and the ability to reorganize a few printed letters or words is one of the characteristics of individuals who have difficulty establishing grapheme-phoneme correspondence because of a dysfunction of the temporal region. A person who is unable to discriminate between simple and complex auditory stimuli, blend sounds or deal with the phonetic values of words will have difficulty utilizing a phonic approach to reading. A more detailed discussion of disorders of auditory stimulus processing may be found in chapter 2.

Kinesthetic Perception

Lesions of the inferior divisions of the postcentral region of the left hemisphere have been found to disturb the kinesthetic organization of motor acts (Luria, 1966). A dysfunction in this area results in either motor aphasia or apraxia of the oral apparatus and interferes with the production of the coordinated motor acts which are necessary for articulated speech. Because the subject has lost his selectivity in innervating lips and tongue, he has to concentrate in order to produce sounds or words. In reading, disturbances which are associated with a defect in the kinesthetic basis of the speech act and the direct recognition of well established words may not be affected, but the true analytic-synthetic process of reading may be impaired.

An impairment in articulating sounds distorts the pronunciation of words and interferes with the auditory analysis and decoding of the complex sequence of sounds which form spoken words. Articulatory problems due to motor aphasia may cause difficulty in reading. Not only is the ability to read aloud likely to be affected, but the reader may experience difficulty in phonic skills as blending letter sounds into syllables. Syllables are read as separate letters because of difficulty in sound blending. With the defects occurring at this level, it is not surprising that children are unable to read whole words. Even when individual letters can be identified, a deficiency in kinesthetic synthesis makes word recognition difficult if not impossible, and many children may guess at word meanings or try to succeed on the basis of individual word fragments. The end result is an interference with phonic word-attack skill. Research needs in kinesthetic processing are discussed in chapter 4.

Memory

The ability to recall or reproduce what has been learned is a necessary behavior in learning how to read. The learner must: (*a*) retain impressions or traces of visual and auditory stimuli; (*b*) make comparisons with past auditory and visual experiences; and (*c*) store and retrieve grapheme-phoneme correspondences. A deficiency in the storage and retrieval process will interfere with or retard progress in reading. A more detailed discussion of memory as a correlate to learning is presented in chapter 6.

Integration of Multiple Stimuli

All approaches used for teaching reading to hearing and seeing children require the visual and auditory

systems to function both semi-independently and in coordination with other systems. The integration of stimuli which are being transmitted through different modalities require the learner to relate information which has been received through one modality to information which has been received through another modality. In learning how to read the printed word "cat," for example, the learner must relate the word-name /kaet/ to the printed word "cat." In learning to use phonic word-attack skills, the learner must associate a set of printed symbols with a larger set of auditory sounds, or graphemephoneme correspondences. These tasks require intersensory integrative processing. A more detailed discussion of integrative processing is presented in chapter 5.

Laterality

There is a large body of research literature which indicates that many inadequate readers are left-handed, or have failed to exhibit a consistent preference in and between hand, foot, and eye (Monroe, 1932; Orton, 1937; Bakwin, 1950; Burt, 1950; Harris, 1957; Vernon, 1957; Zangwill, 1960; Kephart, 1960). In contrast, both Hallgren (1950) and Hermann (1959) failed to find a correlation between poor laterality and low achievement in reading. This situation is confounded by: (*a*) those individuals who seem to have failed to develop cerebral dominance, as reflected in hand, eye, and foot preference but have learned to read; and (*b*) backward readers who appear to have developed cerebral dominance.

There is need to study cerebral dominance as it occurs in combination with other behavioral problems. It may be possible to identify several different syndromes which may have different effects on reading, speech, and language performance. Moreover, there is need to study and analyze the quality or nature of the reading disorders in those individuals who have not exhibited consistency in hand, foot, and eye preference.

Genetic Factors

Hermann (1959) has related reading disabilities to a single factor, "word blindness." He defines word blindness as:

> * * * a defective capacity for acquiring, at a normal time, a proficiency in reading and writing corresponding to normal performance; the deficiency is dependent upon constitutional factors (heredity), is often accompanied by difficulties with other symbols (numbers, musical notation, etc.), it exists in the absence of intellectual defect or of defects of sense organs which might retard the normal accomplishments of these skills, and in the absence of past or present appreciable inhibitory influences in the internal and external environments (pp. 17–18.)

More specifically Hermann identifies the basic condition as an inherited undervelopment of directional function. This "primary" form of reading handicap is distinguished from a "secondary" form of reading disability in which the development of reading ability is hampered by environmental circumstances such as poor teaching, inadequate school attendance, lack of interest, low intelligence, physical and mental illness, and sensory defects.

In reviewing the difficulties in reading and writing in congenital word-blindness Hermann discusses certain "primitive errors" which give the word-blind individual's performance a distinctive character. These errors include rotations (b/d), reversals (calm/clam), and uncertainty over letters and numbers of similar shape.

Hermann (1959) states that it is usually easy to demonstrate the genetic factor. In reviewing materials at the Word-Blind Institute, he found information relating to heredity in more than 90 percent of the cases. In order to investigate this "inherited" defect, Hermann turned to parallel disturbances of function which are found in organic brain disorders. By studying disorders of acquired language such as aphasia, Hermann sought to understand the functions which make up the process of reading and writing. He pointed out the similarity between dyslexia and Gerstmann's Syndrome (disorientation for right and left, finger agnosia, acalculia, and agraphia). Because of the similarities between Gerstmann's Syndrome and dyslexia, Hermann theorized that a fundamental disturbance is common to both, and related to a defect of directional orientation.

The disturbance of the directional function in Gerstmann's Syndrome is related to a failure of lateral orientation with reference to body schema and spatial orientation. This difficulty of orientation has consequences for the ability to operate with symbols such as letters, numbers, and notes. The directional uncertainty is shown by right, left, up-down, backward-forward, confusions, reversals, rotations, and disfigurements of letters.

In Sweden, Hallgren (1950) conducted genetic studies with 276 cases of specific dyslexia. From a genetic-statistical analysis Hallgren concluded that there is a hereditary type of dyslexia. He also indicated that it is difficult to clinically differentiate this hereditary dyslexia from a secondary type. A study by Eustis (1947) suggests that an inherited slow tempo of neuromuscular maturation is a fundamental cause of word-blindness. Drew (1956) found that inherited delayed development of the parietal lobes disturbs Gestalt

recognition of visual patterns and results in word blindness.

In summary, future research in genetics might examine the neurophysiological and biochemical conditions which seem to interfere with reading and which may be transmitted genetically. There is need for family studies including studies of siblings, or fraternal and identical twins who have been reared together or apart. One of the major research questions is: What is transmitted genetically and to what extent are these conditions influenced by environmental factors?

Emotional Factors

There are a number of clinical studies which show a high incidence of emotional problems among clinical cases of disabled readers (Monroe, 1932; Gates, 1936; Witty and Kopel, 1936; Gates, 1941; Robinson, 1946; and Harris, 1961). Introversion, lack of self-confidence, shyness, fear of reading, overdependence upon approval, withdrawal, truancy, tenseness, and obnoxious behaviors have been related to individuals with poor reading ability. Differences in definitions of reading disability, emotional disturbance, age of children, and the source for sample selection may help account for the wide disparity in incidence estimates.

There is need to identify the relationship between reading disorders and emotional disturbance. Under what conditions does an emotional disorder of either functional or organic origin cause reading disabilities? Under what conditions does reading failure result in an emotional disorder? Are most cases those in which the emotional disorder and the reading disorder interact, each intensifying the other (Monroe, 1932; Gates, 1941, Robinson, 1946; Harris, 1961)?

Assessment and Treatment of Reading Failure

In this report, a distinction has been made between the child who has failed, the child who is in the process of failing, and the child who might be expected to fail prior to instruction in reading. Consequently, it seems logical to discuss the assessment and treatment of reading failure under the first two categories and the prediction of reading failure under the third category.

The Child Who Has Failed

Kirk (1962) describes a widely used five-step procedure for diagnosing children who have failed to learn to read: (1) estimating reading potential or capacity; (2) determining reading level; (3) determining behavioral symptoms of faulty reading; (4) analysis of correlated factors; and (5) recommending remedial procedures. This section will summarize the literature under these five steps.

(1) Estimating Reading Potential: Individual intelligence tests which estimate mental age provide both a quantitative and qualitative estimate of a child's presumed capacity or potential for learning to read. Since verbal understanding is closely related to both intelligence and reading capacity, vocabulary tests may provide supplementary information with respect to reading capacity. The use of arithmetic computation tests which do not require reading or verbal understanding often show that a child is capable of learning and that the child's disability is specific to reading (Monroe, 1932; Kirk, 1962). However, this suggests that a person can learn to read with the same degree of competency as he already demonstrates in auditory-vocal language. This suggestion puts much emphasis on language development which is more observable than is the vague term "intelligence."

Estimating how well a person should learn to read is currently based on performance on an individual intelligence test. Since one of the corollaries to reading is auditory-vocal language, an appropriate approach would be to develop procedures to assess language performances more completely.

(2) Determining Reading Level: Traditional methods of assessing reading level have used standardized tests. These standardized achievement tests vary in the kind and amount of reading behavior sampled. Typically, they include sections on word analysis, vocabulary, recognition, comprehension, speed of reading, and study skills (Strang, McCullough, and Traxler, 1961). The standardized achievement test will identify the child who is failing.

Oral reading ability may be assessed by a standardized oral-reading test such as the Gray Oral Reading Tests (Gray, 1963) or an informal reading inventory. According to Chall (1967) some measures of reading performance can be taken only by listening to the child read aloud. On an oral reading test the teacher or examiner notes such aspects of reading as word pronunciation, connected oral reading, letter-sound correspondences, fluency, and expression. It is possible, also, to note the specific reading errors that are made: Reversal of letters, omission of phonemes, addition of phonemes, and substitution of one phoneme for another. Betts (1958) used oral reading performance to determine various reading levels. Basal reading level, independent reading level, and frustration level are based on the child's performance on comprehension and word recognition.

Chall (1967), recently commented on standardized reading tests.

> I found, however, that most teachers and principals have little faith in the standardized tests now given periodically in every school. The results of these tests are not used, as they might be, as a basis for instruction and for decisions on methods and materials. Further, the standardized reading tests often mask some of the important outcomes of reading instruction because they measure a conglomerate of skills and abilities at the same time (p. 312).

What are standardized reading tests like? They can be analyzed according to the stimulus-processing model used in this report. Most reading tests administered to groups of children present various units of visual stimuli. These units can be letters, words, phrases, sentences, or paragraphs. The typical response required is that of marking another word or words chosen from several alternatives. Only a meager analysis of errors can then be performed because of a limited observation of a limited set of performances. According to Chall (1967):

> The teacher needs simple diagnostic tests, while the researcher needs more complex ones * * *. We also need tests that provide absolute measurements—that tell us how much of each component of reading a child has mastered at a given time. Such tests can also tell us how well 8-year-old children, say, are doing in 1965 as compared with 8-year-olds in 1975, thus avoiding the periodic accusation that too many Johnnies can't read (p. 313).

(3) Determining the Behavioral Symptoms of Faulty Reading: An important part of the diagnostic process is to observe the child during the reading act and analyze the child's reading process. How does he attack unfamiliar words? How does he blend sounds? Does he use contextual cues? Does he read slowly, word by word? Does he understand what he has read? Are there reversal errors? Which words and sounds are omitted, added or distorted? Can he read silently? Observation of the reading process combined with a detailed error analysis will provide a symptomatic behavioral description of the reading problem and give directions for further analysis of those factors which might be associated with the problem.

Reading diagnosticians often employ the Informal Reading Inventory (IRI) which is intended to permit an estimation of the child's reading at three performance levels so as to determine the grade level at which instruction should begin (Betts, 1950). Recently, the criteria for determining the "independent, instructional, and frustration" levels has been questioned. Powell (1968) suggests that a reevaluation of the fundamental assumptions underlying informal reading inventories should be made. Research is needed for performances on reading tasks which will result in tests that specify the terminal behavior and the subperformances involved in acquiring reading proficiency.

(4) Analysis of Correlated Factors: The fourth step of the diagnostic process is to determine why the child has failed to learn how to read. Assuming the child has had adequate instruction, the first correlates which should be examined are medical problems including sensory deficiencies and intellectual retardation. If a severe emotional disturbance is present, it may be necessary to deal with the emotional and behavioral disorder before a major effort can be made with reading activities.

Furthermore, central processing functions underlie both reading and language. Dysfunctions in the analysis and synthesis of auditory, visual and haptic information, which may be accompanied by memory and integrative dysfunctions, will affect the acquisition of prerequisites to reading. Perhaps these prerequisite correlates can be considered as determining the basic potential for reading. Future research is needed to develop specific tests and procedures for measuring perceptual problems as they specifically relate to reading tasks. It is necessary, also, for the medical profession to improve and develop techniques for examining biochemical functioning, neurophysiological disorders and genetic factors. There is need for educators to improve procedures for systematic screening, referral, and diagnosis of these problems. At present, many teachers and physicians may be aware of the existence of these correlates, but have few concrete alternatives for identification, referral, or treatment.

(5) Recommending Remedial Procedures: The final step in the diagnostic process is to prescribe specific remedial or treatment procedures. These should be based on the child's estimated capacity, behavorial symptoms, and suspected cause or causes of this problem. Such recommendations should include methods, materials, and sequence of tasks in which the child is to become competent.

Research on the efficacy of assessment methods should follow guidelines for good research design such as control over the situation, allowance for such possible confounding factors as age, sex, teacher bias, and Hawthorne effect (Campbell and Stanley, 1963).

The five-step procedure for diagnosing severe reading disabilities presents five interrelated problem areas in which research should be conducted. There is need to develop more precise procedures, methods, and equipment with which to conduct a thorough differential diagnosis.

What intervention procedures are available for children who have failed to learn how to read? The educator has developed three basic approaches to the teaching of reading: Developmental reading, corrective reading, and remedial reading.

A common approach to teaching children who have failed is to give them increased attention by placing them in a smaller group or working with them on an individual basis. In these cases, children often receive "more of the same" developmental approach under which they have already failed. The efficacy of the "more of the same" approach is questionable.

A second approach to teaching the child who has failed is corrective intervention. Corrective procedures often individualize the regular reading program by using a different developmental approach in an individual or tutorial situation. They frequently utilize the child's assets and interest areas and are often erroneously called remediation. An auditory approach to reading might be recommended for a child who has not learned to read through a visual whole-word approach. What often happens is that a basal reader is selected which employs the opposite assumptions about the reading process. Historically, this suggests that reading teachers were using one method, while reading clinicians tend to "gravitate" toward the opposite method. Since some children seem to improve under different reading systems, much of the research has tended to support the use of an "opposite" approach.

Because many of the corrective approaches to reading were not successful in teaching reading to children who had failed, remedial procedures were devised for ameliorating the psychological deficits thought to underlie poor reading. Remedial approaches are intended to remedy or ameliorate the underlying factor or factors which are contributing to the problem. While this approach may utilize the child's assets, the deficient areas are the target of instruction. If a child has poor auditory memory or visual discrimination, for example, a remedial approach might include procedures designed to improve these areas.

No remedial method was found which emphasized the acquisition of sight vocabulary alone. While most methods include some phonic work, there are those methods which emphasize the visual aspects of reading by having the child focus on the whole word. This is sometimes called the "look-say" method because the child is required to look at the word and say it until he can recognize the word at sight. Attention is usually called to such aspects of the word as length and shape. Gray (1960) proposed the teaching of the whole word followed by a phonic analysis of sound-letter correspondences. However, no provision was made for the direct learning of sound values of letters or sound blending. Kirk (1940) also recommended that the child acquire a basic sight vocabulary before phonic instruction is initiated.

The approaches which emphasize phonics are primarily concerned with teaching the child a procedure for "decoding" written language. Systematic instruction in grapheme-phoneme correspondences, blending, and rhyming provide the child with a method of word attack. These skills make it possible to determine the pronunciation of an unknown visual word. Although comprehension is not ignored in most remedial programs, the emphasis of phonic work is on analysis of the spoken form of the printed word apart from its meaning.

One of the earlier attempts to employ a systematic method of word attack was espoused by Monroe (1932) who stressed the use of synthetic phonics, pointing with fingers, and saying the words in working with poor readers. Her rationale for stressing observable motor movements was that: (*a*) such a response is more easily observed by the teacher and child; (*b*) they are probably part of the normal reading process; and (*c*) such responses may assist in discrimination and attention. Monroe noted that typically the overt motor responses gradually disappeared except when the child was confronted with an unfamiliar word. At that time the child would employ his overt attack on that word. Orton (1937) also recommended a systematic phonics approach to remedial reading which stressed overt motor activities such as tracing, copying, and writing.

Another phonic method of remedial reading is that developed by Hegge, Kirk, and Kirk (1940). Their remedial reading drills begin by teaching or reviewing the sounds of the short vowel "a" and most of the consonants. Sound blending is also taught. The authors recommend the use of a grapho-vocal method in which the child writes a letter or word from memory and says the sound of the letter or word at the same time.

English does not have a consistently written and phonetic language; that is, one letter does not stand for one and only one sound (phoneme), nor is one phoneme represented by one and only one letter or set of letters (grapheme). Consequently, the phonic approach to reading sometimes causes confusion. The difficulties posed to the beginning reader are supposedly made easier if the auditory-visual correspondences are one-for-one. To this end, various systems of

notation have been devised to be used in conjunction with the English alphabet as it is commonly printed.

The initial teaching alphabet (i.t.a.) is one modified alphabet scheme being offered as a reform in beginning reading. A study by Downing (1962) showed i.t.a. trained children tested better on oral word recognition than children using traditional orthography. Later studies (Downing, 1964a and 1964b) indicated that most i.t.a. trained children have little difficulty transferring to the traditional orthography. Because of weaknesses in Downing's studies, inadequate information about the subject tested, and confusion in reporting, his results cannot be taken as conclusive. Also, there is some indication that a small number of children experienced much difficulty in transferring to the traditional system (Downing, 1964b).

Other attempts to simplify the inconsistent auditory-visual correspondences of English have been concerned with color coding. In a phonic system employing color, a difference in color is used to indicate differences in sounds. Gillingham and Stillman (1940) and Norrie (1959) use different colors to identify vowels and consonants. A further classification employed by Norrie involves different colors to signal voiced and unvoiced consonants. Gattegno and Hinman (1966) and Bannatyne (1966) use color coding to further differentiate the various graphemes used to represent phonemes.

The integrated multisensory approaches have several strengths. It is often difficult to identify the cause of failure in reading; thus, a procedure which uses several input channels may be effective. Furthermore, these methods tend to stress word-attack systems while basal readers often rely on comprehension. They also frequently use color, motor, or kinesthetic cues to supplement the usual visual and auditory cues. Monroe (1932), Orton (1937), and Fernald (1943) all emphasized the use of haptic cues by tracing letters and writing letters in their remedial strategies.

Gillingham and Stillman (1940) accept the theory of incomplete cerebral dominance as a factor in the letter reversal so commonly seen in some poor readers and developed remedial methods for reading and spelling based on the systematic development of increasingly complex phonetic units. This method attempts to establish associations between visual, auditory, and kinesthetic records or memory traces within the child. At first, Gillingham presents one letter at a time and has the child learn one and only one visual-auditory association, either letter-sound or letter-name. Later, the child will learn multiple associations, for example, the sounds represented by the letter *c:* /k/ and /s/.

Fernald (1943) combined the visual emphasis with kinesthetic activity and vocalization. Her method consisted of four stages: (1) the child traces the letters of the word with his finger, saying each part aloud and then attempting to write it; (2) he learns a new word by looking at it, saying it, writing the word while saying it; (3) the child looks at a new word, says it once or twice and writes the word without saying it; (4) the child generalizes from words he knows to new words and can say the words without writing them.

While the integrated remedial or corrective procedures have many strengths and are often successful, they have several weaknesses. They usually do not identify the type of reading problem for which their method is appropriate. The teacher may choose a method for a particular behavioral symptom; but the method may be inappropriate because several different causes may create the same symptom. Many of these methods do not get at the basic physical and psychological correlates which are involved. For example, a child may be limited to a purely visual approach because his auditory skills in auditory memory, discrimination, and sequentialization may be inadequate and seem to prohibit a phonic approach. It is possible, therefore, that no attempt will be made to ameliorate these weaknesses.

Some corrective or remedial reading methods tend to accept the theory that a child who is deficient in one channel should be taught to read by those procedures which emphasize his strong channel. For example, a child with poor visual ability would be taught to read by an auditory method while a child with poor auditory ability would be taught to read by a visual method. Johnson and Myklebust (1967) accept this principle when they say, "The visual dyslexic * * * cannot retain the visual image of a whole word and consequently needs a more phonetic or elementary approach to reading" (p. 156). They have found that the most successful remedial approach with this kind of dyslexic child is that described by Gillingham and Stillman (1940). Isolated sounds are taught, then they are blended into meaningful words. On the other hand, the auditory dyslexic has difficulty in relating the temporal sequence to a visual-spatial sequence (Johnson and Myklebust, 1967). Problems in the auditory area may result in an inability to learn through the phonic approach. Therefore, they recommend a whole-word approach including tactile and kinesthetic methods. Training is initiated in visual memory and sequentialization. General form and configuration discriminations are trained by various matching activities. Training in perception of detail and orientation of

letters is also included. While Johnson and Myklebust (1967) tend to emphasize teaching through the strong channel, they also make recommendations for strengthening the weak channels. Silver, Hagin, and Hersh (1967) reported that boys gained in reading from a program of perceptual training in deficit areas. For purposes of remediation, however, it is necessary to go beyond the superficial visual aspects of reading, identify the correlates which are contributing to failure in reading, and intervene with the most appropriate remedial procedures.

The Child Who Is Beginning To Fail

At present, there are no systematic procedures for identifying the child who is beginning to fail in reading. The usual sequence of events begins with the child experiencing difficulty in the early reading tasks. Because a certain amount of difficulty is expected of most students who are beginning to read, the errors made by the child who is beginning to fail may not attract undue attention. As times passes, however, most of the class acquires increased proficiency in reading skills. Meanwhile, the child who is beginning to fail may be acquiring these skills at an abnormally slow rate or not at all. Teachers sometimes explain the child's retardation in reading as temporary. The child is sometimes called a "late bloomer" and many classroom teachers believe that they can teach the child with a little "extra work and individualized attention." For some children this is all that is needed. The occasional successes teachers experience with such children serve as intermittent reinforcement and help maintain continued attempts to assist the child through "extra help" programs. In cases where central processing dysfunctions are involved, however, a tutorial program with emphasis on word recognition or word meaning may not be successful.

As the child who is beginning to fail continues to fall behind, skill by skill, page by page, book by book, it becomes obvious that "extra help" is not a sufficient condition to alter the pattern. When this happens, the child is no longer beginning to fail. He has failed.

At present, the alert teacher classifies good readers and poor readers by observing their reading performance and placing them in appropriate reading groups. There is need, however, to develop systematic procedures for teachers to use for measuring progress so that they can more readily identify the child who is beginning to fail. Checklists consisting of detailed steps for progress under each reading task may help teachers objectify children's progress and to identify as quickly as possible the children who are beginning to fail. Such a checklist will help the teacher make judgments about the behavioral symptoms of failure so the most appropriate intervention procedures may be introduced at the earliest possible time.

There is need to develop techniques which will help maintain the children's interest in reading during the period of early failure. Della-Piana (1968), for example, presents techniques which have been successfully employed: use of content in child's area of interest (Harris, 1961); use of materials concerning human values (Crosby, 1965); use of child's personal experiences (Moss, 1961); use of rewards (Clark and Walberg, 1966); making a pleasurable activity contingent upon the performance of a less pleasurable activity (Premack, 1959, 1962, 1965; Addison and Homme, 1966); making a systematic presentation of the desirable reward of the student's choice contingent upon good performance (Della-Piana, Stahmann, and Allen, 1968).

Predicting and Preventing Failure in Reading

Educators and researchers are becoming increasingly aware of the need for methods of assessment which will lead to early identification of children who run a high risk of reading difficulty. Early identification should lead to the establishment of programs and instructional procedures which will hopefully prevent reading disabilities.

Parents and pediatricians often can provide information which may help identify preschool children who, after they enter school, may fail in reading. Indications such as late attainment of developmental milestones such as lifting and turning the head, visual tracking, crawling, walking, understanding, and using spoken language may help identify high-risk children prior to their entry into school (Shirley, 1931, 1933). The kindergarten provides another means of studying children's behavior in different learning situations. There is need, however, to identify the psychological correlates to beginning reading and to develop procedures for early assessment. The research which has been done on reading readiness, however, provides some information with respect to these correlates. This section will review the research which is related to the concept of reading readiness and the development of readiness tests.

The Concept of Reading Readiness: The concept of reading readiness has a variety of meanings. It is viewed by some as the chronological age necessary for the child to learn how to read. For others, readiness for reading consists of a complex combination of social, emotional, mental, and psychological factors. There are a number of research studies which have been conducted to identify the factors involved in

reading readiness. Most of these studies have attempted to identify the correlates to reading readiness by comparing the characteristics of good and poor readers after a period of instruction.

Russell (1961), for example, found that reading readiness is dependent upon four general factors: Physical, mental, social-emotional, and psychological. Other research studies have attempted to isolate more specific correlates which would be of value to educators in planning reading readiness programs. A study by Karlin (1957) was conducted to ascertain whether certain measures of physical growth were related to success in beginning reading. This study showed that the measures of physical maturation had little correlation to reading readiness test scores, but that the reading readiness test scores were related to skeletal development. Carroll (1948) found that learning facility in the preparatory period for reading was affected by sex differences in favor of girls.

Bond and Wagner (1961) state that the degree and extent to which speech defects cause difficulty in learning to read is uncertain. However, if the reading method emphasizes phonic instruction and oral reading, the child with a speech problem might experience difficulty in learning how to read. Maddox (1957) found a correlation to exist between reading readiness and the ability to produce consonant sounds. Children with articulation errors had low scores on readiness tests; older children made fewer articulation errors; girls had acquired more consonants than had boys; and the higher the IQ score, the fewer the articulation errors.

Factors such as emotional adjustment, auditory readiness, physical condition, and the time which reading instruction should begin, were identified by Williams (1958). A study by Natale (1959) found that intelligence, giving opposites to vocabulary words, memory span, and word discrimination were related to reading readiness. Intelligence test results and readiness test results were identified by Stephey (1957) as valuable criteria for teacher use in determining reading readiness. McMillan (1960) also found positive relationships between intelligence and reading readiness, between intelligence and use of context; and among intelligence, use of context, and auditory discrimination.

Probably one of the most comprehensive studies of the correlates of readiness has been done at the Gesell Institute. Ilg and Ames (1965) provide an extensive list of developmental behavior tests to aid in determining a child's readiness for school.

In summary, lists of factors thought to be related to reading readiness have been generated by comparing certain characteristics of good and poor readers. These lists include such factors as: Physical growth, speech defects, sex differences, visual and auditory discrimination, chronological age, intelligence, emotional adjustment, physical condition, abilities required for completing vocabulary opposites, memory span, word discrimination, and use of context. Because most of these lists are long and cumbersome, it is difficult to use them for assessment purposes. The extent to which these variables are interrelated and contribute either singly or in combination to reading disorders is not clear. Finally one might raise the question: Are the correlates for reading readiness the same for each child in light of individual differences, both strengths and weaknesses?

Both Gagné (1962a, 1962b) and Ausubel (1963) present an alternative approach for identifying the correlates to reading readiness. Gagné hypothesizes that no individual can perform a final task such as reading without having the subordinate capabilities or appropriate learning sets already established. Thus, by analyzing the reading task itself, identifying and rank ordering the component tasks in their proper sequence, it may be possible to identify the correlates to reading readiness.

Ausubel (1963) defines readiness as "* * * the adequacy of existing cognitive equipment or capacity at a given age level for coping with the demands of a specified cognitive task." (p. 29) Ausubel differentiates between readiness and the concept of maturation which is often equated with a process of "internal ripening" and has a more restricted meaning than readiness. Maturation is merely one of the two principal factors, maturation and learning, that contribute to the child's readiness to cope with new experiences. Unfortunately, Ausubel does not specify the components necessary for reading readiness beyond his two general categories. Ausubel comments on the serious dearth of research in the cognitive aspects of readiness which he obviously considers to be so crucial.

Rather than study the characteristics of good and poor readers, a more productive approach to the assessment and identification of the correlates to reading is to focus attention on the reading task itself and the processes by which this task is accomplished. Future research should concern itself with this issue.

Chall (1967), in reviewing 40 years' work reported by test authors and researchers, concludes that the concept of readiness for reading is largely determined by the definition of beginning reading. Those persons

using a complex definition of beginning reading (getting the meaning) tend to have a larger conception of readiness, concerning the "whole child" and favor a later start in learning to read. Those who define beginning reading as learning to translate a visual code for an auditory code favor an earlier start and have a more specific conception of readiness. Most code-emphasis persons consider readiness training as learning to identify and name the letters.

The Development of Reading Readiness Tests: One method used to predict future success or failure in reading is the reading readiness test. Since concepts of readiness for reading are largely determined by definitions of beginning reading (Chall, 1967), a variety of readiness tests have been developed. Those who define beginning reading as learning to decode a visual code of graphic letters for an auditory code of language signals are interested in the child's ability to identify and name letters. More general tests of readiness such as the Metropolitan Readiness Tests (Hildreth and Griffiths, 1949) sample a larger but less clearly defined set of behaviors. Nevertheless, general readiness tests have been found to predict success and failure in beginning reading. Some published basal reading series include their own tests of reading readiness. These tests have the advantage of being predictive of success in learning to read by the method to which the child will be be exposed. However, according to Chall et al. (1965), existing tests do not lend themselves easily to educational planning.

Various researchers have attempted to isolate the factors underlying the reading process and use these factors in development of tests which will predict reading success or failure. The factors often used are auditory discrimination, visual discrimination, language ability, perceptual-motor performance, and self-concept or personality factors. These tests are usually designed to be given in kindergarten or early first grade before reading instruction has been initiated.

Wepman (1960) found that auditory discrimination was correlated with early reading scores. With intelligence held constant, some 27 percent of 80 children in the first grade showed inadequate auditory discrimination and reading scores significantly below the reading level of the children with adequate auditory discrimination.

Although many researchers agree that visual discrimination is predictive of success in reading there is considerable disagreement on what kind of visual discrimination is most predictive. Smith (1928), Wilson (1942), and Gavel (1958) contend visual discrimination of letters is most predictive. Gates, Bond, and Russell (1939) favor visual discrimination of words, while Potter (1949) used shape matching, and Goins (1958) used four tests of visual perception of geometric figures and pictures. Barrett (1965) tested the predictive value of nine readiness factors, seven of them involving visual discrimination. He found the Gates Reading Letters and Numbers Test, the Pattern Copying Test, and the Gates Word Matching Test to be strongly predictive of reading achievement as measured later on the Gates Primary Paragraph Reading Test (Gates, 1958). However, Barrett (1965) concluded that the visual discrimination tests should not be used alone but in combination with other measures and observations. Smith and Keogh (1962) support the predictive value of a pattern copying test as they concluded that a group version of the Bender Gestalt Test was an effective screening device.

Several attempts have been made to predict reading success by assessing personality factors. Using a battery of psychological tests, teacher observations, and a play therapy session, Cohen (1963) determined the child's level of anxiety and depression in various situations. He found that excessive anxiety in a low ability child was predictive of failure while moderate anxiety in a child of average ability sometimes led to overachievement. He also found that the kindergarten teachers had a high degree of accuracy in prediction. Wattenberg and Clifford (1964) measured two aspects of kindergarten children's self-concepts: feelings of competence and feelings of personal worth. These measures were obtained from an analysis of tape recordings of each child's utterances while drawing pictures of his family, and his responses to an incomplete sentence test. They found self-concept to be significantly predictive of progress in reading.

Because of the large number of factors involved in reading, some researchers have developed tests which measure skills in several areas. Weiner and Feldman (1950) included language, perceptual discrimination, and beginning reading skills. Their Reading Prognosis Test had subtests of word meaning, story telling, visual similarities, visual discrimination, auditory discrimination, small letter recognition, capital letter recognition, and sight vocabulary. Preliminary validation studies showed that scores on the Reading Prognosis Test were highly correlated with those on the Gates Primary Word Reading Test of 1958.

DeHirsch, Jansky, and Langford (1966) who now view failure in reading as part of a more comprehensive language problem, contend that deviations in perceptuo-motor and behavioral organization underlie difficulty in the decoding and encoding of verbal sym-

bols, delayed speech, and disorganization of written and spoken language. They attempted to determine "whether a distinct and identifiable pattern of perceptuo-motor and oral language deficits at preschool age is predictive of difficulties with visual language * * * in subsequent years." (p. xv)

DeHirsch et al. administered 37 tests of perceptuo-motor and language ability to kindergarten children. Ten of these tests were found to be predictive: Pencil Use, Bender Visuo-Motor Gestalt, Wepman Auditory Discrimination, Number of Words Used in a Story, Categories, Horst Reversals, Gates Word-Matching Subtests, Word Recognition I and II, and Word Reproduction. The authors found that this battery of tests identified 10 of the 11 children who failed in reading on the second grade testing. Five of the 10 tests involved printed words. One of the advantages of a diagnostic test like the Predictive Index is that it suggests specific areas for prevention and remediation as well as being predictive. It can be concluded that the more the proposed predictor task resembles the criterion task, in standard reading tests, the better the proposed task will predict. Of the remaining five tests, two involved visual-manipulative activities and the remaining three required some type of verbal response.

In comparing the predictive ability of the revised Stanford-Binet Intelligence Scale and the Illinois Test of Psycholinguistic Abilities, Hirshoren (1969) found the Visual-Motor Sequential subtest had predictive ability for school achievement as measured by the California Achievement Test.

As the status of knowledge is increased with respect to the factors which constitute reading readiness, it will be possible to develop even more effective assessment instruments. The identification of the correlates of reading at an early age and the development of measurement procedures appears to be a promising area for future interdisciplinary investigation. Armed with this information, it should be possible to develop intervention techniques which will ameliorate these correlates or help children compensate for their deficits.

Preventive Training: Instructional programs designed to prevent failure in reading should probably be directed toward the remediation of deficits in reading readiness. It is somewhat difficult to plan an instructional program because the correlates to reading readiness are not always clearly identified and are sometimes difficult to measure. Often it is not known how deficient a correlate must be before there is an effect on reading. In order to remediate the deficiencies in the high-risk child, it will be necessary for the schools to operate preschool programs with special emphasis on readiness activities. Different types of programs should be studied to determine the efficacy of various methods.

Directions for Future Research

For the purposes of this report, reading has been analyzed as a series of acts for obtaining meaning from graphic symbols. Also, a distinction has been made between the child who has failed, the child who is beginning to fail, and the child who might be expected to fail in reading even before he goes to school and receives instruction in reading. There are several major areas in which research is needed.

The Graphic Code

Research in reading is needed concerning the language code itself, the characteristics and abilities of the person learning the code, the measurement of these characteristics and abilities, and the efficacy of various remedial methods. Linguists have done a fairly good job of analyzing language but there is need for research on the significance of all the fundamentals of the graphic language code. It is known that shape and directional orientation are crucial discriminative aspects of a letter while size is not. Future research should study the learning of graphic shapes of individual alphabet letters and nonalphabetic signs; the space-direction sequence and English spelling patterns.

Task Analysis of the Reading Act

Research on reading and reading failure should proceed from an analysis of the reading act along two dimensions: time phases and tasks. The time phases are the prereading, beginning to read, and advanced reading stages through which children must pass if they are to become practiced, efficient readers of the graphic language code. The main task is breaking the graphic language code. The subtasks are automatically recognizing the units of graphic language, combining those units into their corresponding auditory language signals, adding those elements of auditory language not found in the graphic language code, and relating past experiences to that which has been read and adding to the store of one's knowledge by reading new information.

Analysis of the reading act into component and possibly hierarchical tasks will produce a checklist of observable behaviors found necessary to perform the reading act. Research can help determine: (*a*) the amount of practice necessary to attain competence in each component; (*b*) the alternate methods of presenting the tasks to children who differ in their initial behavioral repetoire; (*c*) the selection of approaches

to beginning reading; and (*d*) the decisionmaking process for selecting the remedial method on the basis of critical characteristics of failing readers.

Correlates to Reading Failure

Present research indicates that visual and auditory acuity, intelligence, verbal ability, visual, auditory and kinesthetic perception, integration, laterality, biochemical functioning, genetic factors, and emotional factors are related to reading failures. In each case the exact nature of the relationship is not clear. Attempts to demonstrate the correlations between these variables and reading failure have had conflicting results. There is need to determine the extent to which a deficiency in any area affects the acquisition of reading skill as well as determining the results of various combinations of deficiencies. With respect to sensory acuity, it is necessary to study specific visual conditions and the degree of severity necessary to disrupt or interfere with the reading process. In the case of a hearing loss, such variables as age of onset, severity of the loss, and the language involvement should be studied with respect to success or failure in reading. Other critical variables related to loss of hearing need to be identified.

Research is needed to determine whether each identified correlate to reading is composed of one or several factors. Intelligence, for example, has usually been treated globally with respect to reading but it might be more productive to study the individual factors thought to constitute "intelligence" and try to determine the extent to which each factor or various combinations of factors are related to reading. Verbal ability, for example, has been found to be related to intelligence, and is thought to have significance for reading. Basic research should be directed toward disorders which limit verbal functioning. There is also a question of whether there is one common visual-perception factor or several separate factors. Visual processing is difficult to study because each different visual task makes slightly different demands upon the processing mechanism for visual stimuli. Research is needed, also, to describe the development of visual perceptual skills.

Several theories have tried to link cerebral dominance to the difficulty in learning to read. There is need to study cerebral dominance as it occurs in combination with other behavioral problems. Syndromes which may have different effects on reading, speech, and language should be identified. Also, there is need to analyze the exact nature of reading disorders in individuals who do not exhibit consistency in hand, foot, and eye preference.

At present, there is little evidence concerning biochemical functioning as a correlate to learning disorders. However, this area may be a productive avenue for future research. Future work in genetics might examine the neurophysiological and biochemical conditions which seem to interfere with reading and which may be transmitted genetically. Studies should include siblings, or fraternal and identical twins who have been reared together or apart. There is need to determine just what is transmitted genetically and to what extent these conditions are influenced by environmental factors.

Confusion exists over the relationship between reading disorders and emotional disturbance. Research is needed to identify the conditions under which emotional disorders cause a reading problem and the conditions under which a reading problem creates an emotional problem. If emotional disorders and reading disorders interact, each intensifying the other, it is necessary to define the nature of this interaction.

There is need to determine if the correlates to readiness and the correlates to reading are the same and if the correlates to reading readiness are the same for each child. Although some of the motoric correlates to reading readiness have been identified, there is a lack of research on the cognitive aspects of readiness.

In addition to studies concerned with the language code and the neurophysiological correlates to reading, research is needed to develop procedures for measurement and remediation. Better methods of assessment are needed for each of the correlates to reading. Procedures need to be developed for assessing language performance more completely. Tests are needed to measure perceptual problems as they specifically relate to reading tasks. Although teachers and physicians may be aware of the existence of correlates, there are few alternatives for identification, referral, or treatment. Thus, it is necessary for the medical profession to develop techniques for examining biochemical functioning, neurophysiological disorders, and genetic factors, while educators need to improve procedures for systematic screening, referral, and diagnosis of these problems.

Diagnostic and Remediation Procedures

The need for procedures leading to early identification and diagnosis is especially crucial. The identification of correlates to reading at an early age and the development of procedures for measuring these correlates appear to be promising areas for future interdisciplinary investigation. The identification of correlates to reading and the development of assessment

procedures should lead to remedial programs which include training in specific correlates and the reading process itself. Special attention should be given to develop programs designed to improve a child's readiness to read. Furthermore, there is need to develop techniques which will help maintain the child's involvement in reading during a period of early failure. The efficacy of various assessment and remedial methods should be studied. Testing of procedures for training the correlates should include the effect of training versus no training and the effect of instruction in the reading process in conjunction with specific remedial measures for particular correlates.

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