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REPORT OF THE FIFTH RESEARCH PLANNING CONFERENCE HELD UNDER THE AUSPICES OF PROJECT LITERACY, IN NEW YORK, NEW YORK, DECEMBER 10-12, 1965--PROJECT LITERACY REPORTS, NO. 6.

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PROVIDED IN THIS REPORT ARE COMPLETE TEXTS OF THE PAPERS PRESENTED AT THE FIFTH RESEARCH PLANNING CONFERENCE OF "PROJECT LITERACY." THE CENTRAL THEME OF EACH PAPER IS BASIC RESEARCH AND/OR CURRICULUM DEVELOPMENT IN AREAS OF EDUCATION RELEVANT TO THE ACQUISITION OF READING SKILLS. TITLES OF THE SEVEN PAPERS PRESENTED ARE (1) "IN SEARCH OF CENTRAL NERVOUS SYSTEM (CNS) CORRELATES OF READING SKILLS AND DISABILITIES," (2) "HOW TO READ WITHOUT LISTENING," (3) "PERSONALITY AND COGNITIVE GROWTH," (4) "A PRELIMINARY OUTLINE OF RESEARCH ON PERCEPTUAL CORRELATES OF THE IMPULSIVITY-REFLECTIVITY DIMENSION," (5) "THREE APPROACHES TO THE PROBLEM OF UNDERSTANDING LANGUAGE DEVELOPMENT," (6) "PROJECTED ACTIVITIES," AND (7) "SOME NOTES ON LEARNING TO READ AND LEARNING TO SPEAK." (JH)

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CONTENTS

In Search of CNS Correlates of Reading Skills and Disabilities

E. H. Lenneberg

Harvard Medical School

I would like to present here some of the findings of reading disabilities that are acquired due to cerebral lesions. I believe that a description of the symptoms and a few considerations about the possible cause of these disorders may very well lead to hypotheses concerning the underlying mechanism of reading and thereby to a new type of experiment that might be relevant to both Project Literacy as well as to a general theory on how the nervous system works.

I. Description of Symptoms.

In the severest of cases patients are unable to recognize visually presented letters and are not able to read any words or sentences Even in these cases one sees occasionally a patient who may be able to recognize a letter when it is drawn with the fingernail on his bare back or into the palm of his hand. Thus, he has not lost the ability to synthesize the individual points stimulated on his skin; he can still recognize the pattern through the tactual modality. It is primarily the processing of visual data that is specifically difficult for such a patient. In less severe cases patients may be able to identify visually presented letters or even short words, say up to three or even four letters, but the reading of words that entail longer sequences and thereby tax some sort of storage capacity cannot be achieved any more.

Sometimes it is said that such a patient has lost the general ability for dealing with symbols and this condition is given a clinical name: asymbolia. An even more fanciful name is given to a congenital reading disability, namely, strephosymbolia, which means twisted symbols. I am very skeptical about either of these concepts. They imply that a specific disability exists that wipes out or generally interferes with man's capacity for recognizing or manipulating symbols. I find this to be very unlikely because I have never yet seen a patient with an acquired or even a congenital reading disability who could not readily recognize the outlines of stars, recognize the meaning of an arrow, understand the significance of a Valentine, or comprehend a short story told in stick figures. In each of these instances the graphic representation is entirely symbolic and lacks all realistic aspects of anything one might encounter in the physical environment. Thus there is always "symbolia" and I find no evidence whatever that this general facility for dealing with symbols can be specifically abolished by well placed lesions.

II. Clinico-Pathological Correlations

We need not go into any great detail here. The material has recently been reviewed by Hecaen (1964) and his graphs tell the story eloquently. Some degree of dyslexia is very common in the presence of general aphasic symptoms. The only exceptions are very mild expressive disorders. Further, dyslexia becomes a predominating factor in the clinical picture in patients who have lesions on the left inferior surface of the temporal lobe, particularly lesions that are large enough to extend into the occipital lobe, that leave in their wake a clinical picture in which dyslexia exceeds dysgraphia.

III. The Meaning of Cortical Maps and Connections

From these clinical data it is quite clear that reading may be interfered with by fairly specific lesions. This poses the question of the meaning of cortical location with respect to reading and writing. Would it be legitimate to say that we have a reading center in the inferotemporal lobe?

Man is a difficult subject for neurophysiological investigations. Our best insight about the nature of cortical projection with regard to behavioral function comes, naturally, from animal experiments in which surgical lesions have been carefully placed and controlled observations can be performed. Now this type of research gives us a picture that is very difficult to interpret.

Our knowledge of the function of the cerebral cortex comes from methods in which the cortical surface is destroyed experimentally, or is electrically stimulated, or from electrical recordings from the exposed cortex, or from the more recent technique of neuronography.

When we make a cortical lesion we destroy millions of cells and the method is about as precise as if we took a sledge hammer and banged it into a high speed electronic computer in order to study the subsequent behavior disorders.

The electrophysiological studies are more promising. As you know it is possible to elicit behavior by cortical stimulation. For instance, with properly placed electrodes deep in the brain one may cause certain lower vertebrates such as chickens (but also mammals) to go through highly complex and well-integrated action patterns. Chickens may go through the movements of roosting, or of attacking, or of pecking, etc. The cat may crouch down to the floor, retract its ears, show its teeth and eventually hiss or meow. During the normal activation of such behavior patterns, that is, in the absence of electrical and artifical stimulation, we must assume that highly complex and rather specific patterns of neuronal discharge and firing take place. When we stimulate the cortex, however, we just pass an electric current that spreads out through the electrotonic field and it is unthinkable that we happen to be replicating the exact neuronal firing pattern that takes place naturally during activities. The only possible explanation for the eliciting of complex patterns by such gross methods as electrical brain stimulation is that of triggering action. Apparently it is possible to stimulate certain structures which then release a chain of reactions which runs off by itself in a fixed and prescribed order and thus elicits the behavior observed. In general then, our methods are still very crude and by themselves do not entitle us to make very precise inferences.

In general, there is good evidence that no behavior is ever located in just a small colony of cells, neither in deep cerebral structures nor in the cortex. Several neuroanatomists have shown that, for instance, the interference with behavior patterns that can be produced by cortical lesions may also be replicated by lesions deeper in the brain. In fact, the homunculus of Penfield which is so widely known and which is drawn on the cortex of every brain shown in psychological textbooks has recently been shown by Hassler (1962) to be very well duplicated in thalamic structures in the midbrain and there are even indications that similar homunculi exist in the cerebellum and perhaps in other structures. It appears that behavior may be interfered with optimally from certain points but the same behavior may be equally well interfered with from other points thus indicating that behavior is actually a function that involves wide parts and structures of the brain and is never lodged within given cells or areas of cells. We must, therefore, look at properties, or possible properties, of cerebral functions that make and or break the elaboration of behavior rather than to look for centers, and I should like to propose that one such property of cerebral function has to do with the processing in time, the translation of perceived patterns into temporal patterns. Visual incapacities, such as acquired reading disorders, might be seen as interference with such functions or perhaps they are interference with storage capacities of temporal patterns.

As you know the main theories underlying our teaching of reading skills are based on an associational model. According to such a model one imagines something like a visual percept or graphic pattern to be associatively linked with a sound pattern such as a word. The CNS correlates for this process are then thought to be some physiological linkage between the area where the visual percept is stored with the area where the auditory percept is stored and presumably this linkage takes place through transcortical fibres. I would like to point out some of the inadequacies of this model. Let us first talk about the physiological interpretation of cortical projection areas. It is now quite well established that there is a topical one-to-one relationship between certain points of sensory receptors in the periphery and correlated cortical areas. This is for instance true if points in the retina with points on the striate cortex. However, it does not follow from this that there is isoporphism between a visual pattern that is projected as an image upon the retina and a cortical excitation pattern

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We must now say a few words about the possible physiology of the so-called association fibres and trans-cortical fibre tracts in general. There was a time when it was believed that the transcortical fibres had no function whatever. However, Myers and Sperry have shown in a series of ingenious experiments that this is not so. For instance, they have demonstrated that the fibres known as the corpus callosum are essential in order to transfer information from one hemisphere to another. The information that is thus transferred may for instance be some learned response to a given arbitrary stimulus. If one prepares an animal in such a way that one may be sure that the initial stimulation is sent to only one of two hemispheres it is possible to show that this information at once crosses over to the other hemisphere through the avenue of the corpus callosum. Sectioning of the corpus callosum will prevent the passage of information from one side to the other. However, this phenomenon is a demonstration of how individual percepts become associated through specific fibre tracts. It is particularly interesting to note that the relative equipotentiality of certain projection areas, demonstrated through possibility of partial ablations with impunity, is also replicated in the population of fibres. Consider, for instance, the portion of the corpus callosum which connects the visual cortices of the two hemispheres. If only some of the fibres are sectioned but not all of them the information that is necessary for the recognition of the visual pattern can still cross from side to side. One has not severed some of the fibres which would, for instance, transmit a given corner of the triangle so that only two corners can be transmitted to the other side but not the third. (This phenonmenon must not be confused with the phenomenon of neglect of side seen in certain human patients.) Furthermore, it has never been possible to teach an animal to associate something visual with something auditory and then take a scalpel and sever association fibres in such a way that this learned association becomes disrupted through the surgical maneuver. All attempts at surgical dissociation have been failures so far. This is not to say that fibre-connectivity has no function nor that it is not possible to demonstrate deficits resulting from certain disconnections. The assertation merely is that associations may not be specifically dissociated and behavior may not be fragmented by cutting specific connections. In more recent experiments in which behavior was handicapped entirely by disconnecting fibres we do not yet have an exact account of the nature and true cause of the interference. There is no reason to believe that in these experiments the disruption is a dissolution of associations.

IV. Time as the Cardinal Dimension of CNS Correlates

The purpose of this discussion, which may be more detailed than is called for in the present context, is to bolster my assertion that acquired reading disabilities due to cerebral lesions are not due to destroyed tissues which had originally stored fragments of behavior, but that the proper interpretation of reading disabilities is interference with the physiology of pattern perception, and further, that we may attain new insight into this physiology through attempts to piece together the scattered experimental and clinical evidence. Perhaps this will lead to a new model for the cerebral mechanisms underlying reading. Postulation of such a model may then give us clues to how reading is normally accomplished, it may suggest new experiments on reading, and it may induce new ideas about overcoming reading disabilities and thus, perhaps, implement methods for teaching to read.

It may be possible to overcome some apparently paradoxical findings by assuming that the "language of the nervous system" is a time-code. If we make that assumption, a great many other findings and empirically verified but paradoxical experimental results could be explained satisfactorily, but the details of this reasoning are definitely beyond the scope of this short outline.

Let me conclude by explaining what I mean by time-coding. Suppose two people who cannot see one another have the task of communicating to each other which one of an array of visual patterns each one is pointing to. They are looking at triangles, squares, ovals, etc.. As they encode the visual experience they substitute a word for an image, that is, a pattern with a time dimension (acoustic vibrations) for a pattern with spatical dimensions.

First I shall give an example of theoretical message transmission in the CNS that does not involve time-coding. Here the image of the triangle is projected against the retina and each of the nerve cells stimulated sends its own independent message to the area striata and in the area striata as many cells are activated as were stimulated at the periphery. In this instance of spatial isomorphism the triangular pattern can be transmitted instantaneously but a great number of cells are required for the transmission of the information. I have presented evidence that militates against this theory. Now let me give an example of theoretical message transmission that does involve time-coding. In this instance, a triangular pattern is again projected against the retina but due to peripheral mechanisms the various cells that were stimulated by the triangular pattern begin to interact at once in such a way that they spell out a peculiar "tune" (much the way one can tap out a rhythm) which is the equivalent of the sensation of "triangle and this "tune" can now be transmitted through just one or very few fibres. In this model much fewer cells are needed to relay the message to the brain but longer periods of time are required to transmit the entire "tune."

There is, in fact, quite a bit of evidence that pattern perception takes a very long time indeed for transmission and there is also evidence that a considerable amount of stimulus-processing does take place at the most distal periphery such as the retina. Without going into any of the experimental details to support this view let me simply state that the hypothesis advocated here is not as unreasonable as it may perhaps sound to some of you at first blush.

V. New Research into Reading Disabilities Suggested by These Considerations

The type of experiment that might be interesting in view of what has been said would be entirely geared to testing out the temporal capacities for time patterns in individuals who have reading disabilities. For instance, one might use the techniques of meta-contrast and see whether reading-disabled persons have different time constants from those of normally reading people. Further, one might want to do research with tachistoscopic presentation of various patterns and measure the temporal thresholds for people with reading disabilities as against those without. Another type of experiment might be that in which the spatial display of stimulus configuration is varied in such a way that one stimulus display requires more eye movements than another so that the subject is forced to store images over longer periods of time in one instance than in the other. In all of these experiments it is important to remember that we are talking about temporal dimensions that must be measured in terms of milli-seconds and not the sort of time-lapses that are usually required for reading a passage. The general suggestion is that reading disability may have to do with the microgenesis of pattern perception itself. I see from the outlines submitted, particularly from Bever and Bower, that very similar notions have suggested themselves to these students even though their original reasoning may have had its origin in linguistic considerations rather than physiological ones.

Postscript: I am informed by Tom Bower that a number of the experiments that I am suggesting here have already been performed by him though the material is not available in print.

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How to Read Without Listening[1]

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Harvard University

Introduction and Summary

It has long been held that reading research should integrate the structural discoveries of linguistic science with practical programs for the analysis and teaching of reading. Until recently, structural linguistics has been most proficient in the analysis of sound systems. This led to a general preoccupation with mapping the sound system of a language onto the most intuitively and scientifically rational alphabet so that children could use their knowledge of their language to facilitate their reading. Current developments in the formal analysis of syntax, however, offer new insights into what children know when they know a language. These linguistic insights clarify the nature of different kinds of reading habits and thus provide a basis for the discussion of goals in the teaching of reading.

We view the study of reading as an investigation of how a reader's knowledge of his grammar and strategy for auditory sentence perception is recruited in the perceptual processing of written material. Of course, there is more than one way in which the grammar and perceptual habits developed for spoken language are employed in reading. In fact, available data indicate that there are two general strategies for the utilization of grammar in reading. The majority of readers use primarily

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1. The research on 'visual' and auditory readers was carried out at Cornell University. The relevance of the data to linguistic theory was first pointed out by Ragner Rommetveit, who gave a great deal of invaluable advice.

the perceptual processes used in auditory perception of sentences. Other readers appear to analyze the visual input directly, independently of auditory processes. These 'visual' readers comprehend written material better and faster than 'auditory readers.' Thus we propose that reading can and should be taught as a visual skill, enabling readers to analyze written sentences into their fundamental psychological structure directly, without auditory mediation. If readers can be taught to extract a linguistically correct and psychologically pertinent syntactic and semantic interpretation from the way written sentences look rather than from the way they might sound, unconscious dependence on mechanisms learned for auditory perception can be circumvented.

Linguistic Structure and the Description of Sentences

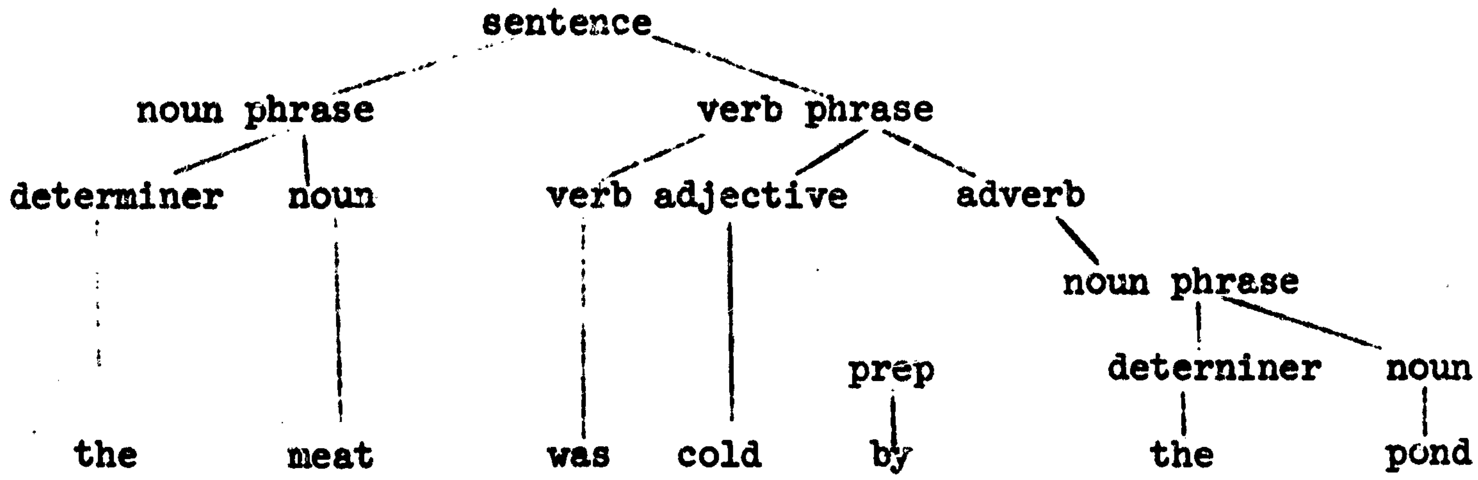
Linguistic study analyzes those strings of words which are felt intuitively to be acceptable sentences. Intuitions about sentences and the relations between sentences are psychological facts fully as palpable as any other psychological data. Consequently, a theory which accounts for these intuitions is a psychological theory, albeit one which is relatively primitive. This psychological theory of language employs several descriptive levels which occur in the complete analysis of any sentence. For our purposes, we can isolate four structural levels: the analysis of phonology, or sound structure of a sentence; the analysis of the apparent phrase structure of a sentence; the analysis of the underlying of 'logical' phrase structure of a sentence; and, the analysis of the semantic structure of a sentence.

Most people concerned with the study of language are familiar with the description of sound systems, since this is the most obvious aspect of language and has been of enduring concern for the past 100 years of linguistic study. At this level the continuous auditory input is analyzed into sequences of discrete segments of sound (phonemes) which are themselves categorized along several descriptive dimensions. For example, the sentence represented in (1a) would be like (1b).

(1a). The meat was cold by the pond.

(1b). ʃa met uas kold bai ʃa pand.

The sequences of phonemes in a sentence are themselves organized into larger segments, words and phrases. For example, sentence (1a) has the hierarchical segmentation into words and phrases shown below. (1c).



At this level of linguistic analysis it is possible to represent formally the intuitive relations which these phrases bear to each other, like "subject," "predicate," "object" and so on. Consider sentence (1a). The first phrase, "the meat" is clearly the subject, the second phrase, "was cold," is the predicate and "by the pond" is an adverbial phrase modifying the predicate.

The deepest syntactic level represents the basic or 'logical' relations which phrases have to each other. Often two sentences have the same apparent grammatical relations, but quite different basic relations: consider sentence (2). Its apparent phrase structure is similar to that shown in (1c) and it is possible to state that "meat" is also the subject of "was sold." But at the deeper level "meat" is the object of the verb "sell." However, it is in no sense the object of the verb phrase "was sold" in (1a).

The apparent phrase relations often coincide roughly with the underlying relations as in (1a). But this is by no means the general case. In sentences (2), (3) and (4) for instance, the same apparent phrase relations occur but it is immediately clear that the logical relations between the phrases differ from each other and from (1a).

2. The meat was sold by the pond.
3. The meat was sold by the pound.
4. The meat was sold by the poor.

In (2) "the meat" is the underlying object, and in (4) "the meat" is the underlying object while "the poor" is the underlying subject of the action.

Examples of this sort demonstrate conclusively that at least two levels of relations between phrases occur in natural language. In the linguistic enumeration of sentences by a grammar, these levels are elaborated in the reverse order of the one presented above: for example, a grammar generates sentence (4) by starting with the underlying phrase structure which produces the underlying structure of sentences, These structures are mapped onto the surface phrase structures by a set of transformations peculiar to a particular language. Finally the phonological component of a language maps the surface phrase structure of a sentence onto a sequence of articulatory movements.

In present grammatical theory, semantic analysis provides each sentence with an interpretation presented in terms of a general semantic theory. Each interpretation describes the semantic relation which that sentence bears to other sentences. The semantic analysis of sentences operates on the underlying phrase structure only. Part of the motivation for this is that many superficially different sentences have the same underlying syntactic and semantic structure. For instance, all the sentences and phrases in (5) share the same underlying structure as in Figure 1.

5. The poor sold the meat.

   It was the poor who sold the meat.

   It was the meat that the poor sold.

   The selling of the meat by the poor....

   For the poor to sell the meat....

   That the meat was sold by the poor.... etc.

Since the basic semantic relations between the phrases is the same for all these sentences the semantic analysis would have to 'de-transform' the superficially different structures back to the common underlying structure in Figure 1. If the semantic analysis applies directly to the underlying structure, an arbitrarily large number of such 'de-transformations' will be avoided.

This yields a picture of the grammar shown in Figure 2. The underlying phrase structure is interpreted in two different directions --

on the one hand the semantic rules analyze the meaning of the underlying structure, on the other hand the syntactic transformations and phonological rules map the underlying structure onto a particular surface phrase structure and a particular pronunciation.

The Auditory Perception of Sentences and the Psychological Reality of These Levels

Above we have outlined the theory of language behavior which explains certain basic intuitions which speakers have about their language. This theory is not a description of how sentences are perceived, produced, or remembered. This theory is descriptive of the structure of sentences and thus is a general constraint on the descriptions of sentence perception, production, and memory.

For instance, any description of spoken sentence perception must show how the phonological level, apparent and deep phrase structure levels and semantic interpretations are discovered from the acoustic rendition of the sentence. The perceptual process is represented as bipartite: on the one hand, the linguistic grammar represents what the listener knows about the structure of his language; on the other hand, the auditory perceptual strategy organizes the use of his structural knowledge to perceive and comprehend the structure of spoken sentences (Figure 3). Recent psycholinguistic research has brought out certain features of this strategy.

It is clear that there is a very close interaction of the phonological and surface phrase structures with the perception of many gross acoustic features of sentences. The research at Haskins Laboratory and elsewhere has shown that the segmentation and discrimination of speech sounds are extremely complex and involves active knowledge of the phonological rules. The perceptual segmentation of speech proceeds according to the surface phrase structure, and the perception of stress and pitch depend heavily on an active use of grammar.

The organization of the linguistic grammar presented above indicates that the perception and comprehension of a sentence involves the discovery of an appropriate underlying phrase structure for which the semantic rules can provide an interpretation. Of course the phonological level is directly represented in speech by many acoustic parameters (although the analysis of these is by no means straightforward). The surface phrase structure can also be expressed in certain acoustic features (e.g., pause, primary stress, pitch, rhythm). But the underlying phrase structure is not represented directly in <u>any</u> aspect of pronunciation. Thus auditory sentence perception is formally the analysis of an acoustic signal conveying phonological and surface phrase structure information, into the appropriate underlying structure.

Current linguistic and psychological research indicates that the underlying phrase structure does not interact directly with the perception of the acoustic speech signal. Many experiments, however, indicate that the discovery of the underlying phrase structure is the perceptual goal of the interaction of the lower grammatical levels with the acoustic signal.

Mehler and Carey have demonstrated that subjects use the underlying structure of sentences to form perceptual 'sets.' Miller, Macmahon, Savin, and others have shown that the larger the number of transformational rules intervene between the apparent and underlying analysis of a sentence, the harder the sentence is to recognize, perceive, or comprehend.

Similar research has shown that subjects remember sentences by decoding them into their underlying structure and memorizing them in that form. Miller and Mehler have found evidence that in sentence learning the underlying structure of sentences is memorized first. Mehler and others have shown that in time errors are made in sentences which tend to simplify their underlying structure.

In brief, then we have the following picture of the auditory perception of sentences (Figure 4). The acoustic signal interacts with the phonological level and surface phrase structure level to produce a gross perceptual analysis of the acoustic signal into sequences of sounds organized into higher order sequences of words and phrases. A grammatically possible underlying phrase structure for this surface phrase structure is then found and is semantically interpreted. This underlying structure is the psychological form on which sentences are remembered.

Underlying Structure and the Problem of Reading

Corresponding to the auditory analysis of sentences the skill of reading can be viewed as the ability to extract from a visual signal the underlying structure of sentences. The information directly available in current orthography is similar to the information available in the auditory signal. The segmentation of the written sequence into letters and words is distinctly represented as are certain major features of intonation and pause (with commas, question marks, etc.).

Of course, by the time he starts to learn to read, every reader has a well-developed perceptual routine for the analysis of spoken language. Consequently, every reader has the choice of how much of the auditory perceptual routine he will use in reading. One extreme, for instance, would be to read every word out loud and then analyze the written sentence with the already developed perceptual routine as though somebody else had spoken it. The other extreme would be to develop an entirely new, entirely visual perceptual strategy for the comprehension of written sentences.

Literally reading the sentence subvocally or out loud is clearly avoided by most readers. Many readers, however, may proceed by mapping the written sequence onto an internal perceptual analysis of what the sounds would have been had they been actually pronounced. Thus there are two extremes in the perceptual strategies which readers might reasonably pursue in the analysis of sentences. The first would utilize as much as possible of the perceptual routine already developed for the perception of spoken sentences, without actually reading sentences aloud. Readers using this strategy could treat reading as a problem in how to map the perceptual analysis of a visual signal onto a corresponding auditory one.

The second strategy would be to use a purely visual perceptual routine independent of the acoustic perceptual routine. Readers using this strategy would develop underlying phrase structure directly from the visual input and then map that onto the underlying phrase structure for auditory sentences. Thus the non-visual reader maps a perceptual analysis of a concrete visual signal onto the analysis of a concrete auditory signal, while the visual reader maps an abstract visual construct onto an abstract auditory construct.

The Efficacy of These Strategies and Their Natural Occurrence

A priori arguments can be made in favor of either non-visual reading or visual reading. On the one hand, non-visual reading should be relatively easy to learn since it maximizes the use of available psychological processes while visual reading requires the development of entirely new processes. On the other hand, once the two strategies are learned, non-visual readers may be limited in the speed with which they read and the accuracy with which they comprehend and remember. Many features of spoken language perception may limit its use in visual perception by the fact that there is a normal speed at which spoken language proceeds.

Several studies indicate that both visual and non-visual readers occur without special training. Although we are not required to postulate that non-visual readers literally pronounce sentences to themselves, we do claim that they are integrating the visual percept with an auditory one at a low grammatical level. This indicates that non-visual readers should match written and simultaneously spoken sentences better than matching two simultaneously presented written sentences. Visual readers, on the other hand, should show no improvement with audio-visual sentence comparisons. In fact, if required to get all the superficial details of the written sentence correct, visual readers might do generally worse than non-visual readers. This is likely since visual readers proceed immediately to the underlying sentence structure, while non-visual readers are more concerned with the phonological and actual surface structure of the sentences.

In a same-difference experiment (Bower, 1966) written sentences were presented tachistoscopically immediately after spoken or written versions and subjects were asked to judge whether the sentences were completely identical or not. (Sentences differed in one misprinted letter.) About 92% of the subjects did much better in auditory-visual comparison than in the visual-visual comparison. The remaining 8% (N = 18 out of 225 subjects) of the subjects did no better than with the visual-visual comparisons. In fact, although the general comprehension of these subjects was higher than average, their general ability to compare the details of pairs of sentences was lower than average for either kind of comparison.

Another prediction about non-visual readers is that they should tend to absorb written material from left to right (in English) since the auditory processing of phonology and apparent phrase structure also proceeds in time. Visual readers, on the other hand, should be free to process the written material in any order to facilitate the direct visual discovery of the underlying phrase structure. In an experiment in which sentences were briefly presented (1 - 100 msec) the same 92% of subjects who benefited from the auditory presentation, also recognized the briefly presented sentences decreasingly well from left to right. The 8% who were not aided by the auditory presentation did not pick up words in briefly presented sentences particularly from the left or right, but correctly identified words in different positions depending on the paticular sentence.

The pattern of words the 8% identified first is quite suggestive. It appeared that the first word recognized was the underlying subject regardless of the apparent phrase relation that word had in the apparent phrase structure. Second, this 8% correctly identify the syntactic form of the sentence, even when they get none of the words right. Third, when they do get the words right, they often put the sentence into its simple declarative form (which has a surface structure more similar to the underlying structure than any other type of sentence.)

We intend to test these findings using more carefully designed materials. For instance, visual readers should give quite different results on the recognitions of the word "meat" in sentences (1) and (2), while auditory readers should yield similar results for both sentences.

The Significance and Natural Teaching of Visual Readers

Additonal data gathered at Cornell indicate that visual readers comprehend faster and better than non-visual readers. They appear to analyze written sentences directly into underlying structures. These underlying structures are not only postulated by linguistic theory as the essential form of sentences, they have also been found psychologically to be the form in which sentences are coded.

We are interested not only in the light these readers may shed on the psychological use of grammar but also in studying methods which may naturally train all readers to see what they read, rather than hear it.

Visual Readers and Speed Reading

The relation of 'visual reading' to so-called 'speed reading' may seem apparent. It may then seem hopeless to consider a general program in which all children are taught to read 'visually' since the methods for teaching 'speed reading' are expensive, time consuming, and presuppose a general reading ability. We are not so discouraged for one thing because the visual readers we found appear to have instructed themselves. Secondly, we have shown that visual readers are using their grammar visually in a particular way. This makes it possible for us to use the linguistic grammar in designing printed materials which will bring out automatically the kind of perceptual strategy which visual readers have. For instance, if small print is used specific features of the linguistic structure can be directly represented. Secondly, we may be able to train readers to be 'visual' by presenting sentences tachistoscopically in their underlying structure order. (See Bever & Rosenbaum, 1965, for a discussion of printing methods).

Although it appears that non-visual reading should be easier to learn, this may not be the case. It is quite likely that some features of writing are arbitrary with respect to auditory analysis. It is also likely that many features of auditory sentence perception are unique to acoustic analysis and arbitrary with respect to visual analysis. Bower (1966) has already found that the attentional process underlying visual reading is docile and easily trained. Thus it may not only be more efficient to be a visual reader, it may also be easier to learn to be one.

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The psychology of cognition needs a vocabulary. The generic headings in this vocabulary list include the concepts of cognitive units, cognitive processes, and determinants of attention.

Cognitive units are the hardware of mental work: the things that get manipulated in mentation. Three basic classes of cognitive units include perceptual schema, language units, and rules of transformation. Cognitive processes refer to the more dynamic events that act upon the cognitive units, much like catalysts act upon basic compounds in chemical solution. The processes of labeling, evaluation, hypothesis production, and transformation are fundamental. Consider a typical problem solving situation in which the child is confronted with a set of initial thoughts that are problematical or external information which he has to resolve. The first task is to label the information presented, a phrase that Guilford calls "recognition". The child then generates hypotheses in accord with these labels. At this point the process of evaluation becomes relevant. The child should pause to evaluate the validity of his hypotheses and initial labels. Finally, the child implements the hypothesis he decided upon with appropriate transformation rules. Labeling, hypothesis generation, evaluation, and implementation of transformations are basic cognitive processes. Perceptual schema, language symbols, and rules are the units that are acted upon by these cognitive processes. Cognitive style refers to systematic and consistent intra-individual tendencies to use preferentially certain labels or transformations, or to <u>process</u> information in particular ways.

The final category in our vocabulary list includes determinants of attentional involvement. Problems of learning, relearning, recall, and problem solving require attention to the task at hand. Attentional involvement is the basic medium in which cognitive activity occurs and degree of attention governs the accuracy and efficiency of the final cognitive product. Without attentional involvement, these processes are not effectively activated and new information is not assimilated. The basic determinants of attention fall into two categories: Violations of expected events, and personological variables we usually call motivation and conflict. Let us consider this latter group.

<u>The motive for acceptance and positive evaluation</u>.

The desire for praise, affection, and symbolic signs of positive evaluation from adults leads a child to work at the mastery of new skills in order to obtain and retain these rewards. To many children of four or five years of age, learning is a socially motivated enterprise. Learning multiplication tables is intrinsically boring to many children. The child becomes interested in acquiring this skill because adults whom he admires praise and reward him for that mastery. The value of these adult favors depends on the sex and age of the child and the nature of the task. In general, adult praise is more significant for girls than for boys, for younger children than for older children, and most relevant when the task is be mastered is related to previously valued instrumental skills.

The motive for differentiation.

There is a general human tendency to accrue attributes that differentiate the self from peers and siblings; to develop characteristics that allow the child to label himself in some unique way. The child's understanding of who he is derives, in part, from the skills he has mastered and his specific skills chosen are determined by the values of his subculture. Since our social community places emphasis on intellectual mastery, most children choose this route for self definition, and their striving for excellence in the academic milieu is partially in the service of the desire for differentiation.

The motivation to maximize similarity to a model.

Children and adults want to maximize similarity to adults who command power, status and instrumental competence. The child desires these intangible goals but does not know how to obtain them. He believes that if he made himself similar to the adult models who appear to possess these resources he might share vicariously in their power, status and competence. If these models display an interest in the mastery of intellectual skills, the child will attempt to mimic such mastery in order to maximize similarity with the model and increase the probability that he will share in these intangible goals. The absence of this dynamic in many lower class families is partially responsible for the fact that lower class children are less highly motivated to master intellectual skills. The lower class child's inadequate performance in school is not solely the result of his parents' indifference to his school performance. Lower class parents often exhort the child to work for grades and punish the child for failure. However, the lower class parent is not perceived by the child as a person who values intellectual mastery. The child does not view intellectual mastery as a likely way of gaining the adult resources of power and competence that he perceives his parent to possess. It may seem inconsistent to state that the child has a strong motive for differentiation and an equally strong motive for maximizing similarity to an adult model. One of the basic characteristics of man is an attempt to maintain a balance between a desire to differentiate himself from a larger group with less resources than he commands and an equally strong desire to make himself similar to a group who he believes possess more resources.

There are four major motives that mediate behavior change: (a) the desire for an external reinforcement, such as praise, love, money, toys, candy, etc., (b) the desire to avoid an unpleasant experience, (c) the desire to be correct and/or to be competent at a task, and (d) the desire to maximize similarity to a model.

The most popular incentives used by teachers, parents, employers, and psychologists to effect a change in response hierarchies capitalize on the first two motives, the child's desire for a positive social response and his desire to avoid a punishment. Some students of the tutorial process insist that the mere attainment of a correct answer is sufficient reward, and they remove all human agents from the learning situation.

The incentive least likely to be exploited is subject to controversy; namely, the child's desire to maximize similarity to a desirable adult. It is acknowledged that children spontaneously imitate and adopt selected responses displayed by particular adults. There is disagreement, however, as to the reasons for this imitation. It has been argued (Kagan, 1958) that the child wishes to maximize similarity to a desirable adult in order to share vicariously in his resources. This process eventually leads to an identification with the model. The motive to maximize similarity to a model appears to be of major importance in the establishment of unusually strong motivations for a career, especially intellectual careers.

In one aspect of our work, we decided to compare the differential effectiveness of training in conceptual reflection under two conditions, a normally nurturant condition between child and tutor, and one in which the child was persuaded to believe that he shared some attributes with the tutor. By becoming reflective he could increase the pool of shared characteristics. It was assumed that the initial belief in similarity to the tutor would act as an incentive to motivate the child to add to the number of shared similarities. If a child believed that the tutor valued reflection he should be more highly motivated to adopt this attitude than the child who perceived no initial similarities to the trainer.

First grade children previously classified as impulsive were trained to delay offering answers under two conditions. In a high similarity condition the child was persuaded to believe that he and the examiner shared many attributes and interests. In the low similarity condition no such procedure was used. A group of control impulsive children was not seen at all. Readministration of tests of reflection-impulsivity following training revealed that training in delay produced longer response times for both trained groups, in comparison to the untrained impulsive children. The effect of high perceived similarity to the trainer had an advantage for a few girls, and no advantage for boys.

In future work we plan to test the hypothesis that similarity in sex of teacher and pupil will facilitate early learning in the primary grades. Specifically, it is expected that boys with male teachers will progress more quickly in the mastery of academic skills than boys in classes with female teachers. This research plan calls for random assignment of boys and girls to classrooms with same and opposite sex tutors and continual assessment of reading progress during the first two years of school.

A Preliminary Outline of Research on Perceptual Correlates of the Impulsivity-Reflectivity Dimension

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Jerome Kagan has studied a dimension of behavior which he calls "impulsivity-reflectivity". This dimension describes "the child's consistent tendency to display slow or fast response times in problem situations with high response uncertainty," where response uncertainty is defined as a situation where several response alternatives are available simultaneously or contiguously in time, no one alternative is obviously correct, and one alternative must be selected.

Kagan's basic measure of the impulsivity-reflectivity dimension is the Matching Familiar Figure test (MFF). Here the subject is shown a picture (the standard) and six highly similar pictures. Both standard and variations are always available to the subject; memory is not a factor in performance. The task is to select the one stimulus which is identical to the standard. The major variables scored are number of errors and mean response time to the first selection. Response time (RT) and error scores are inversely related, with r's usually in the high .60's. Kagan assumes that long response latencies on the MFF are accompanied by active consideration of the differential validity of the various alternatives. Supportive of this is the high association (r in the high 90's) found between RT and the number of times the child moves his head and eyes from the variants to the standard. This suggests that the time spent by reflective children was actively used and was not simply a manifestation of sluggishness or hesitation. Yet we are left with the question of precisely how children go about evaluating the validity of one or more alternatives. Certainly there must be differences in methods of evaluation on the MFF, and some of these differences may coincide with the reflective-impulsive split. Does the child scrutinize one variant at a time, continually comparing it with the standard until he finds a difference, then moving on to another variant? Or does he shift rapidly from one variant to another in his comparison with the standard, perhaps not always comparing each variant to the standard with respect to the same detail? How many variants does the child consider? What parts of each variant does he compare with the standard and in what order?

In short, I am interested in determining how subjects go about dealing with the MFF test and in discovering the ways in which reflective and impulsive individuals differ in approach. One means of doing this is to obtain eye fixation data on impulsive and reflective children and adults while these subjects perform on MFF-type items. Subjects will be rated as impulsive or reflective on the basis of performance on the MFF test administered in the standard fashion. The Mackworth eye-marker camera will then be used to record eye fixation patterns while these subjects deal with similar items. They will be asked to decide which of six variants is identical to (in the sense of being nondiscriminably substitutable for) the standard stimulus.

Since successsful performance on the MFF test requires that the subject be able to judge whether two visual stimuli are the same or different, it also seems important to determine whether or not impulsive and reflective subjects differ in their ability to make this judgment and differ with respect to the bases upon which this decision is made. Hence eye fixations will also be recorded while subjects are presented with pairs of figures and are asked to judge whether the two are the same or different. These two figures will be larger than the seven previously used. Thus for the pair items, more detailed information can be obtained on the parts of the figures looked at.

The recorded measures will provide the following information. For the MFF items - how many of the variants were considered before a response was given, how long each variant was considered, in what sequence variants and standard were looked at, and what segment of each stimulus was fixated upon. For the stimulus pairs - how long various parts of the stimulu were regarded, in what order they were looked at, and how many and which parts of the two stimuli were compared before a judgment was rendered. Several predictions will be tested concerning differences between impulsive and reflective subjects on these variables of visual regard and task strategy.

Impulsive and reflective subjects have been found to differ on various tasks related to reading. For instance, in a serial learning task with familiar words, impulsive children were more likely than reflective children to make errors of commission - that is, were more likely to report words that were not present on the list (Kagan). Similarly, when children were shown five printed words and asked to point to the word the experimenter had just read, impulsive children made more reading recognition errors than did reflective children of similar ability and social class background (Kagan). Future research might well deal with eye movements of impulsive and reflective subjects as they read sentences and passages of various lengths, levels of difficulty, and subject matter.

Three Approaches to the Problem of Understanding Language Development

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Three research projects are in the planning and pilot stage. Although they are not superficially related, all bear upon the basic problem of understanding language development and the relationships between spoken language and written language.

1. Hesitation phenomena as indicators of encoding units.

Pauses and other hesitation phenomena give some promise of yielding information about the encoding units of natural speech. The points in speech at which people hesitate are presumably points of indecision, and require extra processing time. Since we are particularly interested in the developmental aspects of language, we want to analyze hesitation phenomena in children's speech and to compare these results with those found for adults, in order to throw light on possible differences in points of indecision and in encoding units. This study relates directly to our ultimate goal of understanding the types of psycholinguistic units and their relation to verbal abilities, and to our second goal of understanding the role of the units of natural language in learning to read.

Since Lounsbury in 1954, called for much "more study of hesitation pauses in speech," a few papers have appeared. They are largely exploratory in nature, based on small samples of rather restricted sorts of language. The most ambitious undertaking was Maclay's and Osgood's analysis, where four types of hesitations were identified and located. The results were interpreted as supporting Lounsbury's hypothesis that hesitation pauses occur at points of highest uncertainty, although the argument was from gross class (function vs. lexical item) and the transition probabilities were not considered. They conclude that "hesitation phenomena are clearly related to the dynamics of grammatical and lexical selections." Goldman-Eisler has contributed several studies. She concluded that pauses are a necessary condition for an increase in information. Quarrington found that stutters also pause at points of low transition probability. Levin, Silverman, and Ford have applied Goldman-Eisler's technique to child speech.

The procedure to be used here is similar to that used by Maclay and Osgood, except that the total corpus will be analyzed instead of a sample. Natural informal conversation among peers will be analyzed for 5 types of hesitation: (1) Filled Pauses, (2) Unfilled Pauses, (3) Repeats, (4) False Starts, and (5) Multiple Hesitations. Each of these will be coded according to relation to form classes and possibly to syntactic location. Distributions will be made of the frequency of occurrence of each kind of hesitation for each age group. Identification of hesitations in 5th grade speech is nearly complete. The analysis is expected to show to what extent children's hesitations are similar in kind and location to those of adults, and presumably to indicate how psycholinguistic units develop as the native language is mastered.

2. Use of context in comprehension of language.

There have been many studies of effect of order of approximation to English upon performance. Typical is the study by Miller and Selfridge which showed that recall increased with order of approximation. There have been a number of replications of this. Since the closer the order of approximation to English the greater is the context provided, it is reasonable to conclude that context is important in recall. Morton has shown that the same kind of context is important in reading speed for adults, and that the faster readers utilize additional constraints as compared to the slower readers in his group. Goodman has shown that early readers are able to recognize many more words in the context of a story than they can recognize in lists. Treisman studied subjects' ability to supply missing words in normal English and in "syntactical" English in terms of correct words, correct concepts, and correct grammatical class. She found that grammatical structure made an independent contribution to the redundancy of language and concluded that we need to know more about how verbal context can define the hierarchy of possible responses through which a search is made for the proper word.

It is obvious that context is important in word recognition, and also that there are several independent factors operating under the guise of context. It appears reasonable to suppose that an analytical approach, evaluating the effects of the several factors separately, might lead to a more precise assessment of language skills and to more effective methods in teaching reading skills.

The first step here will be an assessment of the ability of children to use context to understand language, using a kind of guessing game, for auditory and visual presentation separately. Pilot work will start with children who are reading well - about 5th graders - and will explore contexts of several sorts (grammatical, general set, lexical, and word contour). Attention will be directed to the question of which contexts are most important in defining several kinds of units, and where the greatest individual differences lie. Scores on these tests will be correlated with measures of reading skill to see whether ability to use visual or auditory context is related, as hypothesized, to reading ability. Later the investigation will be extended to other age groups. This way it should be possible to discover what kinds of context are effective at each level, and so to make an estimate of the kinds of units which are used in decoding. Finally, an experiment in teaching children to use the kinds of context found to be most closely related to reading skills will be carried out.

3. False recognition as a limiting factor in reading skill (with E.C. Carterette).

In an experimental study just completed, a simple recognition task was used to evaluate the influence of frequency of language occurrence and modality of presentation with 64 subjects of each of 4 age groups. One of the most important discoveries was that errors of false recognition behaved quite differently from ordinary failures to recognize. Subjects of all ages made more false alarm errors than errors involving failure to recognize, implying that false recognition accounts for a larger proportion of difficulties in reading comprehension than does sheer ignorance of lexical items. Since this aspect of language processing is not normally assessed independently, a large potential source of the variance between readers is being overlooked. Secondly, it is in false recognition that the low frequency words show themselves to be special trouble spots. In errors involving failure to recognize, low frequency words appear to be intermediate between those of high and those of zero frequency, but they occasion far more false recognitions than either of the others. This implies that in reading, low frequency words will cause the greatest amount of trouble. Since a child's reading comprehension is dependent upon both his failure to recognize some words and his false recognition of others, and these are apparently different, a measure which combines the two should be superior to either alone in prediction of performance. We used ROC curves for this purpose.

We propose to apply this procedure to children of a number of levels of reading skill, using both auditory and visual presentations and to relate this measure to reading success. It is of some interest to compare visual and auditory performances in the same individual, and to discover to what extent visual language skills are related to visual sequential processing for recognition and auditory language skills to auditory recognition. It would also be useful to follow subjects over a period of several years to see whether their visual or auditory ROC curves change with their reading skill. In our present data, the ROC plots for adults show much less scatter than those of

First Graders for both auditory and visual recognition.

It is apparent from the ROC plots of our present data that First Graders have a bias in favor of errors of commission (false alarms). One would predict that their reading progress would be slower because of it. An attempt to manipulate the bias whould prove interesting. If a bias toward errors of omission can be established in 6-year olds, it might be predicted that the precision of word recognition would increase, possibly leading to more rapid increase in reading skills in the early stages. It might also be hypothesized that later in the process of learning to read, errors of commission are preferable. Clearly, here are two techniques of training which could be evaluated rather precisely in terms of immediate and later progress.

The very interesting question arises as to whether these biases are docile. They may, of course, be related to Kagan's "response styles" and thus to a relatively profound temperamental trait which is difficult to modify. But even so, one suspects that teachers tend to train children in the direction of errors of commission. We propose to attempt to train children to favor one or the other type of error and then to follow their reading progress.

Projected Activities

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1. For the rest of the academic year, I will be working with Wick Miller towards the completion of a monograph on children's grammatical development. The children in our sample were drawn from the waiting list of the Berkeley Child Study Center and are from high SES. For about two dozen children we have monthly longitudinal tests of specific grammatical patterns, particularly plurals, pronouns, and question-and-answer sets. In addition, for half a dozen we have longer texts obtained through interviews and play. The testing began around the age of two, and for the smaller group was at weekly intervals at first. We plan to describe the grammars of each child in the small group at the outset, show how a system for one child (with the longest record) changes through time, and characterize change in sub-systems of the syntax and morthology as seen in all of the children.

2. Dan Slobin, John Gumperz and I have been formulating plans for work which will begin sometime in the coming academic year. Each of us has other work to finish, but some pilot studies will begin in the form of student work prior to our own full attention to these studies. We see these as loosely related small studies, permitting our experience in developing methods on each study to help the next.

2.1. A series of studies would be concerned with <u>comparative grammatical development</u>. These will be comparative because the children will come from communities with different adult grammatical norms, for English.

2.1.1. We would like to try to characterize formally the distance between a given child's grammar and the adult grammar in terms of the rules of conversion. Thus it would be possible to measure the difference between various adult norms and the various children's grammars. We would expect that up to a point the children in the various groups would be equidistant from standard English. If this is true, these may be stages in grammatical development where exposure to standard English instruction may have most efficient impact, for those who are not exposed in the home.

2.1.2. For various types of rules, we would like to know whether the children in different dialect communities have <u>identical</u> grammars up to a point (though their parents do not). These might be rules which in fact disappear in later stages of development. There is some evidence, for example, that the grammars of Russian and Bulgarian children are quite similar to the grammars of children exposed to languages with much greater order regularities.

2.1.3. Bellugi has shown for two children a similar order for development of inflections. If this generalization holds up in our data, (or some other sequential pattern), we would like to study such sequences (cross-sectionally) in other dialect communities. If some of these inflections are missing, will the remaining items preserve their order? Would a training experiment show that ... ching at the point where the inflection normally appears in speakers of standard English would be most effective?

2.1.4. There is an argument regarding the relation between comprehension and production. We will obtain both kinds of data (and sometimes imitation) in an effort to obtain the best estimate of grammatical status.

2.2. In the second set of studies we will investigate variations in linguistic socialization. We will begin by maximizing contrasts, including perhaps white middle class, white lower class, negro lower class, Mexican-American, and American Indian families.

2.2.1. Variables to be studied as examples of factors affecting language development are (a) values and practices affecting how much children talk; (are they told to be quiet, are they interrupted?) (b) values and practices affecting learning of meanings and structure (do parents correct the children?) (c) amount of exposure to adult speech of varying types; (d) values and practices regarding age-graded styles, such as baby words, (e) special forms in adult speech to children at various ages; (f) the functions of language for adults in the family (descriptive, narrative, abstract, social responses, etc.); (g) functions of adult speech when children are present; (h) functions of children's speech (esp. with regard to differences leading to styles Bernstein has described); (i) range of styles to which adults switch outside and inside family; (j) development of style-switching in children.

2.2.2. Over and above characterizing modal differences between the social groups, we would like to identify when possible the sociological factors which give rise to the values and practices we find. In order to do this, we shall try to include families differing in factors which might be relevant, such as number of adults in the family, authority structure, the social network membership of the families, including occupational as well as social relationships. These would include both features of intra-family structure (absence of fathers, presense of extended family) and features of extra-family contacts which influence the use of language.

2.2.3. Eventually, we would relate the differences in family practices to specific items in child behavior, such as rate of development in syntax, fluency, vocabulary diversity, in varying contexts. For example, there have been puzzling sex differences in language development which vary with social group, but it is not clear what socialization practices might be responsible.

Some Notes on Learning to Read and Learning to Speak

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This is a paper which perhaps does not need to be written. I intend to point out some things which are obvious -- or at least should be obvious -- but must be kept in mind in formulating research and thinking on reading. Perhaps it will be useful in gathering together in one place some of these obvious facts and observations.

One of the most obvious facts is that language is learned. This, in spite of the fact that language is seldom deliberately taught. Language is not only a uniquely human characteristic -- only Homo Sapiens have it -- but is so typically human that we can say all normal children have the capacity to learn language. That is, children who lack the capacity are not considered normal. Lenneberg and his coworkers have, in a number of articles, presented compelling arguments along with some evidence that the capacity for language is a species specific trait, genetically transmitted, and the result of evolutionary development (see, e.g., Lenneberg 1960, 1964). If Lenneberg's thesis is correct, the particular capacity that humans have, what ever that might be, plays a significant role shaping the nature of language and the nature of language universals. The child's learning of language, then, can be viewed as the inevitable unfolding of this capacity. We should expect that different children and children learning different languages will exhibit similar patterns of language development. Recent research in child language tends to support this expectation (see e.g. Brown and Bellugi 1964, and Ervin 1964; see

McNeill n. d. for a synthesis of the research). Almost all of the current research in child language that is formulated in a way that is useful to this particular problem is, unfortunately, with English speaking children.

Language has certain properties that enable its users to translate the system into different channels and to utilize different sending devices and to utilize different sense modalities in receiving. In short, speech surrogates are possible. Writing is the most important and fullest surrogate but there are others such as drum and whistle surrogates (Stern 1957). What is it that make speech surrogates possible? It is difficult to give an answer, but some of the features of the design of language must be considered (Hockett 1960, Hockett and Ascher 1964). Perhaps the most important is what Hockett calls the duality of pattern. Every language consists of two levels or components; the phonological and the grammatical. Most (perhaps all) speech surrogates -- including at least all alphabetic and syllabic writing systems -- depend on this property of language. The code-like aspect of language results in part from the duality of language. It is possible to recode language by translating the phonological component into another channel. Investigations of the code translation or code switching are basic to any sophisticated understanding of reading; research under the heading of "phoneme-grapheme correspondences" (I would prefer to call it "phoneme-letter correspondences") is currently under way by a number of people, and should shed light on some aspects of the code switching. Just as important is the capacity that humans have for code switching. Comparative data would be helpful; everybody knows, for example, that a chimpanzee does not have the capacity to learn language (much less, to learn to read), but we do not know exactly what it is that the chimp cannot do. If viewed from the point of view of the biologist, we can say that man is preadapted for reading. But what is the nature of this preadaptation?

The change in channel and the change of the sense modality present somewhat different decoding tasks for the hearer and for the reader. Thus, the phonological component is represented in the orthography by discrete units, namely letters. In speech, the flow of language is continuous, but patterned in such a way that it is possible for a linguist to analyze the flow into discrete units, namely phonemes. It is this property, of course, that makes orthographies possible. The linguist often finds that there are alternative analyses, but in orthographies there is only one spelling, or at any rate only one correct spelling (with certain marginal exceptions such as "color-colour"). The learner, then, must learn to associate discrete units (letters) with the flow of continuous patterns. The situation is complicated by the fact that the representation of the system in the two channels is never perfectly regular. That is, all orthographies have at least some irregular spellings (see Chafe and Kilpatrick 1963 for an example in Cherokee where one would be tempted to predict that there would be no irregular spellings). The orthography for English is more irregular than most orthographies, but, as Chomsky (1964) has argued, this is not as large a problem as is generally thought.

There is a different relationship between the speaker and the hearer on the one hand, and the writer and reader on the other. The hearer must proceed at the same rate as the speaker, but the reader can set his own pace, can skip ahead or go back if he likes. The reader can process whole words or even groups of words at a time. But the hearer must wait and gather the information sequentially -- or else guess what is coming -- before he can process larger units. The problems of decoding are different in the two cases, and we can expect that the learner must accordingly utilize different strategies in the two situations. There is to date a great dearth of experimental data that can be brought to bear on the problem.

The grammar utilized by the hearer and reader in decoding is the same, or at least is practically the same. Otherwise a literate person would be bilingual, using one language in speaking and listening, the other in reading and writing; and clearly this is not the case. The question is: How is a person able to use the same grammar in processing linguistic information when two different channels are used, and when the information arrives by way of two different sense modalities?

If it is true that the capacity for language is the result of evolutionary development (presumably covering hundreds of thousands or millions of years), and if the capacity for reading represents a preadaption (brought into play only in the last few thousand years and until very recent years utilized by a very small segment of the world's population), we can expect the capacity for language to be developed to a much greater degree. And this, in fact, is what we seem to find. Language is learned, but not taught, and all normal children exhibit a capacity for language. Reading, on the other hand, is learned, but few seem able to learn unless it is deliberately taught. In addition, some normal children fail to learn. It is likely that some of the failures are due to lack of a capacity for reading, though certainly there are other important factors; lack of exposure, lack of motivation and functional advantage (to take an extreme case, an Eskimo is not likely to learn to read Eskimo because there is not much written in the language), and poor teaching techniques must be considered as well. Also, the nature of the imput and the nature of the teaching techniques (both deliberate and nondeliberate) appear to be more important in learning to read than in learning to speak.

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WHAT IS PROJECT LITERACY?

Project Literacy was organized at Cornell University on February 1, 1964, by a developmental projects award from the Cooperative Research Branch of the United State Office of Education. This project represents one of the major commitments of the Office of Education to basic research and curriculum development concerning both child and adult literacy.

The purpose of Project Literacy is to organize, in various universities, laboratories and state departments of education, research which is essential to understand the acquisition of reading skills. The major initial effort is to bring together researchers and educators from a variety of disciplines to plan research which, when taken as a whole, will give us more substantial results than any single study can provide. Each investigator in the research consortium will be completely responsible for his own activities. The project will provide mechanisms whereby the individual scientists can communicate their research strategies, problems and results to each other and when necessary they will be able to meet together. The research findings will be brought to bear on curriculum developments. When called upon, Project Literacy can provide technical research consultation. The group at Cornell University will also undertake a program of studies similar to those which will be initiated in other settings.

We believe that much current and potential research in learning psychology, visual perception, cognitive behavior, neurophysiology of vision, child development, descriptive linguistics, psycholinguistics, the sociology of educational innovation, research with culturally disadvantaged children and programmed instruction (to cite some examples) are essential to understanding literacy. Consequently, we are endeavoring to locate research interests which heretofore may not have been considered relevant to this crucial educational research area.