DOCUMENT RESUME

ED 041 345 | 24 | CG 005 775

AUTHOR	Bosco, James J.
TITLE	Social Class and the Processing of Visual Information. Final Report.
INSTITUTION	Western Michigan Univ., Kalamazoo.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
BUREAU NO	BR-9-E-041
PUB DATE	May 70
GRANT	OEG-5-9-325041-0034(010)
NOTE	90p.
EDRS PRICE	EDRS Price MF-$0.50 HC-$4.60
DESCRIPTORS	Disadvantaged Youth, *Elementary School Students, Information Processing, Learning, *Social Class, *Social Differences, *Visual Learning

ABSTRACT

This investigation estimates the magnitude of the relationship between social class and visual information processing rates, and compares the development curves of processing rate for advantaged and disadvantaged children. Subjects were grade school children in a metropolitan area of southwestern Michigan. Estimates of the information processing rate were obtained by tachistocopically presenting two stimuli to the subject. The interval between the stimuli required by the subject to process the first stimulus was that subject's information processing rate. Social class was quantified using Duncan's "Socioeconomic Index". Data analysis involved use of the Pearson correlation, multiple regression technique and analysis of variance. Results indicated that disadvantaged children do process visual information more slowly than advantaged children. The development curves for the two groups tend to converge as they proceed through school. (Author/CJ)

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FINAL REPORT

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SOCIAL CLASS AND THE PROCESSING OF VISUAL INFORMATION

James J. Bosco
Western Michigan University
Kalamazoo, Michigan

June, 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education
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The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Acknowledgements

In doing the research which this report describes, I have been assisted by several individuals. I am pleased to have an opportunity to acknowledge the help which I received.

Robert M. W. Travers infected me with curiosity about visual processing and gave generously of his knowledge and insights. My discussions with him enabled me to avoid many mistakes. Robert Mendelsohn assisted in the collection and tabulations of the data as well as in the preparation of measurement techniques. His skillful and dedicated work was a tremendous facilitation. The principals, teachers, staff and pupils in the Grand Rapids Schools were most cooperative and understanding during the data collection, which entailed some disruption of their program. Foster Buchtel, Michael Walters and the Office of Research Services were most helpful from the point at which the study was a "gleam" to the moment when this document was completed. Michael Stoline provided valuable consultation during the analysis of the data. The quality of this report was enhanced by the art and graphic work of Mary Frances Fenton. The Grand Rapids Public Schools--Western Michigan University Center for Educational Studies greatly assisted in logistical aspects of the study. And certainly I am grateful to my "California family" for providing an atmosphere which made even the wrestling match with the first drafts of this document pleasurable.

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Summary

The purpose of this investigation was to estimate the magnitude of the relationship between social class and visual information processing rates, and to compare the development curves of processing rate for advantaged and disadvantaged children. The information processing rate is a measure of the speed of cognitive functioning in visual perception. In order for a visual stimulus to be recognized, a duration of time free of input of any other stimuli is required by the perceptual system. Previous investigations have revealed that there are considerable individual differences in the amount of time required by humans to process information. Some cross-cultural studies and investigations of sensory deprivation suggest the possibility of a relationship between information processing and the social status of individuals. Other studies indicate that development curves for scholastic performance of advantaged and disadvantaged children diverge as they proceed through school. It was not known if such a phenomenon would occur with visual information processing.

Subjects for the experiment were grade school children in a metropolitan area in southwestern Michigan. Estimates of the information processing rate were obtained by tachistocopically presenting two stimuli to the subject. The interval between the stimuli required by the individual in order to process the first stimulus was the subject's information processing rate. Social class was quantitized using Duncan's "Socio-Economic Index." The analysis of the data involved the use of Pearson correlation, multiple-regression technique and analysis of variance.

The analysis of the data indicated that disadvantaged children do process visual information at a rate which is slower than advantaged children. The development curves for the two groups tend to converge as they proceed through school. The findings are interpreted using available information about neurological, cognitive, and affective aspects of perception.

Objectives and Conceptual Framework for the Study

During the last ten years many investigations of the scholastic performance of disadvantaged children have been conducted. These studies support the generalization that the achievement of children reared in economically impoverished environments is inferior to children from more favored situations. Clearly, economic status and school performance are related. Our understanding of the nature of the association, however, is less clear. A simple cause and effect model between economic status and scholastic performance is obviously invalid. It seems more plausible to contend that money can provide environmental ingredients which promote the development of characteristics in the child that make success in school more likely.

Consider a comparable situation. There is a strong relationship between poverty and tuberculosis. People, however, do not develop tuberculosis because they are poor, but because they have been infected by Mycobacterium tuberculosis which is prevalent in impoverished areas. Our ability to treat tuberculosis effectively is a direct result of our thorough understanding of the etiology of the disease. Similarly, our understanding of the way in which poverty promotes educational failure needs to be expanded. Accordingly, we need greater information about variables which may intervene between economic status and scholastic performance. In essence the basic question is: What is there about the economically disadvantaged child which promotes poor scholastic performance; or, in what way does poverty contribute to the development of the variables which inhibit achievement? This study will explore one potential intervening variable--rate of information processing in the human visual perception system.

One of the most frequent assertions dealing with the disadvantaged is that children reared in such environments tend to be "slow learners." Riesman, whose book, The Culturally Deprived Child (1962), has had considerable influence, contends that "the deprived child typically works on academic problems in a slower manner." (Riesman, 1962) According to Riesman, the disadvantaged child's environment promotes a cognitive style which may be characterized as slow and deliberate. The slow learner, although not necessarily a poor learner, may become such as a result of the treatment he is given in the schools. Others, such as Crow, Murray, and Smythe (1966), Beilin and Gotkin (1967), Rees (1968), and Johnson (1966), have made similar assertions.

Were it not for the distinction which is made between slow learning and poor learning Riesman's point would be circular. That is, Riesman would be saying that the disadvantaged child is a poor learner because he is a poor learner. Riesman advances the notion that aspects of the deprived child's environment result in a slower rate of learning which is disfunctional only because teachers deem it such. In other words, teachers view the "slow" learner as a poor learner, and acting on this perception make it a reality.

Reflection on Riesman's position raises an important question. What is slow about the slow learner? What factors account for the extra duration of time required by some learners to master a learning task? Are his basic cognitive processes slower? Does the "slow learner" tend to have a shorter attention span and spend greater amounts of time attending to distracting stimuli? Does he require more redundancy in learning situations? Generally the "slow learner" is identified as the child who scores low on achievement tests. To say, however, that the slow runner is the individual who crosses the finish line last is to say little about the factors which explain his performance. In much the same way, low scores on achievement tests generally reveal little about the nature of the learning difficulties. Also, the use of an achievement test score to identify the slow learner does not enable distinctions between slow learners and poor learners if such a distinction is useful. Unfortunately, analyses of the nature of slow learning or conceptualizations of the "slow and deliberate" cognitive style tend frequently to be circular or very sketchy.

This investigation will focus on the first of the three above-mentioned possible sources of slowness in learning--basic cognitive processes. More specifically, it will deal with the duration of time required by the child's perceptual system (eye - optic nerve - brain) to process visual information. Selection of this variable is not meant to imply that slowness in learning is solely attributed to slow rate of processing information. Other factors (such as those mentioned above) may also contribute. Or, perhaps, there are several types of slow learners each type resulting from different factors.

In recent years, educators have shown increased interest in perception. There are at least three reasons which make this interest warranted. The ability of the human to structure the light which impinges upon the eye is requisite to more complex cognitive phenomenon. To use an illustration of Forgus, the ability of an individual to solve mathematical problems is based on his ability to understand the meaning of symbols and the ability to understand symbols requires the individual to be able to discriminate the difference in the pattern of lines and circles which comprise the symbols. The difference between this sign + and this one **X** is but the rotation of a few degrees and requires a subtle discrimination, but in order to solve a multiplication problem the student must be able to make this discrimination. (Forgus, 1966) The first grade reading teacher with a child who cannot make discrimnations such as an m from an n, a b from a d, or a p from a b expects difficulty teaching the child to read.

There is a second reason for interest in perception. Visual perception is not synonymous with acuity, but entails cognition. Conceptions of man which regard visual perception as a "developmental given" are inaccurate. Perception is not a passive pouring in process but rather a process which is regulated by the prior learning and development of the organism. Unless perception is disassociated from cognition, and the evidence suggests that such a disassociation is untenable, then it is not rash to expect that knowledge about perception can contribute to the creation of more adequate understanding of man the learner.

Eleanor Gibson's Principles of Perceptual Learning and Development (1969) is a recent attempt to explain cognitive aspects of perception. This book presents considerable evidence to support the conclusion that nature does not produce an infant with the skills and knowledge necessary for efficient perception. Rather, information gained from successive interactions with the visual environment and stored in the brain may function to develop the child's ability to perceive. The genes do not seem to guarantee such development.

If nature does not build in the cognitive strategies and processes necessary for success in various visual tasks, there is little reason to expect a uniform degree of success. What variables are useful in explaining the variability in success? This study will examine the explanatory power of social class.

Until recently, relatively little attention has been paid to the relationship between social environment and basic perceptual processes. As Cynthia Deutch observed, "perception has traditionally been regarded as a function quite independent of one's over-all social milieu, an assumption which is open to serious question." (1967) The growing concern for the education of the disadvantaged has helped to generate inquiries into this problem. Such studies may not only provide bases for curriculum decisions, but also provide answers to basic questions about learning.

There is one other reason why it is useful to focus on perception. Although our understanding of perception is far from complete it is considerable. It is not enough to compile lists of things that disadvantaged children cannot do--we must understand why they cannot do them. Such an understanding is advanced by knowledge about the task. If, for example, a doctor knew nothing about the physiology of the heart he might have difficulty understanding why obese people are more susceptible to heart disease. As the doctor understands more about the heart and the work that the heart does, he is increasingly able to formulate an explanation for the relationships between heart disease and obesity. The interpretation of the data to be presented later in the document will be based on the knowledge which is available about perception. Thus, if our task is not just to find the magnitude of the relationship between variables but to explain the relationship, the state of knowledge relative to each of the variables is an important consideration since what is known about the variables will be an important determination in our ability to create a useful explanation about relationships. Research in visual perception has produced abundant knowledge, and application of this knowledge to problems of the disadvantaged should be productive.

In this study we will use an information processing model as the conceptual foundation. The origin of contemporary information theory can be traced to a paper published in 1948 by Shannon which he called, "The Mathematical Theory of Communication." (Shannon, 1948) Although Shannon was primarily concerned about the transmission of information through mechanical systems (telephone and telegraphs), it was not long until psychologists saw that the concepts developed by Shannon were applicable to the transmission of information within the human perception system.

Information theory was developed in order to explain the process of transmission of a message from a source to a receiver. The principal elements in an information system as proposed by Shannon are depicted in Figure 1.

The information source selects a message from an ensemble of a set of all possible messages. The message which has been selected is translated into the signal, and the signal is sent over the channel.

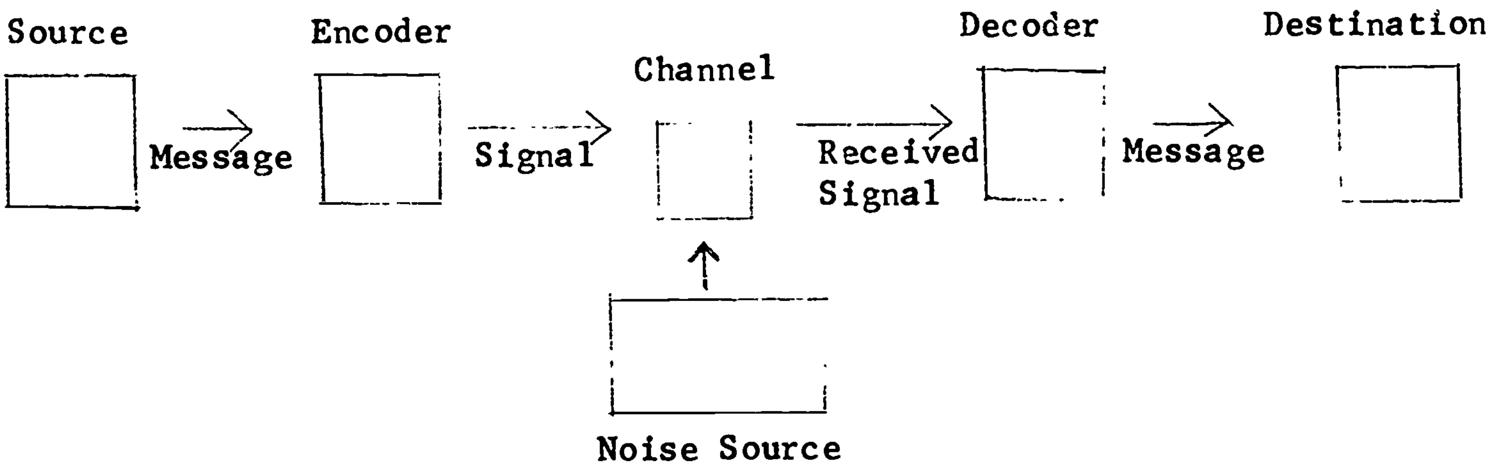

Fig. 1--Diagram of a general information transmission system (Travers, 1964)

The receiver must decode the message which was coded at the transmitter. As the signal is moved over the channel it may become contaminated with noise. Noise is defined as unintended aspects of the message as received.

The use of information theory provides a basis for the construction of communication systems by providing mathematical formulations which enable engineers to determine crucial aspects about the system, i.e., what is the capacity of the channel? How can designers of communications systems counter the effect of noise?

As stated above the communication system provides for the transmission of messages from a sender to a receiver. The total collection of all messages which may be transmitted within a given system is called the ensemble. Given the selection of a message from the ensemble, it is coded and sent along the channel. The maximum amount of information that may be transmitted through a channel is termed the channel capacity. Any system can handle a finite amount of information. When the information being sent exceeds the handling capacity, breakdown in communication will occur. In order to predict the amount of information which can be handled by any system, some method of quantifying information is necessary.

The basic unit for quantifying information in Shannon's theoretical system is the binary digit or bit. One bit is the amount of information that is necessary to resolve two equally likely alternatives. If, for example, a fair coin is flipped and we are told it has landed on tails we have received one bit of information. If a number from one to eight is to be selected, and we are told that the number is one we have received three bits of information. It is to be noted that the amount of information in bits is equivalent to the minimum number of binary questions (answerable with yes or no) needed to resolve the uncertainty. In the case of the selection of the number between one and eight the questions might be:

Q. Is it 5 or more?

A. No.

Q. Is it 2 or less?

A. Yes.

Q. Is it 2?

A. No.

Thus by process of elimination we have learned that the number is one. Three binary questions were needed. Refle .cion on this would indicate the following relation:

$$U = c \cdot \log k$$

where U is the measure of uncertainty, k is the number of possible outcomes, and c is a constant needed to relate the value to a given unit of measurement. For the problem above the formula would show $U = 1 \cdot \log_2 8$ or 3.0 bits. With an ensemble of numbers from one to eight each message presented (i.e., showing a card with a number on it) contains 3 bits of information. This definition of uncertainty holds only for the instances where each message is equally likely.

The field of computer technology has also provided concepts which have been used in studies of perception. A computer can be described as a piece of hardware which can be instructed or programmed to process data. Data which are fed into the computer are called input. These data are treated according to the instructions on the program, and the results are sent out of the computer. The processed data are called output. Frequently the satisfactory execution of the process requires the use of stored data. Data may be stored permanently or for a short term. Those data which are stored permanently survive the completion of the processing of a given input, and can be recalled for subsequent input. The duration of temporary storage is confined to the processing of a given input. Computers are not equally efficient data processors. The processing time for the same input varies according to the model of the computer. Processing rate varies in relation to differences in the programming. There is more than one way to instruct a computer to do a task, and not all ways are equally as efficient.

Certainly, the human perception system is neither a telegraph nor a computer, but concepts developed by computer technology and information theory such as bit, channel capacity, noise, ensemble, processing rate, permanent storage, temporary storage, and program are useful in perception studies. Having briefly reviewed some of the key concepts of information theory and computer technology, let us consider information processing in the human visual system.

The processing of any visual stimulus begins as light strikes the surface of the eye. Let us consider a human observer who is "looking at" some object in his environment. The processing act is said to be begun when he attends to the object and is concluded when he has a cognition of the object or emits some response to the object.

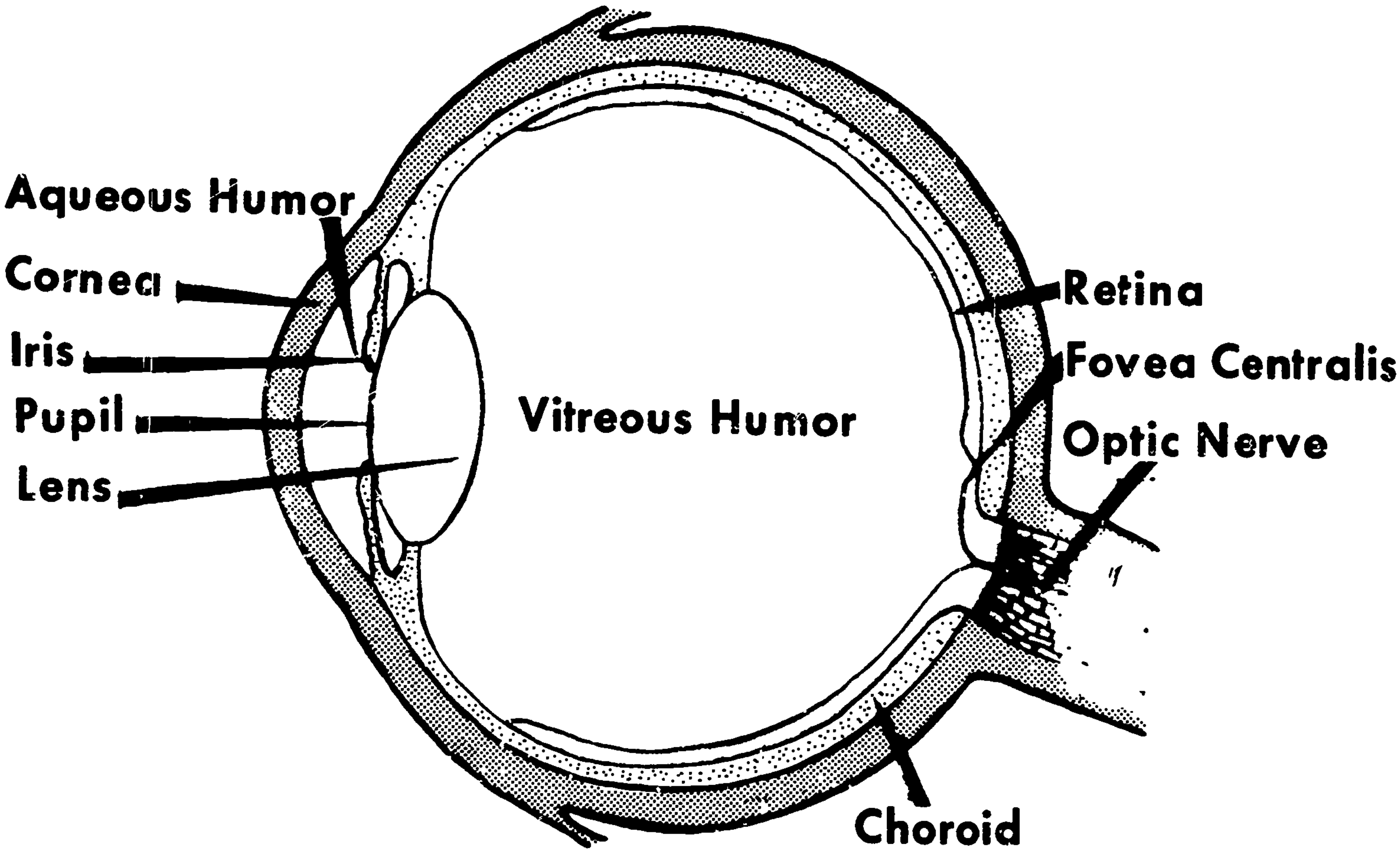

Fig. 2--Stylized representation of the human eye

As the observer attends to a stimuli, light which is reflected from the stimulus strikes the cornea of the eye which refracts the light. The anterior chamber contains a clear liquid called aqueous humor. Located at the rear of this chamber is the lens. The passage of light through the pupil opening to the lens is controlled by the contraction and expansion of the iris. The lens adjusts to accommodate the eye to the distance of the stimuli and thus keep the image in focus in much the same way that turning the lens on a motion picture projector focuses the image on the screen. Upon passing through the lens the light passes through the vitreous humor--a gelatin like substance. As the message strikes the retina it is a pattern of light and shadow which though small and inverted corresponds to a fairly similar representation of the external objects. (Glickstein, 1969) The eye, however, is not a perfect optical instrument; accordingly, the configuration of light which reaches the retina is a somewhat blurred representation of the stimulus. (Leibowitz, 1963; Riggs, 1965)

The primary photo receptors are found in the retina in the form of cells called rods and cones. The rods and cones are distributed in such a way that in one area--the fovea--only cones are found. The rods increase in number toward the areas further from the fovea. In the eye there are approximately 6.5 million cones and 130 million rods. The rod and cone cells are transducers or devices which transform the light energy into bioelectrical energy. The rods and cones each contain a substance (rhodopsin in the rods, erthrolabe and chlorolade in the cones) which produces a photochemical change when light is absorbed. A complete understanding of the way in which retinene and opsin, the end products of the photochemical process in the rod cells, trigger the bioelectrical charge is not known. (Grossman, 1967)

The first synaptic junction (a synapse is a junction where a neuron forms a functional connection with another neuron) occurs in the retina. The rods and cones form synapse with bipolar cells which in turn form a synapse with the ganglion cells. There is not one way in which the neurons form synaptic connections, but at least four different patterns have been identified, with each pattern producing a different result. (Riggs, 1965)

After a neuron has been stimulated by light, there is a period of about .5 millisecond during which time no other impulse can stimulate the neuron. The cell is in a state of absolute refractoriness. Following the state of absolute refractoriness, the cell is in a state of relative refractoriness. During this period of from 3 to 5 milliseconds only very intense stimuli activate the cell. The states of absolute and relative refractoriness limit the number of impulses which a neuron can conduct. After the relative refractory period follows the supernormal period at which time stimuli below threshold can exite the neuron. The last stage in the cycle is the subnormal period during which greater than normal stimulation is required to propagate an impulse. The impulse travels over the cell at a rate which is dependent on the diameter of the fiber. The largest diameter fibers conduct at a rate of 3 to 14 meters per second; the smallest fibers conduct at a rate of 2 meters per second. One factor which explains why processing is not simultaneous are these temporal demands of the neurological channel. (Grossman, 1967)

A review of the research concerning the functioning of the retina leads to the conclusion indicated by Hartline that "a great deal of elaborate and sophisticated 'data processing' takes place in the thin layer of nervous tissue that is the retina." (Hartline, 1969) The retina and visual pathways serve two functions: analytic and codification.

The above discussion of the excitation cycle dealt with neurons which conduct an impulse when stimulated with light. Not all neurons function in this manner. In microdissection studies of response characteristics of nerve fiber, it has been learned that some fibers give no response until the light is turned off, at which time they discharge. (Hartline, 1969) The sensory receptors perform analytically, responding selectively to specific features in the environment. If a given input does not have the trigger feature which activates the unit, it will not respond to stimulation. (Barlow, 1969) Work by Lettvin and his colleagues has shown that there are functionally different components in the frog eye. Five such components were identified: boundary detectors, convex boundary detectors, changing contrast detectors, dimming detectors, and a small group of unclassified detectors. (Lettvin, Maturana, Pitts, McCulloch, 1961) This work supports the notion that the retina and visual pathways in effect analyze the input in a way which extracts information necessary for redintegration at the level of the brain.

An important characteristic of the retina is the interrelationships of components. Within this organ there is much communication between elements. Such communication enables the analysis to occur regardless of where the image strikes the retina. Recent investigations have identified considerably more intercellular connections at the horizontal plane, or at right angles with the rod and ganglion cells:

> After light hits the retina the light energy absorbed in specific regions of the image is transduced and transmitted from the photoreceptors to other cells through some of these horizontal nerve connections. In this way, each photoreceptor is able to measure some properties of the light and transmit the properties to other retinal cells. (Pedler, 1970)

An equally important finding concerned the interacting functions. The activity of other cells can affect the pattern of discharge of a given cell. Hartline found that "the brighter the light in the neighboring receptor, the greater the slowing of the discharge of a receptor being tested." (Hartline, 1969). The function of inhibitory interaction is to enhance contrast.

> Strongly excited receptor elements in brightly lighted regions of the retinal image exert a stronger inhibition on receptors in more dimly lighted regions than the latter exert on the former. Thus the disparity in the actions of the receptors is increased, and contrast enhanced. Since inhibition is stronger between close neighbors than widely separated ones, step intensity gradients in the retinal image--edges and contrast--will be increased by contrast. (Hartline, 1969)

Thus in order to understand analyses at the retinal level we must understand the intercommunication of the elements as well as the elements themselves.

In addition to its analytic function the retina also codes the information gained by the analysis for transmission through the optic nerve to the brain. Considerable information exists about coding in the retina. Much of the knowledge of the coding process which exists is the result of electroretinogram studies. Using the electroretinogram it is possible to identify the pattern of electrical discharge of a stimulated nerve. The code which is used by the visual system is a frequency code. Although early studies seem to point to a lack of relationship between stimulus intensity and impulse frequency, later studies point to association. Even though individual elements may react in a way which would make a one-to-one association untenable, the relationship holds when the activity of all of the units involved is considered. (Granit, 1955)

Fibers from the ganglion form the optic nerve. The bundles of nerves from both eyes divide at the optic chiasma in such a way so that half of the fibers from each eye continue to one hemisphere of the brain. The optic nerve contains approximately one million fibers. About 80% of the fibers terminate in the lateral geniculate body of the thalmus. The other 20% terminate in the superior colliculi and pretectal area. These are afferent fibers and make connections with motor nuclei which control pupillary light reflexes and eye movements. The fibers which arrive at the lateral geniculate body of the thalmus form synapse and continue to the striated area of the left and right occipital lobes. (Grossman, 1967)

The optic nerve divides at the chiasma in such a way that the temporal side (outer side) of each retina is connected with the occipital lobe on the same side (ipsilateral connection) while the nasal side (inner side) is connected with the occipital lobe on the opposite side. Any stimulus to the right of center stimulates the left half of both retinas and are transmitted to the left occipital lobe.

The evolution of the optic nerve was affected by two factors. First, it was necessary that there be a sufficient number of fibers in the nerve in order to carry the needed information to the brain, but also the dimension of the nerve had to be of such a size so to enable the eye to move. This first solution which might occur would be to reduce the diameter of the fibers. Since there is a relationship between the diameter of the fiber and rate of conduction, with the fibers of smallest diameter conducting the slowest, this would have resulted in slower visual processes. Given the importance of vision for survival in most vertebrates, slowing visual processing would have been unsatisfactory. Since visual information typically is highly redundant, processing at the retinal level is useful. In a sense, the brain is spared the necessity of a huge flood of information, much of which is redundant. (Pedler, 1969) Thus processing activity at the retinal level has a physiological exigency as well as a functional utility. Barlow suggests that the code which is selected for transmission of information through the visual system reflects much stored information about the environment; since, probabilities of sensory events and joint probabilities of group events are required in order to select a code. Barlow thus hypothesizes that synaptic connections are genetically determined so that the animal's typical sensory environment can be represented with a minimum of activity. If the environment is changed, the activity should rise until changes in the synaptic connections take place. (Barlow, 1969)

In a sense, then, the experiences which an individual has had may represent an important aspect in the way in which he "programs" himself. And the program which is established may be more or less appropriate or effective for a given perceptual experience. The nature of the past experience of the organism not only helps to determine the utility of coding (and perhaps analysis) at the retinal level, but also the efficacy of synthesis at the brain.

It is clear that we do not see the retinal image but, in Neisser's words "one sees with the aid of the retinal image" (Neisser, 1968) the retinal image in effect, supplies the raw material out of which a perception is made. In Neisser's words:

> the eye and brain do not act as a camera or a recording instrument. Neither in perceiving nor in remembering is there any enduring copy

> of the optical input. In perceiving, complex patterns are extracted from the input and fed into the constructive process of vision so that the movements and inner experiences of the perceiver are visually good corresponding with his environment. . . . Although the eyes have been called the windows of the soul, they are not so much as entry ports supplying raw materials for the constructive activity of the visual system. (Neisser, 1968)

The information gained from any one fixation is partial, and frequently distorted. Certainly the ports must be open in order for perception to occur, but to be successful the organism must be able to structure the raw material.

The studies cited by Hebb (1949) dealing with congenitally blind persons whose sight was restored furnishes strong evidence to support the conception of perception as described by Niesser. Even in the case of the perception of relatively simple stimuli like a square or a circle a considerable amount of past learning is requisite before one can quickly glance at such a figure and perceive it as a circle or square. Another illustration comes from studies of the experience of subjects who view a photograph for the first time. Such individuals, because they have not learned to use the information which the retina is presenting, have difficulty "seeing the picture." Research indicates that African illiterates find it very difficult or are unable to interpret two-dimensional pictures three-dimensionally. Several other studies which have been done support the notion that visual skills required to perceive pictures is associated with cultural environment. (Stacey, 1969)

A necessary but not sufficient requisite for the successful processing of a visual stimulus is a duration of time. Research has established that the perception of a visual stimulus may be disrupted by the presentation of a second visual stimulues (Sperling, 1960; Averback and Coriell, 1961). The minimum time that must be allowed between the initiation of the first stimulus and the appearance of the erasing stimulus in order for recognition of the first stimulus to take place is referred to here as the minimum interval for recognition.

In a series of investigations at Western Michigan University, techniques utilized by Gilbert (1959) have been modified in order to make possible more precise measurement and control. (Travers and Bosco, 1967; Bosco, Travers and Wilkins, 1968; Wilkins, 1968) The processing rate calculated using these procedures is a measurement of the speed of cognitive functioning in visual perception. It represents the time required to process the incoming batch of information to the point where the recognition can take place. Based on the previous discussion of processing of visual information, five stages can be discerned:

1. input of light into the visual system;

2. analysis of signal and transduction of light into bioelectrical charge at the retinal level;

3. transmission of the signal through the optic nerve;

4. reception of signal in the brain;

5. response or output (e.g., "I see a square.")

Estimates of the information processing rate are obtained by tachistoscopically presenting stimuli to the subject. The minimum time that must be allowed between the first stimulus (test stimulus) and the appearance of a subsequent stimulus (noise) provides an estimate of the maximum functional (i.e., the information can be processed) flow of information through an individual's perceptual channel. The measurement technique that has been employed in these investigations involves the quantification of the amount of information carried by each stimulus in terms of bits using Shannon's mathematical theory of communication. (Shannon, 1948)

There are two differing theoretical positions relative to the way in which the noise stimulus affects processing time. Kahneman labels these two conceptions integration theory and interruption theory. (Kahneman, 1968) Ericksen has been one of the chief proponents of integration theory. He maintains that stimuli which are separated by very brief intervals are perceived as a composite. Ericksen and Spencer maintain that "a noise field immediately following a stimulus display may have the same effect as though the two fields had been presented simultaneously." (Ericksen and Spencer, 1969) In effect, the second stimulus tends to dilute the intensity, contrast or clarity of the first stimulus.

Among those who have proposed an interruption theory have been Averback and Coriell, 1961; Sperling, 1960; Haber and Nathanson, 1969. Interruption theory maintains that the mask interferes with or interrupts the processing of the test stimulus. Interference theory explains masking in the following manner.

After a stimulus is turned off, information which is stored in short-term storage continues to be perceived much as if the light source was still on. If we consider the minimun time required by an individual to process a given quantity of information as the duration between t_1 and t_2, there are two ways that the necessary duration could be provided. The necessary time might be provided by allowing the light source to remain on for the required duration (see b. in Figure 3). Or it may be provided by a briefer duration of the light source, if the icon is of sufficient length to supply the other necessary component of time (see c. in Figure 3 below). Interference theories explain masking as the disruption of the icon, thereby providing insufficient time (in some instances) for processing.

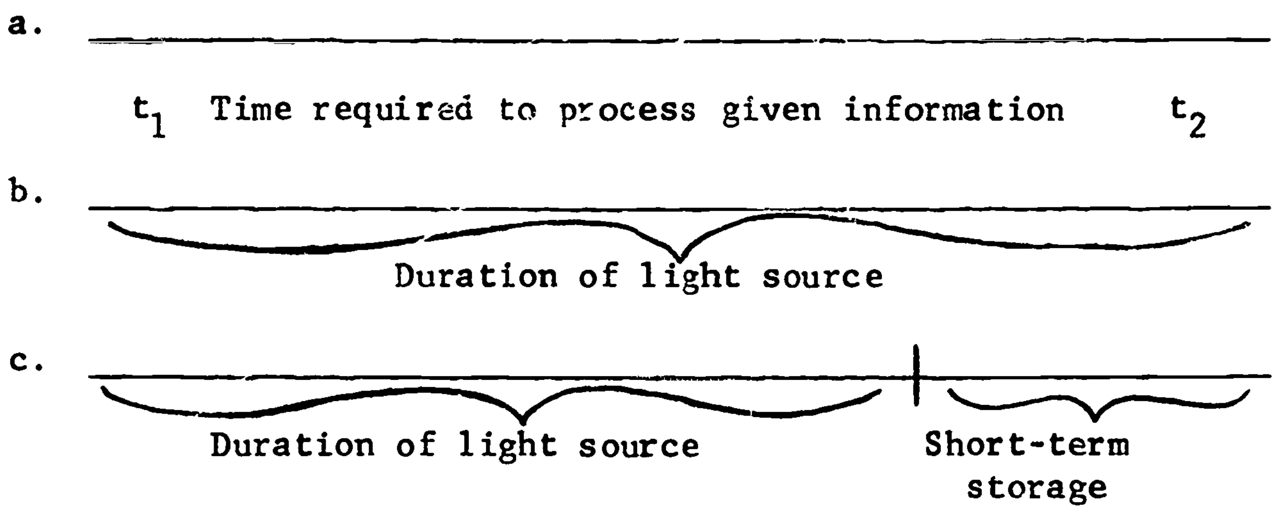

Fig. 3--Two alternatives providing sufficient time for processing

Studies by Schiller indicate that several types of interference exist depending on the nature of the situation. Schiller differentiates between masking without countour interaction, pattern masking and metacentrost. Schiller used electrophysiological recordings of the optic tract, the lateral gentriculate nucleus, and area 17 (pattern recognition area) of the cat. In his study of pattern masking (the type of masking which was used in the study reported in this document), Schiller found that the presentation of two stimuli in rapid succession with borders which fall very close to each other, the receptive fields near the borders responded similarly to the paired stimuli and the single stimulus. This effect occurs at the cortical level. (Schiller, 1969)

Although the resolution of the theoretical dispute will constitute an advance in our understanding of visual perception the existence of the dispute does not weaken the case for the use of the masking procedure in studies of perception. Both theoretical positions assert that a certain duration of time free of any additional visual information is required in order for a visual stimulus to be processed. The critical notion upon which the study is based is that if visual processing is to be successful a duration of time is required and that there is variability in the duration required. The procedures to be described in the following chapter involve techniques for estimating the processing time required by subjects.

The basic purpose of this investigation was to explore the relationship between social class and the rate of cognitive processing of visual information in young children. Two questions form the basis for the study.

Do disadvantaged children process visual information at a rate which differs from children reared in advantaged environments?

Investigations of sensory deprivation in human and non-human organisms have revealed disruptions in perceptual processes. (Corso, 1967) Bruner contends that early sensory deprivation hinders the organism from developing a model of the environment. Without such models, he contends, it is impossible to separate signal from noise and also to use partial information effectively. (Bruner, 1966) In much the same way, Martin Deutch argues that the lack of variety of stimuli in the disadvantaged child's environment thwarts perceptual development. (Deutch, 1967) As was seen in the discussion of the neurological aspects of processing, it is not absurd to contend that the social environment may have neurological concomitants which might result in variation in rates of handling visual information.

Do development courses of information processing rate for advantaged and disadvantaged children diverge as they proceed through the grades?

As a result of his own and other investigations, Deutch has proposed the cumulative deficit hypothesis. (Deutch, 1967) He maintains that as the disadvantaged child proceeds through the grades he becomes more and more retarded relative to middle and upper class children. The disadvantaged child enters the school penalized by virtue of this environment, failure breeds failure, and thus in the later elementary grades the disadvantaged child is further behind his advantaged colleagues in academic achievement than he was upon entering school.

Procedures for the Study

Selection of Universe and Sampling Procedure

The first step in the data collection process was the selection of the universe. Since the investigation was conducted in order to compare children from varied social classes, it was necessary that the universe be one which included families which ranged from low to high social class. Also an urban area was sought so the universe for this study would be comparable to the bulk of literature on the disadvantaged. Given these considerations, the obvious choice for data collection in southwestern Michigan was Grand Rapids. Grand Rapids is the second largest city in Michigan (population 300,000), and contains a sizable inner-city area with a disadvantaged population. Permission was given by the Grand Rapids Public Schools to collect data in October 1968.

In establishing the sampling procedure three characteristics of tachistoscopic testing were kept in mind:

1. Collection of data with the tachistoscope is a fairly expensive process. Each subject requires from 25 to 45 minues of individual testing, and it is necessary for the tester to be carefully trained.

2. Although it is possible to move the necessary instruments, it is not feasible to move them frequently.

3. Testing requires a room which can be closed off from school use, and one wherein the instruments can be stored for the duration of

the data collection.

These considerations caused limitations in the total N of the sample, and the number of schools which could be represented.

The sample for the study consisted of two schools. One of these schools was in the inner-city, the other was in the suburban area. The inner-city school will be called Fernside and the suburban school will be called Kenwood in the ensuing discussion. In these two schools a room for testing was available, and disruption which the data collection process would entail was accepted. Discussions in the school system did not reveal any aspects of either school which suggested that the school was unlike other schools of similar type.

Within each school, thirty children from each of three grade levels--grade one, grade three, and grade six were randomly selected for the study. At each grade level, an equal number of subjects were selected from each class. This was done so that the effects of tracking (homogenous grouping based on school achievement) would not affect the results. Table 1 shows a breakdown of subjects included in the study.

TABLE 1

Subjects for the Study

	School	
Grade	Fernside	Kenwood
First	N = 30 (selected from two classes)	N = 30 (selected from two classes)
Third	N = 30 (selected from two classes)	N = 30 (selected from three classes)
Sixth	N = 30 (selected from two classes)	N = 30 (selected from three classes)

Testing was done at threegrade levels in order to provide sufficient data points for the plotting of development curves.

Measurement of the Dependent Variable

The estimation of processing rate was accomplished with the use of a Gerbrants 2-field tachistoscope. This instrument permits a visual stimuli to be presented for durations ranging from 1 msec. to 1,100 msec. on either of the two stages of the device. Using the dials on a timer, the experimenter can control the durattion of an exposure of field one, field two, and the pause between fields one and two. For example, the timer can be set to provide an exposure of 40 msec. on field one, a twenty-three msec. pause followed by a 15 msec. exposure on field two. The stimuli to be presented in the two fields is manually inserted into a holder at the rear of each field.

Since the tachistoscope which was to be used did not have fixation points, it was necessary to build them into the tachistoscope. This was done by cutting strips of luminous red plastic into strips. The strips were painted with black paint with an area 2 mm left unpainted. A flashlight bulb was installed above each of the plastic strips causing two dim red squares (just above threshold) to appear above and below test stimuli. The fixation points enable the subject to orient his gaze inside the tachistoscope.

Basically, the procedure consists of presenting an image in field one for a fixed length of time. This image was called the test stimuli. After the termination of the test stimulus, there occurred a pause at which time no image appeared. The duration of this pause was decreased during the testing procedure. Following the termination of the pause (which was called the inter-stimulus interval), a second image was presented. This image was the noise stimulus. The information processing rate for a subject was obtained by locating the point on the time scale at which the inter-stimulus interval was too brief and caused the noise stimulus to disrupt the processing of the test stimulus. The visual information processing rate for a subject was his maximum rate of handling visual information.

The first step in using the tachistoscope for this study was the selection of the test stimulus. Prior investigation at Western Michigan University has involved letters (Travers, Bosco, 1967), words (Wilkens, 1968), and numbers (Bosco, Travers, Wilkins, 1968).

Not uncommonly cross-sectional studies have involved modifications in procedure for different groups. Such modifications may provide considerable problems in interpretation of results from the various groups. (Epstein, 1967) Thus, for the study, test stimuli were sought which could be administered to all of the groups. None of the stimuli used in previous experiments were satisfactory. After considerable trial and error with various stimuli, four common geometric shapes were selected: circle, star, square, and triangle. Each measured three-eighths inch. Since there were four stimuli and the probability for all of the stimuli to be transmitted was .25 the information carried by each was two bits.

The shapes have the following characteristics:

1. They can be discriminated by first grade children. Pilot work with disadvantaged children indicated that disadvantaged first-graders could discriminate these shapes.

2. These four shapes maximize inter-stimulus dissimilarity. A diamond, for example, was rejected since it would be confused with a square.

3. In order to promote comparability among stimuli, all figures used were closed figures.

4. All figures were symmetrical.

5. All figures were solid white on a black background.

Although the selection of the test stimuli required an appreciable expenditure of time, the development of the noise stimulus posed a considerably more complex problem. Noise stimuli which had been used in other studies were inappropriate.

Numerous noise patterns were examined and discarded. Some were discarded because they failed to effectively mask the test stimulus. Others were discarded because they tended to bias responses toward one of the test stimuli. One discarded masking stimulus, for example, contained two semi-circles and tended to be structured as a circle. Another pattern that was discarded was a random pattern of white spots. This pattern did not mask the test stimulus. That is, it did not function as a visual noise. It seems essential that the masking pattern contains, in the target area, 50% white and 50% black, also there should be no large are s of white or black. The pattern which was eventually selected was a complex design, constructed so that it contained none of the geometric symbols used as test stimuli for this study.

Another of the critical problems involved in the techniques of assessing processing rate is the scaling of the intervals to be used between the test stimuli and the masking stimuli. It is important that testing begin at a point where success is 100 percent for each subject. During pilot investigations with first graders, it was observed that the schedule that had been used with sixth graders was inappropriate. This schedule began with sixty msec. and decreased in intervals of six msec. to six msec. In order to begin at a level above threshold, it was necessary for some children to begin above one hundred msec. Since the tachistoscope can be varied only in units of ten above one hundred, it was decided to adopt a pattern of decrements of ten so that the scale would proceed with a standard and consistent interval. When testing the first graders, two schedules were used. Schedule A ranged from ninety to zero in intervals of ten. If a subject made a sufficient number of errors on the first three levels of Schedule A for a threshold identification, then Schedule B was used. Schedule B ranged from 190 to 100. If a threshold was not identified by the one hundred msec. level, then testing continued on Schedule A until a threshold was identified. Both schedules are contained in Appendix A.

The general nature of the experiment was described to each subject, who was given a card with the four test stimuli to be used printed on it. All subjects were given four trials with each of the test stimulus alone, followed by an additional four trials with the blocking stimulus presented after an interval of twenty msec. In addition, each subject was given four trials with the blocking stimulus immediately following the test stimulus in order to familiarize them with the effect of the complex stimulus. It was explained to the subjects that they should guess if they could not recognize the letter presented. The sequence, dark field--test stimulus--dark field--noise stimulus--dark field, was triggered by the subject pressing a switch. Between trials, subjects were asked to look away from the apparatus into the dimly lit experimental room. Subjects were instructed to respond after each trial. If they did not feel certain of the identification of the test stimulus, they were instructed to guess. Requiring subjects to respond each time controls for individual differences relative to willingness to respond given some doubt about the accuracy of the response.

Each test stimulus was presented for five msec. followed by a dark field varying in duration from ninety msec. to zero msec. (assuming that Schedule A was being used). The dark field was followed by a blocking stimuli presented from ten msec. The test and blocking stimuli appeared between two dim red markers two mm in diameter. The test stimuli were presented in ten blocks of four stimuli in random order within ninety msec. The dark field was followed by the complex design. Subsequent blocks had post-exposure dark fields of 80, 70, 60, 50, 40, 30, 20, 10, and 0 msec.

The visual angle of the stimuli was less than one degree. The luminescence of test and noise stimuli was three ft.1. measured with a Spectra Brightness Spot Meter, Model UB.

At the beginning of each testing procedure, a check-out procedure was followed in orfer to insure the proper functioning of the instruments. Also, the tester followed a standardized procedure for interactions with subjects. The manual used can be found in Appendix B.

Measurement of Independent Variable

Socio-economic status (SES) was quantified using Duncan's "Socio-Economic Index." (Reiss, 1961) Using the "Socio-Economic Index," a score was given to each child based on the occupation of his parent or guardian. Since it is not the policy of the Grand Rapids School System to record parents' occupation, it was necessary to secure such data for the study. This was done by phoning parents or place of employment and requesting specific information about occupation. In Fernside School, the phoning was done by a teacher-aide; in Kenwood School, the phoning was done by a secretary.

Other Data Collected during the Study

Although the principal data for this investigation were information processing rate and socio-economic status, other data were also collected which were considered to be of possible utility for secondary analyses. The following data were collected from cumulative records:

1. Sex
2. Race
3. Birthdate
4. Height
5. Weight
6. Absence and tardy record
7. Reading Step--this indicates teacher's evaluation of the child's reading level
8. Ability to differentiate between shapes, words, and letters--this is a teacher evaluation which appears on the child's report card among other specific skills in reading.
9. Mathematics score
10. Spelling score

11. Social habits (deportment)

12. I.Q.

13. Reading achievement test information

14. Reading readiness test information

Some of these data did not prove to be useful either because of the number of entries missing or because no question was formulated for which the information was needed. More complete description of these measures is presented in the code book contained in Appendix C.

Statistical Analysis

In addition to the use of basic descriptive and inferential statistics such as means, standard error of means, correlations, two analytic techniques were used: analysis of variance, and multiple regression analysis (Kelly, Beggs, McNeil, 1969). In all cases, alpha was set at .05. Additional information concerning the appropriateness of the various statistics is presented in the next chapter along with the analyses.

Research Findings

In this chapter the results of the investigation are presented. First the general characteristics of the sample are presented in Table 2.

TABLE 2

Description of Basic Characteristics of the Sample

Grade	First		Third		Sixth	
School	Fernside	Kenwood	Fernside	Kenwood	Fernside	Kenwood
Number	30	30	30	30	30	30
Sex	16 boys	14 boys	14 boys	14 boys	17 boys	12 boys
	14 girls	16 girls	16 girls	16 girls	13 girls	18 girls
Race	13 white	29 white	12 white	29 white	3 white	30 white
	17 black	1 black	18 black	1 black	27 black	0 black
Mean Age	85.2 mo.	85.1	114.2	109.5	146.8	146.8

As anticipated there was considerable racial differences between schools. Most of the subjects in Fernside School were black and most in Kenwood School were white. Less expected was the similarity in mean age at the various grade levels. Differences between schools in retention rates could have caused age discrepancies at the three levels. Except for a slight difference at the third grade level, mean age in the grade was identical (sixth grade) or virtually identical (first grade).

Deviation from 50-50 breakdown according to sex were minimal, ranging from a high for boys of seventeen (two boys above fifteen which is the 50-50 level) and a low for boys of twelve (three boys below the 50-50 level). Comparisons between the two schools on the characteristics shown in Table 2 do not indicate any defects in the sampling procedure.

In developing the sampling procedure, care was taken to sample in such a way so that subjects would exhibit high and low SES scores. Fernside School was expected to provide the low SES scores and Kenwood the high and middle SES scores. Table 3 shows the outcome of the SES scores for the two schools.

TABLE 3

Means and Standard Error of Means for SES Scores for Subjects

School	Grade		
	First	Third	Sixth
Kenwood	$\bar{X} = 54.14$	$\bar{X} = 58.26$	$\bar{X} = 55.93$
	$SE_M = 4.66$	$SE_M = 3.38$	$SE_M = 3.93$
Fernside	$\bar{X} = 14.63$	$\bar{X} = 19.63$	$\bar{X} = 20.17$
	$SE_M = 1.04$	$SE_M = 1.83$	$SE_M = 3.39$

As this table shows the sampling procedure did have the desired result with regard to SES. Means from Kenwood and Fernside schools were considerably different. There was considerable variability among SES scores; however, there was little overlap of the SES distributions from the two schools. In the first grade two children from Fernside were above the median SES; in the third grade two Fernside children were above the median SES; and five Fernside pupils were above the median SES in the sixth grade.

Thresholds were established for each protocol by finding the first level where there were three or more incorrect responses. The threshold level was the next highest level. If there were three or more correct responses in a block below one containing three errors, then the threshold was designated in a block below the one containing the correct responses.

Three analyses of the protocols were undertaken in order to provide information about the testing procedure. First the percentages of incorrect responses above the threshold were calculated. This can be used as an index of the "cleanness" of the protocol. Protocols with few errors above the threshold are said to be "cleaner" than protocols with many errors above the threshold. The distribution of correct and incorrect responses below the threshold were not calculated since visual inspection indicated that with a couple of exceptions errors below the threshold were well above the expected 75% level. (With four possible responses we expect 25% success as a result of guessing.) Table 4 presents data for this analysis.

TABLE 4

Means and Standard Deviations for Percentage of Errors Above the Threshold According to Grade Levels

	Grade		
School	First	Third	Sixth
Kenwood	$\bar{X}$ = 17.21	$\bar{X}$ = 16.36	$\bar{X}$ = 10.45
	s = 9.81	s = 12.83	s = 7.43
Fernside	$\bar{X}$ = 25.88	$\bar{X}$ = 17.88	$\bar{X}$ = 12.33
	s = 17.50	x = 10.50	x = 8.76

The greatest discrepancy between levels occurred at the first grade level. Here there was approximately a nine percent difference with children in Fernside producing protocols which had more errors above the threshold. In both schools, the trend was toward fewer errors at levels above threshold. The decrease in errors above threshold indicates that random errors caused by a mistimed eyeblink or an improper eye orientation tend to decrease as a function of age.

A second analysis was undertaken in order to discover if the recognition rate of the four stimuli were similar. That is, did the four stimuli provide equally difficult recognition tasks? Tables 5 and 6 show the number of errors for each stimulus. The small number of errors in Table 5 for first grade subjects is a result of the large number of subjects who required the use of two schedules in order to identify a threshold. In such cases testing did not continue to the end of Schedule B, but ended when a threshold was identified.

TABLE 5

Number of Errors for Each Stimulus with Fernside Subjects

	Grade		
Stimuli	First	Third	Sixth
Star	85	148	97
Circle	54	112	78
Square	66	141	116
Triangle	61	136	89

TABLE 6

Number of Errors for Each Stimulus with Kenwood Subjects

Stimuli	Grade		
	First	Third	Sixth
Star	119	105	98
Circle	88	89	67
Square	127	108	90
Triangle	101	98	84

These tables are interpreted as follows. In the first grade sample at Fernside School, the star was incorrectly identified eighty-five times, the circle was incorrectly identified fifty-four times, etc.

Inspection of these two tables shows a fairly consistent pattern in each of the six groups. In each case fewest errors were made with the circle. The next fewest errors were made with the triangle. In three cases, the star was the stimuli which elicited the most incorrect responses. In three cases the square was the stimulus which produced the most errors. Although the four stimuli did not seem to present equally difficult discrimination tasks, the discrepancies were not considered of such a magnitude to jeopardize the validity of the measurement of processing rate. A relatively small amount of discrepancy between stimuli is sufficient to produce the differences observed for the group of thirty.

A third analysis of the protocols focused on the incorrect responses, e.g., how many times was the response "square" used when the stimulus was not a square? This question was asked for each of the four stimuli.

The answer to these questions reveals the extent of response bias. Data for both schools are presented in Tables 7 and 8.

TABLE 7

Frequency of Incorrect Use of Each Stimulus Label for Fernside Subjects

Stimuli	Grade		
	First	Third	Sixth
Star	64	139	94
Circle	86	153	134
Square	56	125	83
Triangle	59	112	67

TABLE 8

Frequency of Incorrect Use of Each Stimulus Label for Kenwood Subjects

Stimuli	Grade		
	First	Third	Sixth
Star	92	90	68
Circle	118	116	120
Square	90	104	80
Triangle	133	89	68

In all groups except one (first graders at Kenwood) circle was the most frequently used incorrect response. Tables 5 and 6 show that the subjects were most successful with the circle stimulus; it is not surprising that their success produced a response bias for this label.

Examinat n of the other stimuli did not reveal any other systematic occurrence which warrants explanation; differences between second, third, and fourth placed stimuli in this analysis were unsystematic or trivial.

The analyses of the protocols suggest no major disruption in the testing procedure, but the circle stimulus did exhibit some troublesome characteristics.

There were two principal questions which this investigation sought to answer: Do disadvantaged children process visual information at a rate which differs from children reared in advantaged environments? Do development curves for advantaged and disadvantaged children diverge as they proceed through school? In the next several pages, the findings relative to these two questions will be presented.

In selecting the sample, variability in social class was built into the sample by selecting subjects from two schools, one a low SES school, the other a middle SES school. Variability in age was accomplished by selected subjects from three grade levels. Two analyses of the data will be reported. First is an analysis of variance which uses grade level and school to quantitize age and social class. Then a regression analysis will be presented. In the regression analysis, age was quantified by mean then of age and social class by the use of Duncan scale. In testing hypotheses alpha was set at .05 level.

<u>Question One</u> - <u>Do disadvantaged children process visual information at a rate which differs from children reared in advantaged environments?</u>

Table 9 shows the means and standard error of means for the Kenwood and Fernside subjects.

TABLE 9

Means and Standard Error of Means for Information Processing Rate with Fernside and Kenwood Subjects

School	Grade First	Third	Sixth
Kenwood	$\bar{X} = 33.48$	$\bar{X} = 28.93$	$\bar{X} = 25.86$
	$SE_M = 5.52$	$SE_M = 3.36$	$SE_M = 2.19$
Fernside	$\bar{X} = 70.33$	$\bar{X} = 46.00$	$\bar{X} = 34.84$
	$SE_M = 9.64$	$SE_M = 5.63$	$SE_M = 5.15$

Information processing scores are threshold scores which reflect the briefest exposure to stimuli which the subject can process. Scores are reported in milliseconds. Table 9 shows that at each of the three levels the advantaged children (Kenwood) exhibited faster processing rates, i.e., less time was required for successful processing. Although there was a decrease in the variability in both groups as grade level was increased, considerably more variability was found in Fernside School.

The data were then analyzed using analysis of variance procedure.

TABLE 10

Analysis of Variance for Information Processing Rates

Source	SS	df	MS	F	p
Total	205718.51	176			
School	19109.81	1	19109.81	14.73	$p < .01$
Grade	14514.74	2	7257.371	9.39	$p < .01$
Interaction	39967.08	2	19983.54	25.86	$p < .01$
Error	132126.28	171	772.67		

As Table 10 shows, school, grade, and the interaction were significant. Both the school attended as well as the age of the student are associated with the processing rate. The age, however, did not appear to function similarly for the two schools, hence the significant interaction term. Age has a much more dramatic effect for the low SES school. The summary of the analysis of variance reported in Table 10 indicates that there were differences in processing rate for children in low SES groups, and high SES groups.

A regression analysis was undertaken in order to consider the impact of social class from a somewhat different perspective. The regression analysis enables the estimation of the contribution of a series of variables toward explanation of another variable. For purpose of the regression analysis, age was quantified in terms of the number of months of life since birth. Social class was quantified using Duncan's scale. (Reiss, 1961) Two models were compared:

Model A Processing Rate = age + sex

Model B Processing Rate = age + sex + SES

The regression analysis tells how much of the variance in processing is accounted for by each model. An additional analysis can reveal if the increment resulting from the addition of SES in Model B significantly increased the prediction. A summary for this is presented in Table 12. Before this summary, a matrix of the correlations is presented.

It is not surprising to find no correlation between age and sex and SES and social class. Both the correlation between SES and IPR and age and IPR were significant at the .05 level.

TABLE 11

Correlation Matrix for Variables in Model A and Model B

	Age	Sex	SES	IPR
Age	——	.02	.00	.23
Sex	.02	——	.00	.00
SES	.00	.00	——	.29
IPR	.23	.00	.29	——

TABLE 12

Summary of Comparison of Regression Model A with Model B

	R	R^2	df	F	p
Model A	.238	.06	$^1/_{174}$	16.94	$p<.01$
Model B	.371	.14			

Table 12 shows that Model A resulted in a multiple regression coefficient of .238, and Model B a coefficient of .371. The multiple regression coefficient when squared gives an estimate of the amount of the variance in the dependent variable explained by the independent variables. Comparisons of the R^2 shows an increase of eight percent. This difference is significant. Inclusion of information concerning SES results in a model which has significantly more explanatory power than does a model with information of only age and sex.

In order to determine if the inclusion of an additional term to account for the interaction of age and SES would increase the explained variance Model B was compared to Model C. Model C is: Processing Rate = sex + age + social + interaction of age and social class.

TABLE 13

Summary of Comparison of Regression Model B with Model C

	R	R^2	df	F	p
Model B	.371	.14	$^1/_{173}$	1.82	p ,05
Model C	.383	.15			

Although there is some increase in the multiple correlation coefficient, the increase is not significant. Thus, although interaction is significant when age and social class are quantified by grade level and school, it is not significant when quantified by months and Duncan's scale.

The regression models just presented assumed a linear association. In order to test this assumption an analysis of the association between age and processing rate and social class and processing rate was conducted. This analysis revealed that the component in the association which could be explained using a quadratic or cubic function was not significant. This analysis supported the use of a linear model.

Although the concern in focus at this point was the utility of social class as a variable to predict processing rates, a secondary analysis was conducted to assess the extent to which variance in processing rates could be explained using other data which had been collected. For this analysis, grade six was used since the data on other variables was most complete for this grade. A fourth model was built and called Model D: IPR = age, sex, SES, height, and absence. Table 14 shows the correlation matrix for these variables.

TABLE 14

Correlation Matrix for Variables in Model D

	Age	Height	SES	Absence	IPR
Age	—	.27	.07	.08	.13
Height	.27	—	.32	-.03	.06
SES	.07	.32	—	-.24	-.18
Absence	.08	-.03	-.24	—	.55
IPR	.13	.06	-.18	.55	—

The most interesting piece of information contained in this matrix is the correlation between absence and IPR. Of all the variables which were examined absence produced the highest correlation with processing rate. The relationship was direct, thus the more absence the slower the processing rate. Whether absence is an index of health status or attitude toward school--or perhaps more properly the extent to which it is each of these is unclear. Whatever absence measures, it is a good predictor of processing rate.

The multiple regression coefficient for Model D was the highest of any of the models: R = .56. R^2 for the model was .31 which means that this model explains about one-third of the total variance in information processing.

<u>Question Two: Do development curves for advantaged and disadvantaged children diverge as they proceed through school?</u>

As the reader knows the data on which this report is based were cross-sectional. The assumption which must be accepted before the data described in this section can be used to answer question two is that the third graders represent a fair description of the sixth grades two years ago, and the first graders a fair description of them five years ago.

Figure 4 shows the plottings of the six data points.

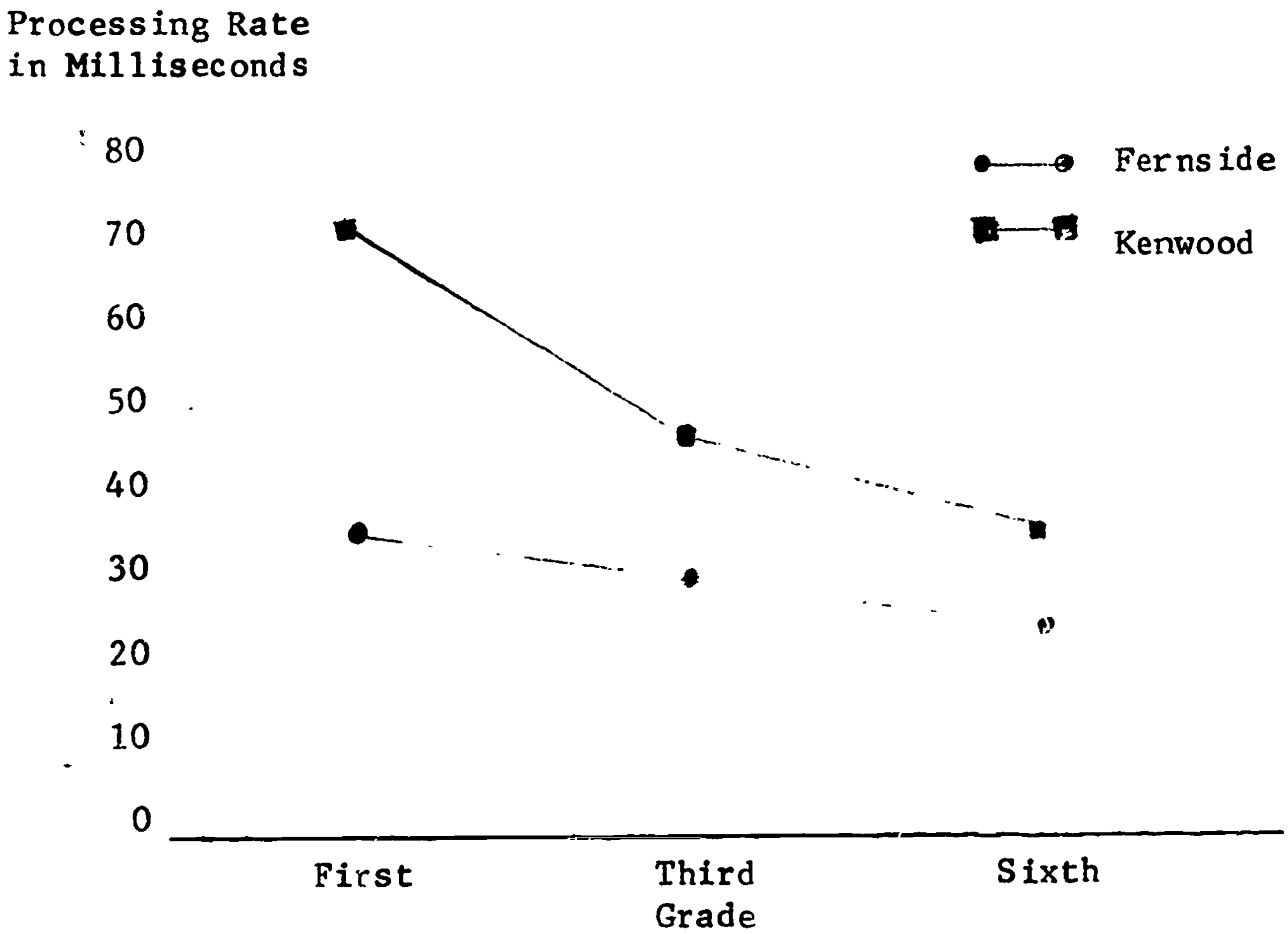

Fig. 4--Mean processing rates for subjects at Kenwood and Fernside schools

The trends of IPR for subjects in the two schools were considerably different. The great difference in scores at the first grade level tends to be reduced as the children proceed through school. The difference between scores at the first grade was 36.85 msec. At the third grade the difference was 17.07 msec., while at the sixth grade it was 8.98 msec. As we move back in time from grade six the increase is geometric. The curves for Ss from both schools appears to be leveling off at the sixth level. Notice, however, that the mean score for sixth graders at Fernside School was 1.36 msec. higher than the first graders at Kenwood. Thus, children in the first grade at Kenwood School process visual information at the first grade level slightly faster than sixth grade children at Fernside.

Question Three- What relationship is there between visual processing rate and other achievement variables?

Answering this question was not a primary objective of this study, but data which were available on school achievement were examined in relation to processing rate. These data need be viewed with some caution since the care with which they were collected is at best uncertain.[1]

Table 15 shows the correlations between processing rate and achievement variables for sixth grade students.

TABLE 15

Correlation Coefficient of Achievement Variables with Processing Rate for Sixth Graders

IPR	vs	Reading Achievement = -.22
IPR	vs	Mathematics Achievement = .14
IPR	vs	Spelling Achievement = .26

Table 16 shows partial correlations with SES as the control variable.

[1]Information concerning the specific tests used is contained in Appendix C.

TABLE 16

Partial Correlations of Achievement Variables with Processing Rate with SES as Control Variable

IPR	vs	Reading Achievement - SES Control = -.18
IPR	vs	Mathematics Achievement - SES Control = .14
IPR	vs	Spelling Achievement - SES Control = .18

Comparison of Table 16 with Table 15 indicates that there is little change in the coefficients as a result of using SES as a control variable.

One other correlation was computed. Processing rate was correlated with a reading readiness score. The coefficient was -.20 which was not significant.

In the following chapter the main conclusions which were derived from the analyses of data reviewed in this chapter will be presented.

Conclusions: Visual Information Processing and Social Class

In the preceding chapter the research findings were presented. This chapter will propose possible explanations for the association of social class and visual information processing. The questions to be considered are: How can the processing of visual information break down? and, In what way can the concomitants of poverty promote a disruption of the process? Before responding to these questions, we will summarize the findings.

1. Does social class membership make a difference in the visual information processing rate of humans? The data which were examined in Chapter III suggest that class membersip is associated with a slower visual processing rate. Using two different quantifications of social class, analyses produced similar results. In the analysis of variance model, using school membership as a social class index (Kenwood School--middle social class; Fernside--low social class), a significant F ratio was obtained for social class. In the regression analysis, using Duncan's scale for SES, the introduction of social class data significantly increased the ability to predict visual processing. Children from middle SES school enter first grade with a mean processing rate that was quite comparable to sixth grade children in the low SES school. In other words, the average advantaged first grader processes visual information as rapidly as does the average disadvantaged sixth grader.

In terms of group trends, it is accurate to conclude that a basic cognitive ability, as expressed by visual information handling capacity, is slower for low SES children than for middle SES children. A longer duration of time is required by low SES children for successful processing of a visual stimuli. Having said this, it is important to indicate that there was some overlap between the two groups. Although the odds are that a disadvantaged child will exhibit a slower processing rate, it is not inevitable; diagnosis of an individual's preceptual ability on the basis of social class identification is tenuous.

In addition to slower mean processing rates, disadvantaged children exhibited more errors above threshold. Even for stimuli which were well above threshold, the low SES child was more likely to be unsuccessful in processing than his advantaged peer. Errors above threshold could be a result of improper visual orientation, motor control deficiencies, or low success motivation for the task. Non-structured observations of subjects during testing did not lead us to suspect significant differences in motivation between the two groups.

There are two ways in which individuals can achieve low (fast) processing rates. Individual differences in the efficiency of the neurological processes requisite to perception could produce variability in rates. The efficiency of the neurological system could influence the ability of the organism to successfully process a given amount of information. Defects in components in the system or inefficiency in the formation of synapses (Barlow, 1969) could increase the time needed for processing.

It seems possible, however, that two individuals with fairly comparable neurological equipment could exhibit differing processing rates. As the duration between the test and masking stimuli decrease, the "strength" of the test stimulus is decreased. Not infrequently, subjects reported that they picked up a piece of the stimuli, and used that piece to make a response. Thus, a second phenomenon which could produce variability in processing rates would be the ability to interpret a message given that the message as it reaches the brain is incomplete. Individuals may vary in their ability to redintegrate the stimulus from partial information.

The effect of either of the two situations described above would be similar. Subjects differ in the time they require with a stimulus before they can successfully process it and can "turn to" another stimulus. This information would suggest that the average advantaged child has the capacity to process more visual information in the same length of time than does the average disadvantaged child. A pictoral depiction of the differences in handling capacity for first graders is shown in Figure 5. This figure shows the advantaged child handling about twice as many stimuli as the disadvantaged child in the same length of time. Certainly, the simple one-to-one extrapolation from the measurements obtained to this Figure must be accepted tentatively. Other variables such as fatigue could enter in during the presentation of a sequence of stimuli, and the effect of these variables may not be similar for both groups.

2. Are the development curves for low SES and middle SES schools similar? The data reveal that the discrepancy between the two groups tends to become less as children get older. This trend is not in accord with the cumulative deficit phenomenon. Although the two groups are

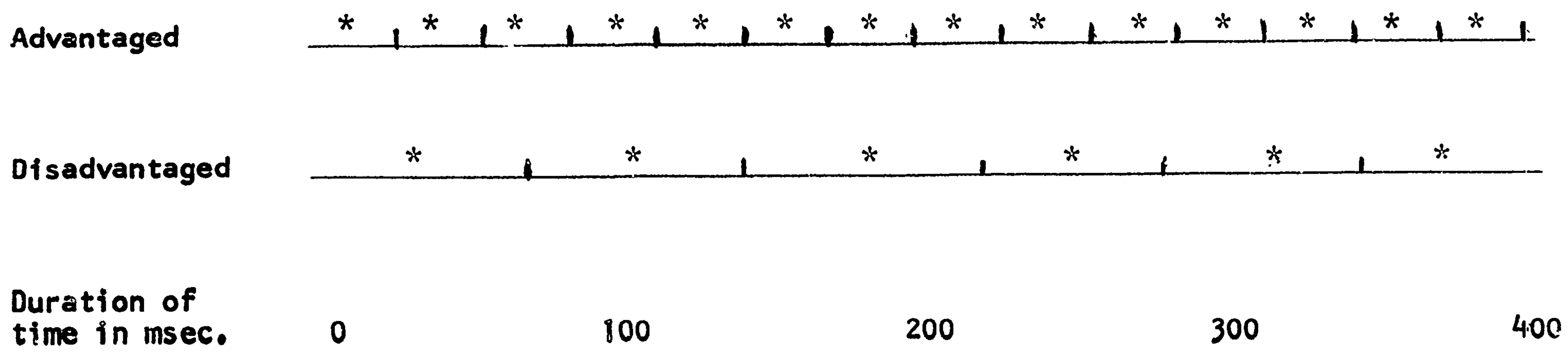

Fig. 5--Representation of the number of stimuli which could be processed by average advantaged and disadvantaged first graders in the same amount of time. The relationship shown in this figure would hold only for stimuli of comparable informational content to those used in the study. Each starred segment represents the time required to process one stimulus.

very different at the first grade level, they tend to be rather similar at the sixth grade level. With both groups, there is improvement over time; however, the improvement is considerably more marked for the low SES children.

Since it would be impossible to get a control group of low SES children who did not go to school, isolation of schooling as a variable could not be accomplished. It seems, however, plausible to contend that schooling is more significant in the development of perceptual processes for the disadvantaged child than it is for the advantaged child. Since it takes the disadvantaged group six years to catch up to their advantaged peers, the utility of their increased perceptual ability is probably blunted.

3. What relationship is there between IPR and scholastic achievement? The evidence collected for this study points to weak relationships between processing and scholastic achievement. The implication of this lack of relationship is not necessarily that the information processing measure is trivial. If achievement in schools was determined only by the child's cognitive ability then lack of a relationship between a variable which purported to assess cognitive ability and achievement would mean that variable was meaningless as a measure of cognition. As it is there is good reason to think that school achievement is a result of a host of variables in addition to cognitive variables. The more a variable assesses a basic cognitive variable the less likely we ought to expect relationship to school success. In order to understand the way in which basic cognitive variables function relative to school achievement, it is necessary to build models which include these

variables and other non-cognitive variables, i.e., teacher effectiveness, teacher-student interaction, norms within the child's social system associated with schooling. We would expect basic cognitive variables (such as the information processing rate) to achieve more utility in explanations of scholastic achievement when seen in interaction with other variables.

The basic model which impelled study was described in Chapter I and is depicted in Figure 6 below.

Independent Variable		Intervening Variable		Dependent Variable
Social Class	→	Visual Information Processing Rate	→	Scholastic Achievement

Fig. 6--Model showing the relationship of principal variables studied

Any naive hopes that the investigator might have harbored for a simple one-to-one association between processing and scholastic achievement may be seen as just that--naive hopes. There is much work to be done before we can cross the chasm between the basic cognitive variables such as the information processing rate and scholastic achievement.

In this investigation, we have been primarily concerned with understanding the relationship between the independent and an intervening variable. With regression model D about one-third of the variance in processing was accounted for. In the following pages we will attempt to explain the phenomena which were observed.

If there is one key generalization which the review of literature on perception and the data which were collected suggest it is this: slow perceptual processing can be the result of numerous different causes. It is important to remember that successful perception is the result of a complex process. As such, perceptual defects may result from a variety of causes. In remedying the situation for a group of children it is unlikely that any one treatment will be optimally useful. By way of example, when a car is not running properly, we do not fix it by doing what is appropriate in many or even most instances of malfunction. Rather, the competent mechanic learns as much as he possibly can about the symptoms accompanying the breakdown, and using his knowledge about the components in the process attempts to fix the car by repairing the defect. We have more to learn before the educator who is concerned about defects in a perceptual process can emulate the auto mechanic, but the state of knowledge is certainly not zero. We shall explore the links between poverty and perception, using three categories of variables: neurological, cognitive, and affective. Categorization of variables into these categories facilitates discussion, but at no time should the interrelationship of the variables be forgotten.

1. Neurological Aspects. In Chapter I, the neurological aspects of visual information processing were outlined. The perceptual processing activities of any organism are constrained by the way in which the neurological constituents operate. One requisite for effective operation is the supply of various nutrients contained in food. While many questions are unanswered, much as been learned about the way in which the constituents in foods such as protein, vitamins, carbohydrates and trace elements (e.g., copper) are used by the nervous system. A child whose caloric intake is insufficient could be expected to exhibit perceptual difficulties since perception requires the spending of energy and a child who is starving may lack the necessary energy. Even with an appropriate

caloric intake, a child who has specific nutritional deficiencies will exhibit perceptual malfunctions. Deficiencies in Vitamin A can produce abnormality in the mucous membrane which lines the eyelids and reflects light onto the eyeball. Such abnormalities interfere with light reflection. Also, Vitamin A is necessary for the proper function of the rod cells in the retina. Deficiencies in riboflavin can interfere with the proper structure of the cornea. An organism which lacks sufficient amounts of various amino acids may develop corneal malfunction and also exhibit poor brain growth and defects in neural development. Vitamin C deficiencies can produce defects in the lens. In addition, other nutrients such as carbohydrates which are a basic fuel for the nervous system are required for proper perceptual functioning. (Stern, 1960; White, Handler, Smith and Stetten, 1959; Proudfit and Robinson, 1961) This incomplete, capsulated discussion of nutrition and neurology is meant to illustrate some of the ways in which deficiencies in diet can thwart neurological functions.

Although much of this information has been available for quite a while, and it certainly is no revelation to say that perception and learning are dependent on the way that sense organs and the brain function, it is only recently that appreciable attention has been paid by educators and psychologists to the relationship between learning and nutrition. A considerable number of researchers on nutrition and learning have been reported. Many of these studies have used sub-human animals. Typically the animals have been under-fed or deprived or protein or some vitamin. These investigations frequently examined either the neurological and physiological processes affected by malnutrition, such as brain size, chemical constituents of the brain, and the characteristics of other nervous tissue or learning behaviors in malnourished animals such as maze running. Animals who have been improperly fed exhibit abnormalities in the nervous system, and tend to achieve less well than animals who have been properly fed. (Scrimshaw and Gordon, 1968; Eichenwald and Fry, 1969) In recent years the literature dealing with malnutrition in humans has been increasing. Much of the literature dealing with malnutrition and learning involving humans has been done in contries other than the United States. This literature generally corroborates the findings from animal studies. (Scrimshaw and Gordon, 1968).

The extent to which the subjects included in the study were malnourished is not known. If malnutrition was a dominant factor then the curve for the disadvantaged group should not have exhibited the sharp increase in processing ability. Children who are in families where malnourishment occurs would probably tend to remain subject to malnourishment. Cravioto found that children who are malnourished show a long term developmental lag. (Cravioto, 1968) Malnutrition which is sufficiently severe and prolonged will probably have permanent effect. (Eichenwald and Fry, 1969) Thus, in explaining the group (given the above caution about cross-sectional study), nutrition doesn't seem to be a dominant factor; however, individual children in the population might be suffering from malnourishment which could alter the ability of the nervous system to function properly.

2. Cognitive Aspects. Visual perception entails the selection and utilization of the information which is communicated by light in that

portion of the spectrum which is accessible to the visual receptors. In most situations, the human is surrounded by a tremendous amount of visual information. Were there not some measure of cognitive screening and structuring of the visual information within eye range the world well might appear as a "blooming, buzzing, confusion." For nearly all humans with sight, the visual experience is in some measure meaningful, but the efficiency of humans to perceive varies.

Perceptual efficiency (at the cognitive level) is a function of (a) selecting-rejecting, and (b) analyzing processes. Before considering these two processes, the following question needs to be answered: What is the organism achieving as it increases in perceptual ability?

Two of the most important theorists who have addressed themselves to this problem are James and Eleanor Gibson. With a series of empirical studies and books, they have produced considerable useful information for the researcher interested in perceptual learning and development. The following discussion leans heavily on their work.

Perceptual learning can be considered as an increase in ability to differentiate visual stimuli. At the grossest, most undefined level there would be two different visual experiences. One when visual input is occurring and the other when visual input is not occurring. An increase in differentiation occurs when one can isolate human faces, even more differentiation has been achieved when one can identify a particular face from other faces. It seems reasonable (and in accord with empirical data) to contend that the perceptual learning results from the detection of properties, patterns, and distinctive features useful for differentiation of stimuli. (E. Gibson, 1969; J. Gibson,

1966) That is, perceptual development is the ability to increasingly isolate and use those aspects of a stimuli which are significant in making it different from other stimuli. Refinement in perceptual ability results when the individual can form sets of stimuli based on finer and finer gradations or differences between stimuli. While a non-artist may see red and green in a scene, an artist may differentiate many shades of red and green. While a young child may see letters and pictures, a child whose perceptual ability is more refined will see a "d," an "o," and a "g."

a. Selecting-rejecting processes. In order for any stimulus to be recognized, it is necessary to attend to the stimulus. Prior to the moments when a given stimulus is being analyzed, there is frequently a preliminary operation which Neisser calls the "preattentive process." (Neisser, 1967). The "preattentive process" results in the isolation of some aspect of the visual environment. During states of preattentiveness the observer is, in effect, searching for or permeable to some visual stimulus. The nature of the search may be more or less pronounced. Using Gibson's example, if a person enters a strange room, looks about, finds a man pacing, and focuses on his face, the nature of the search is pronounced. (J. Gibson, 1966) On the other hand, in the case of a person distracted by walking down the street who suddenly focuses on a pretty girl, the notion of the visual search is less obvious. Yet the notion of finding something (i.e., a focal target) assumes one is looking for something. As Neisser indicates, it is possible for preattentive processes to elicit responses directly. An individual may successfully steer his car for periods of time without "paying attention" to the task. (Neisser, 1966) Although the line separating preattentiveness from attentiveness is fuzzy, some distinction seems useful. Studies of eye movements by Thomas support the notion that "a good deal of the information that arrives at the brain from the retina fails to obtrude on the consciousness." (Thomas, 1968) James and Eleanor Gibson speak of an exploratory phase in perception which in some ways corresponds with Niesser's preattentive process. (J. Gibson, 1966; E. Gibson, 1969) Since the environment frequently contains information which is necessary for the organism, relatively continuous exploration of the visual field is vital, since there is more information in the visual field than could be handled by the organism some filter is necessary. It is not surprising that the concept of a filter appears in several theories of perception. (Broadbent, 1958; Niesser, 1966, E. Gibson, 1969).

The filtering process is indeed important. As the reader reads words he may appear to be oblivious to a variety of stimuli within "eye-shot." If one of these stimuli was a vicious gangster-type with a pointed gun, undoubtedly the reader would shift his attention to that scene and study aspects--possibly the eyes of the man and pistol predominantly--very carefully. It should be clear that scanning, visual exploration, or preattentive processes and the attending selecting-rejecting of input for further analysis is generally not random. Clearly the way in which one draws visual samples of his environment can be more or less useful given a specific task, and the way in which the filtering mechanism works can provide useful information or useful information contaminated with useless information.

b. Analytic Processes. In order for an individual to discriminate a visual image such as a geometric form or a letter of the alphabet, he must cognitively grasp invarient relations within the stimulus. In effect the individual is able to discern the essential qualities of the stimulus from accidental or trivial manifestations of the stimulus. Through successive viewing the individual may come to regard as squares many different images which have a closed in area with four 45^{o} angles and sides of equal lengths, even though the squares differ in color and size, and thickness of line. Even more remarkably he may come to know what W and are all the same letter in the alphabet. Gibson speaks of the identification of the invarient aspects of stimuli as a result of abstraction. (E. Gibson, 1969).

Given some stored information about a visual stimuli, how is the information used for subsequent stimuli? One of the explanations of this process makes use of template as a model. According to this explanation, a master type for the stimuli is stored in the brain. Incoming stimuli are matched with various templates. If there is correspondence with a template, the input is identified. Template theories as they currently exist are either incomplete or inaccurate. In his discussion of template theory, Niesser identifies several problems which these theories cannot handle. Chief among these problems is the difficulty in conceiving of a template that would be a useful guide for the diversity of stimuli recognized as similar. Consider all of the different lower case script "t" you have seen in your life and identified correctly even though many would seem as compatible to other alphabet templates as they would be to the "t" template. A second difficulty concerns small but decisive aspects in a stimuli which are important in the identity of the stimulus. The little hook is a most salient feature in the identification of a "Q" and the difference between "Q" and "O" is small relative to the difference between shapes for "O." (Neisser, 1966) In order to deal with this problem, template theory would have to be modified to include a weighing feature to segments of the template.

Work by Selfridge and Niesser (1959), Feigenbaum (1963) and Uhr (1963) among others suggests that a feature analysis theory may be more appropriate. Such a model is integral with Gibson's theoretical framework. These theories speak of recognition of visual patterns as a function of feature analysis. According to feature analysis explanations, characteristics of the stimulus are used in order to identify the stimulus. One attractive aspect of this explanation is its correspondence with neurological data. As we saw in Chapter I, there is good evidence to suggest that neurons within the retina and visual pathways react selectively to characteristics of stimuli.

In what way can variables with high probability of occurrence in low SES environments thwart the processes just described?

One of the most ubiquitous explanations is the stimulus deprivation theory. According to this theory, the home of the disadvantaged child is devoid of the diversity of objects and his life is experientially vacuous relative to visual perception and as a result he is unable to develop his perceptual process. While it is reasonable to assume that a child who has never seen a clock will not know what a clock is, there are some weaknesses in the theory. The bulk of empirical literature on stimuli deprivation was generated around two problems, neither of which has clear relation to the low SES. There is a body of studies which examine individuals in special environments (such as tubs of water or special rooms) wherein all sensory information is eliminated. The subject cannot see, smell, hear, or feel anything. The other body of literature concerns institutionalized children (in orphanages or hospitals) who are left alone in sterile environments. Such situations can produce a kind of atrophy of the perceptual system or a type of neurosis. (Corso, 1967; Casler, 1961) The information we have about life in the low SES does not correspond too well with either experimental situation.

One by-product of poverty is overcrowded living quarters. The abundance of persons in the disadvantaged child's environment generate considerable visual and auditory stimuli. Although the situation described by Marans and Lourie (1967) wherein the slum child is left alone in his crib with nothing but drab walls and ceilings to look at may occur in rural slums when parents and older siblings work in the fields, such a situation is less likely with the extended family patterns and unemployment which is quite prevalent in the urban slum. This is not to rule out the possibility of perceptual malfunction resulting from stimulus deprivation; rather, it is to say that perhaps the utility of stimulus deprivation as an explanatory variable has been over-emphasized.

One other point along these lines. The stimuli which were used in this study are so pervasive so as to rule out any possibility of them not being present within the low SES environment. None of the children in the study had difficulty identifying the four stimuli during the preliminary part of the testing. Even the disadvantaged first graders responded correctly and promptly. The stimuli we used were evidently not novel to the children.

Rather than an empty environment, it seems as if the disadvantaged child lives in an environment which is probably too full. As Kagan points out, the disadvantaged child lives in a sea of stimulation, but like the sea his sensuous world is amorphous. (Kagan, 1968) Information theory predicts disfunction in the system when it is required to process more information than the system capabilities permit. (Shannon, 1948) In a world of excessive sound, a sound is less significant. In a world of excessive visual stimulation, a visual stimulus is less significant. The distinctiveness of a stimulus is in part a function of the extent to which the stimulus must compete with other stimuli for the sense modality. Several investigations of infants under continuous stimulation have supported the conclusion that continuous stimulation reduces arousal or attentiveness. (Brackbill, Adams, Crowell, & Gray, 1967; Irwin, 1941; Birns, Blank, Bridger, & Escalona, 1965). These studies provide some confirmation of Pavlov's assertion that "every monotonous and continuous stimulation leads to drowsiness and sleep." (Pavlov, 1928) Non-stimulation may provide a kind of "bracket" for stimulation.

One way in which disadvantagement might interfere with perception at the cognitive level is by providing an atmosphere which is disfunctional for the development of attention. The classroom environment, with its typically more structured environment, may provide opportunities for the low SES child to attend to a stimulus with a minimum of competing stimuli.

There is another possible link between poverty and cognition. That link is language. The language patterns may be both a symptom and a cause of cognitive development requisite to effective perception. Research by

Bernstein (1960 and 1962), Hess and Shipman (1965 and 1968), and Lawton (1968) suggests that there may be links between the language in the home and development of cognition. Hess and Shipman's data indicate that there is less use of language for labeling aspects of stimuli in the environment. They state that language is used more frequently to focus attention on status rules rather than to focus attention on "individual characteristics of a specific situation." (Hess and Shipman, 1965) As we have seen, one of the important aspects in perception is the analysis process. Gibson supports the notion that language can facilitate perceptual processes by providing labels which can draw attention to significant characteristics of the stimuli. (E. Gibson, 1969) Although language is not requisite for perception, language can probably be a powerful tool in developing perceptual efficiency.

3. Affective Aspects. That to which the organism attends and the extent to which differences between visual inputs are discerned is in part explained by variables which lie outside of the visual system as we currently understand it. Obviously, for example, the extent to which an artist deems it useful to discriminate color is typically greater than the non-artist. If the young child does not consider the discrimination of the symbol "B" from the symbol "D" in some way rewarding then it is likely that he will not discriminate it.

In the preceding section, language was viewed as a cause for perceptual development as well as a symptom of other variables which promote perceptual learning. Social norms in the home can promote increasing ability to discriminate. When the mother "reads" scenes or pictures to the child, she not only is helping the child to succeed in future such tasks, but she is also telling the child that it is desirable to observe aspects of the things he sees.

Miller, Galanter, and Pribram's TOTE (Test - Operate - Test - Exist) is one attempt to explain how the standards one has set can explain behavior. The TOTE unit functions as a thermostat and provides for the stimulation of behavior compatible with set standards. (Miller, Galanter, & Pribram, 1960) The child develops standards or goals and his activities relate to these standards. It would seem plausible to contend that the desirability of perceptual development is not as evident in low SES environments as it is in middle SES environments.

As was evident in the preceding discussion, many of the interpretations were tentative. More understanding about the role of language in perception, the contribution of neurological, cognitive, and affective variables to perceptual learning is necessary. Models which explain the interrelationships among these variables need to be built and tested. An understanding of the complex relationships between cognition and school achievement is vital, and such an understanding will require a considerable amount of strong research.

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APPENDIX A

Schedules of Stimulus Presentations

SCHEDULE A

Name:

School________________

Date:

Teacher________________

Tested by:

INTERVAL (msec)	SIGN	INTERVAL	SIGN
90	star circle square triangle	40	circle triangle star star
80	star triangle circle square	30	triangle star circle square
70	star square circle triangle	20	star circle triangle square
60	square star circle triangle	10	triangle square circle star
50	square star triangle triangle	0	star square circle triangle

Describe the behavior of the child on the reverse side.
Also make any other comments about the testing session.

SCHEDULE B

Name: School____________

Date: Teacher____________

Tested by:

INTERVAL (msec.)	SIGN	INTERVAL	SIGN
190	star circle triangle square	140	star square circle triangle
180	circle square triangle star	130	square triangle star circle
170	star circle square triangle	120	star star triangle circle
160	circle star triangle square	110	square triangle star circle
150	star triangle square circle	100	circle star square triangle

Describe the behavior of the child on the reverse side.
Also make any other comments about the testing session.

APPENDIX B

Manual of Testing Procedures

Testing Manual

Prepaation of Equipment

1. Put in plugs.

2. Turn on power switch and timer switch.

3. Check to see that power is on mode one.

4. Timer delay should be on and NOT start.

5. Allow instruments to warm up for at least 15 minutes.

6. Check to see if fixation points are on and aligned.

7. Open all four flaps, check to see if bulbs in Tscope are turning on.

8. Close all four flaps.

AFTER TESTING SESSION IS FINISHED * TURN OFF TIMER AND POWER SOURCE AND FIXATION POINTS AND PULL OUT ALL PLUGS.

Testing Instructions

"Hello. How are you? What is your name?" (Write down the student's name on the protocol.) "Who is your teacher?" (Write down the teacher's name on the protocol.) "I would like you to help me find out some things about how boys and girls see pictures (or figures). This is not the kind of test that you pass or fail, but I would like you to try your best to answer the questions I will ask you."

"Look into the box and tell me what you see." (pause) "That is correct, there are two red dots. I'm going to show you some figures (or pictures) and I want you to point to the figure on the card in front of you that is the same as what I showed you." (Hand child the card, then hold up the four stimulus cards--one at a time. Have him identify the card either by pointing at the same picture on the card he holds or by using the correct name--e.g., circle, square, etc.)

"Now, I'm going to put these figures into this box and when I say 'o.k.,' I want you to look into the box and to press that little button in front of you any time after I say 'o.k.' and tell me what you saw. After each picture, I want you to take your eyes away from the box and look at the bottom of the machine." (Show each of the four figures at 100 msec. Then show each at 5 msec.) "Now, I'm going to show one of the figures plus a crazy, mixed-up picture. When you look into the box and press the button, I want you to tell me ONLY what figure you saw first--forget the crazy picture. For example, if you see a triangle and then the crazy picture, your answer would be 'the triangle.'" (Show 8 at 5-150-21. Child may answer by giving the correct name or pointing at the similar picture on his card.)

"Only push the button once."

"Now, there's going to be a time when the pictures will flash real fast. Even if you can't see the first picture, I want you to make a guess. Look into the box and I'll show you." (Show two figures at 5-0-20. Get child's guess.) "Now, we're ready to begin the test." (Use schedule of presentations.)

1. Make sure child has eyes completely into scope before pressing switch.
2. If a child says he can not see the figure and refuses to guess, continue for 2 more exposures. If he begins responding again, keep going to the end of the test. If he does not begin responding, stop at the end of the responses.
3. Keep the lights out in the room whenver a child is in the room. (Room is dim.)
4. If subject flounders through the beginning of the test - at the end of four levels (before beginning level 50 msec.), look over protocol. If there is no grouping of three consecutive correct answers then use Schedule B beginning with the top level.
5. After finishing 5-50-20, give child a short pause asking him (1) "How do you feel?" (2) "Are your eyes getting tired?" and (3) "You're doing real well."

APPENDIX C

Code Book for Data

CODE BOOK

Column Number	Code
1 - 2 - 3	Student Identification Number
4	Sex 1 = Male 2 = Female
5	Race 1 = White 2 = Nonwhite
6 - 8	Age (Given in months, with the reference point being May 31, 1969: at 15 days or over, round to next highest month; under 15 days, round to the next lowest month.)
9 - 10 - 11	Weight (Given in pounds: at 8 ounces or above, round to next highest pound; below 8 ounces, round to next lowest pound.)
12 - 13	Height (Given in inches: at .5 or above, round to next highest inch; below .5, round to next lowest inch.)
14	Missing Data Code 1 = Untestable 0 = Moved and/or Misc.
15 - 16	Occupation of Major Breadwinner in Child's Family (Based upon Duncan's Occupational Prestige Scale.)
17	Question One: Parent's Expectations of Child's Educational Attainment Level: 1 = a. quit now 2 = b. go to high school for awhile 3 = c. graduate from high school 4 = d. go to school to be a secretary or learn a trade 5 = e. go to college for a little while 6 = f. graduate from college 7 = g. more than four years of college
18 - 19 - 20	T-Scope Threshold Level
21 - 22	Percentage Wrong Above Threshold Level

23	Grade Level 1 = First Grade 2 = Third Grade 3 = Sixth Grade
24	Fernside School 1 = Teacher (First Grade) 2 = Teacher (First Grade) 3 = Teacher (Third Grade) 4 = Teacher (Third Grade) 5 = Teacher (Sixth Grade) 6 = Teacher (Sixth Grade)
25	Kenwood School 1 = Teacher (First Grade) 2 = Teacher (First Grade) 3 = Teacher (Third Grade) 4 = Teacher (Third Grade) 5 = Teacher (Third Grade) 6 = Teacher (Sixth Grade) 7 = Teacher (Sixth Grade) 8 = Teacher (Sixth Grade)
26 - 27 - 28	Times Absent (9/67 through 6/68)
29 - 30 - 31	Times Absent (11/68 through 3/69)
32 - 33 - 34	Times Tardy (9/67 through 6/68)
35 - 36 - 37	Times Tardy (11/68 through 3/69)
38 - 39	Reading Step (Roman Numerals)
40	Ability to Differentiate Between Shapes, Words, and Letters (as rated by teacher) 1 = Progress is very well 2 = Progress is satisfactory 3 = Progress is slow
41	Question Two: Parent's Surveillance: Question: "Do your parents know how you are doing in school?" "Pick one." 1 = a. They know everything I do in school 2 = b. They know almost everything about my school work 3 = c. They know some things about my school work 4 = d. They know a little bit about my school work 5 = e. They know nothing about my school work
42 - 43	Math (Stanford Achievement)

44 - 45	Spelling (Stanford Achievement)
46	Social Habits (Average of Ten Social Habits) 1 = Very well 2 = Satisfactory 3 = Needs to improve
47 - 48 - 49	I.Q. Score (Kulhman-Anderson)
50 - 51	Reading Readiness Score (Metropolitan)
60 - 61	Reading Test (Gates-MacGinitie, C Form 1) (Number Attempted)
62 - 63	Reading Test (Gates-MacGinitie) (Number Correct)
64 - 65	Vocabulary (Gates-MacGinitie)
66 - 67	Comprehension (Gates-MacGinitie)

APPENDIX D

Test and Noise Stimuli Used for the Study