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Considerations of Language Learning and Socioeconomic Status in the Etiology of Cultural-familial Mental Retardation

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A Thesis

Presented to

the Faculty of the College of Medicine

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Medicine

Under the supervision

of Frank Menolascino, M.D.

Associate Professor of Psychiatry and Pediatrics

University of Nebraska College of Medicine

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by

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February, 1969

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Considerations of Language Learning and Socioeconomic Status in the Etiology of Cultural-familial Mental Retardation

Mental retardation is an area of human disease which, perhaps, more than any other, has tremendous social and economic implications in the increasingly complex civilization which characterizes the twentieth-century United States. It seems that these implications have only in the last decade been considered important enough to merit a large-scale public education effort on many fronts. Concurrent with these developments has been an impressive increase of professional interest on the part of workers in the fields of medicine, psychology, and social service. While these increased efforts must certainly be contributing to a better understanding of mental retardation by medical school graduates, there are still some basic characteristics of this body of information which cause the student to minimize this area in relation to the many other areas of human disease which he must study during his four years of schooling. One obvious problem is the information explosion occurring in all fields of medicine, and thus the necessarily small part of the curriculum which can be allotted to the study of mental retardation. This explosion also tends to overwhelm the student when he is confronted with the broad range of manifestations and etiologies which have been implicated in mental retardation. A complete listing of these

is awesome, and there is an tendency to feel that any vigorous attempt at understanding it all will simply not be worth the effort.

Another factor which minimizes the apparent importance of learning about mental retardation is lack of exposure due to the institutionalization of severely retarded patients, and other specialized treatment programs not commonly integrated into the medical school curriculum. The most severely retarded, however, have traditionally been easily recognized, and their problems in getting along in the world have been relatively easily defined, but there is a large group of less severely affected individuals whose situation is only recently coming to light. Since most of them are not institutionalized and can become useful members of society, the definition and solution of their problems has perhaps more social and economic significance than any other area of investigation in mental retardation today. In this paper I will make some comments about diagnosis, classification, and treatment of mental retardation in general, and then review some of the recent work which pertains to cultural-familial retardation, with a particular attempt to delineate the role of languge development in its etiology.

Mental retardation

Definition is a prime prerequisite to any scientific discussion of a given topic. This is not only because precise definition aids in communicating a sense of what is being discussed, but it also helps the discussant in his personal

formulation of theories and concepts, irrespective of the communicative function. Historically, there have been some important changes of approach in defining mental retardation. Doll (1941, p. 215) has stated, "We observe that six criteria by statement or implication have been generally considered essential to an adequate definition and concept. These are 1) social incompetence, 2) due to mental subnormality, 3) which has been developmentally arrested, 4) which obtains at maturity, 5) is of constitutional origin, and 6) is essentially incurable." This definition states that the condition of mental retardation is irreversible and many writers have implicitly or explicitly stressed this in the past. This has, however, been shown to be false in certain cases, and a general attitude of optimism is becoming the rule rather than the exception. This definition involves the two basic parameters of human functioning which have been considered most important in assessing the presence of and degree of mental retardation in a given individual: 1) intelligence, and 2) adaptive behavior or social adjustment.

Both of these parameters have presented difficulties in measurement, but both must be considered in an appropriate evaluation of mental normality or subnormality. Perhaps the latter of the two has been considered to be the more important, but the increasingly complex and technical nature of modern society is placing more importance on the former. The measurement of intelligence by means of I.Q. scores has become a highly refined and relatively dependable science, whereas the measurement of social adjustment still necessarily involves some subjective evaluation by a fallible observer.

Definitions of mental subnormality in terms of scores on standardized tests such as the Stanford-Binet or Wechsler Intelligence Scale for Children (W.I.S.C.) have been written into law as criteria for admission to mental institutions, but have been widely and justly criticized for not granting consideration to factors other than the test scores which may be important to the decision being made.

The Stanford-Binet is probably the best single test of mental ability yet devised for children (Robinson and Robinson, 1965), and it is especially useful with individuals of low mentality. This test is categorized into twenty different age levels as determined by increasing difficulty of the questions, and there are six items at each age level (with an alternate item to be used if one of the others is improperly administered). Testing covers the range between the highest level at which all tests are passed (basal age) through the lowest level at which all are failed (ceiling age). Usually at least five age levels are administered, with younger or duller subjects requiring fewer levels than brighter ones. This test includes a wide variety of mental tasks, with the higher levels especially weighted with verbal ability. It was designed to discount as far as possible the subjects' particular education and experience, but responses to almost all the items used have been shown to be related somewhat to social class. I.Q.s obtained are reasonably stable at all levels (test-retest reliability) but become more stable as the child becomes older, and they are more stable in dull children than those of average or superior mental ability. The

Stanford-Binet test purports to measure the general intellectual ability of the subject and it is felt that it does measure a general factor of intelligence, since the scores for each of the items correlate well with the total score of the test. But there is some controversy about how this general factor should be defined (see below).

The Wechsler Intelligence Scale for Children (WISC) was prepared for use with children of ages five to fifteen, and is a downward extension of the Wechsler Adult Intelligence Scale (WAIS). It consists of twelve types of subtest which are grouped by content rather than by age level, and the subtest are recorded on a verbal scale (six of the subtests) and a performance scale (the remaining six subtests). This "serial order" or "spiral" type of testing has proved to require less time for administration than the Binet (age-level) type, and possibly maintains a higher motivation level during the test. The individual subtests of the WISC provide little information in themselves, but the stability of the verbal and performance I.Q.'s has been shown to be reasonably high. It is felt that differences between these two scales reflect real differences between the abilities tapped by each. Retarded children tend to obtain even lower correlations between the verbal and performance scales, and cultural-familial retardates usually obtain lower verbal than performance I.Q.s. Scores on the WISC full scale are apparently as stable as those on the Stanford-Binet.

Developmental scales for testing infants and young children have largely been patterned after the Binet model. These tests are used for describing a baby's present behavior, but the usual reason for administering them is to try to predict later behavior. The currently available tests are largely inadequate for this purpose. This is probably because the sensorimotor orientation of these tests has little correlation with the higher intellectual functions which largely determine the outcome of I.Q. tests administered to the subjects as they grow older. Those who are destined to be severely or moderately retarded are usually identified during the first two years of life, since they often demonstrate a lag in sensorimotor development. Mild retardation, however, is often silent until school age. There is also a significant incidence of false-positive results on individual tests. This may be due to environmental inadequacy, temporary emotional or physical disturbances, or uneven development which may be corrected in the natural course of a child's growth. For this reason repeated testing should be done before a child is labelled as developmentally retarded. Two of the most widely used infant tests are the Yale Developmental Examination, developed by Gesell, and the Cattell Infant Intelligence Scale. These, as well as most of the other available tests, have been standardized with normative samples small in number and biased in selection.

An I.Q. of 70 has been accepted by many as a cutoff score in defining subnormal intelligence, But what is the entity which these tests purport to measure? Two contrasting viewpoints, which have been called the "mighty oak" and the

"splinter" views, (Thorndike, 1967) characterize the poles of thinking on this subject. One view proposes that the oft-noted consistency between different measures of intelligence can be accounted for by a single general intellective factor, "g". This factor is supplemented by specific "s" factors which are involved to varying degrees in the different tests and subtests. The other extreme is best characterized by an elaborate theory which postulates one hundred and twenty distinct types of intellectual operations which are involved in "intelligence" (Guilford, 1968). His theory involved a three-dimensional model with several alternative factors in each dimension. The three parameters he uses to define each type of intellectual functioning are: 1) the contents of the intellectual enterprise (figural, symbolic, semantic, or behavioral), 2) the products produced (units, classes, relations, systems, transformations, or implications), and 3) the operations through which these products are produced (cognition, memory, divergent thinking, convergent thinking, and evaluation). Thus, a conventional vocabulary test measures cognition of semantic units. Statistical analysis of test scores support the idea of a general factor of intelligence, but as the range and variety of the test problems increase, the identifiable specific factors become more numerous and play a more important role in the test scores. Measurement of the broad general common factor seems to be more reproducible than measurement of the specialized "splinter" type factors.

There have been many other characterizations of intelligence, such as Burt's verbal and practical intelligence and Cattell's fluid and crystallized intelligence. It seems safe to say that there will never be universal acceptance of a particular definition. But there is something valuable in even the most diversely opposed ones, and synthesis of the most valid elements of each should bring theorists closer together in the future. Despite the disagreements on a theoretical level, it has been shown that many different procedures of testing intelligence produce substantially similar results. This is despite the fact that intelligence is not an entity which exists in some concrete form, but rather an idea which has been invented to help explain and predict behavior.

The testing of social adaptation is a much less reliable science. Perhaps the most useful test for this is the Vineland Social Maturity Scale, first published by Doll in 1936. It is basically a semi-structured interview about the child's habitual behavior and is comprised of 117 items of social activity, ranging from a baby's laugh and gurgle to activities involving community responsibility. The scale taps eight categories of behavior: 1) general self-help, 2) self-help in dressing, 3) self-help in eating, 4) communication, 5) self-direction, 6) socialization, 7) locomotion, and 8) occupation. The test was standardized on ten male and ten female subjects at each of thirty-one age levels, from birth to age thirty, but has not been restandardized since. Scoring is analogous

to that used with the Stanford-Binet, but the standard deviations on the test are not well-established and therefore a particular score is often difficult to interpret. Test-retest reliability, however, seems to be reasonably high. With the above background of theory and testing principles in mind, let us examine a relatively recent definition of mental retardation which has earned much popularity.

"Mental retardation refers to subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behavior." (Heber, 1961, p. 3). This definition was accepted as the official terminology of the American Association on Mental Deficiency in 1960. The traditional dual criteria of intellectual impairment and social maladjustment are the heart of this definition, and it is usually the latter which calls attention to the individual. The phrase "subaverage intellectual functioning" is defined as current performance of more than one standard deviation below the mean on a standardized general intelligence test. Since this criterion alone would identify about 16% of the total population as mentally retarded, the social maladjustment criterion becomes the crucial factor in diagnostic screening to identify the actual 3% or so who are mentally retarded. Heber has emphasized that his definition makes no reference to intellectual capacity, constitutional origin, or incurability, all of which have been frequently included in past definitions. In brief explanation of these omissions, it may be said that one can measure present intellectual achievement but intellectual capacity can only be postulated,

that there are individuals with psychological disturbances who can now be appropriately classified as mentally retarded, and that experience has shown many types of mental retardation to be at least partially reversible.

The factor of adaptive behavior refers to the effectiveness with which the individual copes with the natural and social demands of his environment. "It has two major facets: 1) the degree to which the individual is able to function and maintain himself independently, and 2) the degree to which he meets satisfactorily the culturally-imposed demands of personal and social responsibility." (Heber, 1961, p. 61). Since the behaviors sampled by general intelligence tests contribute to overall adaptation, the level of measured intelligence will often correlate with the level of adaptive behavior. Heber indicates that significant impairment in adaptive behavior should be defined by a score of more than one standard deviation below the mean on an appropriate standardized test (e.g., the Vineland Social Maturity Scale). This proposal lends valuable precision to the definition, but unfortunately the meaning of one standard deviation on such tests is not yet so reliable as that on the more extensively standardized I.Q. tests.

"A way of classifying a population is a way of thinking about them (S.M. Miller, 1964, p. 139)." Organizing the vast array of types of mental retardation into a useful system has been approached in various ways. One simple method is classifying retarded individuals according to the severity of their symptoms, as reflected in their I.Q. scores. Thus

the traditional terms idiot, imbecile, and moron have been used in the United States to denote I.Q. abilities roughly in the ranges 0 to 30, 30 to 50, and 50 to 70, respectively. The less opprobrious terms mild, moderate, and severe subnormality, and educable, trainable, and custodial have followed this same line of thinking. These classifications have the advantage of objectivity, inasmuch as the I.Q. tests employed are objective, and this facilitates the administrative aspects of social and legal action. It must be remembered, however, that the intelligence levels measured comprise a continuum which this type of classification system has artificially compartmentalized. Also, the factor of adaptive behavior should be given consideration in determining the severity of retardation.

Another important method of classification is based on the etiology of the observed signs and symptoms. There are several ways to approach this, none of which are mutually exclusive. It may be said that there are basically two broad influences which can cause mental retardation: genetic accidents and abnormalities, and environmental influences. These influences, of course, can occur concomitantly and each can alter the expression of the other. Another conceptual approach to etiologic classification would break the causes down into three types: 1) physical-biological, 2) emotional-psychological, and 3) socio-cultural. A third approach which has proved to be quite useful separates the causes temporally, as to when the major influence occurs,. This results in prenatal,

perinatal, and postnatal causes of mental retardation. Finally it may be helpful, since recent research has made effective treatment available for many retardates, to designate these abnormalities as either reversible or permanent. It must be remembered, however, that the goal of our scientific investigations is to place all cases of retardation in the former group. This is theoretically possible only if the area of prevention is fully developed.

The AAMD has officially adopted a classification system, again proposed by Heber (1961), which established eight broad classes of retardation which are differentiated on an etiologic basis. These classes may be summarized as follows:

I. Mental retardation associated with diseases and conditions due to infection
   e.g., measles (prenatal)
   e.g., meningitis (postnatal)

II. Mental retardation associated with diseases and conditions due to intoxication
   e.g., toxemia of pregnancy (prenatal)
   e.g., post-immunization encephalopathy (postnatal)

III. Mental retardation associated with diseases and conditions due to trauma or physical agent

IV. Mental retardation associated with diseases and conditions due to disorders of metabolism, growth, or nutrition
   e.g., phenylketonuria, arachnodactyly, hypothyroidism

VI. Mental retardation associated with diseases and conditions due to (unknown) prenatal influence e.g., microcephaly, hydrocephaly, mongolism

VII. Mental retardation associated with diseases and conditions due to unknown or uncertain cause with the structural reactions manifest

VIII. Mental retardation due to uncertain (or presumed psychologic) cause with the functional reaction alone manifest

1. cultural-familial mental retardation
2. psychogenic mental retardation associated with environmental deprivation
3. Psychogenic mental retardation associated with emotional disturbance
4. psychogenic mental retardation associated with psychotic (or major personality) disorder
5. mental retardation, other, due to uncertain cause with the functional reaction alone manifest.

The complete classification system as presented by Heber Makes an attempt to provide a specific place for all the presently known causes of mental retardation, and he also presents a Supplementary Term Listing which is designed to provide additional information about the specific manifestations seen in each individual being classified. These supplementary categories, to be listed in addition to the etiologic classification from the above list, include:

1. with genetic component

2. with secondary cranial anomaly
3. with impairment of special senses
4. with convulsive disorder
5. with psychiatric impairment
6. with motor dysfunction

This complete classification system, then, is designed to provide a numerical designation appropriate for each individual case of mental retardation encountered, and this should make it a very valuable tool in long-term statistical studies. It may be that the complete system provides a listing of types of mental retardation which, to the relatively casual reader, probably seems as overwhelming as would a listing of each case of mental retardation ever identified. A simplified version of the system, however, does provide a useful conceptual framework for the layman and the professional alike. The principal area of interest dealt with in this paper will be class VIII.-1., and a more detailed definition and discussion of this category will follow later.

Learning

The theory of human learning is a large topic which will not be dealt with extensively in this paper. However, some comments are in order, since various definitions of intelligence have emphasized the "capacity to learn (e.g., Colvin, 1921, p. 136)." One important factor in learning theory is drive, or motive, which may be described as a state of increased tension which is often accompanied by learning. Primary drives are biologic in nature, such as hunger and sex, and secondary

drives are socially imposed motives, such as the desire for prestige or money. Hunt (1963) feels that traditional theories of motivation are based on the avoidance of pain and on homeostatic need, but these sources of motivation do not account for what he terms "motivation inherent in information processing and action" or "intrinsic motivation." This concept is suggested by Piaget's excellent descriptive analysis of the development of children and can be summed up in the aphorism, "the more a child has seen and heard, the more he wants to see and hear."

A second basic factor involved in learning is the signal or cue value of environmental stimuli. Learning deficits may involve this factor in two different ways. First, there may be a defect in the organism's sensory equipment, or secondly, the difficulty may consist of an inability to interpret sensory input. For example, speech cannot be learned unless the organism has the basic capacity to vocalize, and mathematics cannot be learned without the ability to think symbolically.

A fourth factor basic to learning processes is "reinforcement, which may be defined as an event which affects the likelihood of the reocurrance of a response under given drive and cue conditions (Robinson and Robinson, 1965, p. 320)." Positive reinforcements may be called rewards, and they increase the likelihood that a particular response will be repeated, whereas negative reinforcement, or punishment, tends to decrease this likelihood. Generally speaking, reward is a more effective tool in promoting learning than is punishment (Postman, 1962). The effects of reinforcement, however,

depend not only on the current incentive value of the rewards or punishment, but also on the learner's overall pattern of experience with reinforcements for his behavior. According to Rotter (1954) and Cromwell (1959) this enables us to characterize individuals as either "success striving" or "failure avoiding", and positive or negative reinforcement, respectively, will more effectively promote learning in each type of person.

Cromwell (1967) has done considerable work with retarded children and has outlined some important differences between them and normal children, based on the assumption that retardates are more prone to expect failure than are normal children. His studies showed that retardates tend to see the outcome of events on a simple hedonistic level, while more developmentally advanced children see their own behavior as crucial in determining the outcome of the experimental events. This latter orientation was designated as success-failure conceptualization, and these children were said to be demonstrating an "internal locus of control." Further studies have shown that while internal locus of control children are largely impervious to positive, negative, or neutral learning climates, the external locus of control children perform relatively poorly under the neutral and negative climates. These findings have obvious practical implications in educational planning for the mentally retarded, as well as providing interesting insights into learning theory.

There have been several types of learning disabilities associated with the behavioral inadequacy of the retardate. Ellis (1963) has postulated a short-term memory deficit in individuals with central nervous system damage. This deficit may be due to a decrease in the duration and intensity of the brief reverberatory circuit in the brain which is responsible for short-term memory, without any necessary impairment of the long-term memory process. This is perhaps a rather naive characterization of the underlying memory and learning processes, which are currently subjects of controversy by psychologists, anatomists and neurophysiologists.

The postulation of two separate types of memory--short-term and long-term--and two correspondingly separate brain mechanisms is a popular theory, and there is increasing experimental evidence to justify this distinction. An interesting series of experiments by Agranoff (1967) supports this line of reasoning, as well as elucidating the role of protein synthesis in the memory process. His studies involved the injection of puromycin, which was shown to block protein synthesis, directly into the brains of goldfish which were trained to perform a simple task. The injections were given at various times before, during, and after the training period and the subsequent effect on the fish's behavior was observed. Normal training of the fish resulted in about 80% correct responses in the experimental situation for a period of at least thirty days, but if the drug was injected immediately after training the memory of the training was obliterated.

If the injection of the drug was performed one hour after training, however, there was no effect on performance, and injection thirty minutes after training resulted in an intermediate effect. Injection of the drug before training did not seem to interfere with their improvement in correct responses during training, but testing three days later revealed a profound loss of memory for the correct response. These findings indicate that the short-term memory employed during learning is not dependent on protein synthesis, but that consolidation of long-term memory does require this function. Further experiments with these goldfish also showed that consolidation of long-term memory is inhibited when the fish is in an environment providing a high general level of stimulation.

Young (1964) notes that memories, or a code representing them, must in some manner correspond to the external environment, but this system of representation must be quite complex, especially in man. Studies in octopi, monkeys, and cats show that dendrite patterns may be related to the coding, and Young suggests that these patterns may be hereditary and species-specific, having evolved to be appropriate for the environmental "field" in which the species lives. This would not mean that life experience could not further mold these patterns. To the question of where learning changes are likely to be found in the brain, Young points out that current research seems to be largely centered on changes in RNA and synaptic mechanisms. The investigation of synaptic changes has been greatly facilitated by the electron microscope, but

the complexity of initial findings still leaves us with the problem of exactly where to look. There has also been some physiochemical evidence which may pertain to memory mechanisms, but most such experiments have been short-term and acute. For example, the amount of transmitter substance produced at a synapse has been shown to vary with previous activity, and post-tetanic depression of transmission may be considered a memory change in a sense. The study of electrical activity in the brain has also been an extensively studied field of investigation, although its direct application to learning theory is yet to be elucidated. Changes in electrical activity have been detected during conditioning procedures, and the resulting activity has been shown to correspond temporally to the experienced stimuli.

Another topic, which has undergone theoretical discussion but no significant experimental study, is the role of glial cells in nervous system function. These are the small cells which fill in the space between the neuronal cells of the central nervous system and which outnumber them by a ratio of about 10:1. Galambos (1961) is a chief proponent of the view which gives them an intrinsic role in nervous system function. He proposes that glial cells are genetically charged to organize neuronal activity, and that the behavioral manifestation of glial activity is what have been designated innate and acquired responses. This active role is in contrast to the older traditional theories which visualized the glia as simply insulating, physically supporting, and/or

nourishing the neurons. This more active role, however, is not necessarily a new idea, since Nansen had said as early as 1886 that neuroglia was "the seat of intelligence."

Young recognizes a resemblance between long-lasting memory changes and neuronal growth. He notes that peripheral fibers can change form rapidly when neighboring fibers are destroyed, and that increased neuronal metabolism leads to increased RNA metabolism. Also, axons have been shown to increase in size after prolonged activity. These bits of information help lay the groundwork for an attractive theoretical approach which is based on the hypothesis that learning occurs somehow by elimination of unused neuronal pathways. This may be conceived of as either selective inhibition or facilitation of certain pathways, or a combination of both, and Young feels that the small amacrine cells of the brain serve the function of inhibition. "A very simple possibility is that the collaterals, or amacrine processes stimulated by them, might themselves grow and squeeze out the other terminals (Young, 1964, p. 285)." An alternative approach would be to assume that the neuronal pathways are in a state of inhibition in their resting or untrained state and that some type of selective disinhibition results in their use.

This neuroanatomical approach has an interesting parallel in the psychology of learning, where it is noted that natural development of human thinking must increasingly involve selecting the more important stimuli and ignoring the less important among the vast array of input information available to the organism. This probably involves the complex function

of categorization to some extent, but future investigations designed to clarify this possible relationship between neuroanatomical theory and psychological fact would seem to have great potential in explaining the basic etiological mechanism in some types of mental retardation.

Language

Having touched on the general areas of mental retardation and learning theory, I shall now present a brief discussion of language learning and some of the associated social and cultural influences. The definition of "language" must include two concepts: 1) the function of communication between individuals, and 2) the use of conventional (and largely arbitrary) symbols. As the system of communication grows more sophisticated, the rules pertaining to the manner in which the symbols are presented become more important and more complex. Thus some language systems involve very elaborate rules of syntax and grammar while others are relatively simple, but all such systems must, by definition, involve some level of communication.

The transmission of information is said to be the propositional function of language, but many writers feel that its primary function is to induce behavior. This is designated as the purposive function, and Thorpe (1967) notes that this can be implemented with or without the intention of eliciting an associated emotional response. The reasoning behind assigning the purposive function a paramount role would seem to arise mainly from teleological considerations,

and it is easy to see that a very important result of communication among men is to enable them to work together in dealing with each other and with their physical environment. The conveyance of emotional meaning is perhaps better accomplished through modes of communication other than formal language systems, but many such formal systems have indeed developed as rich and effective vehicles for this purpose. The argument about the primacy of the purposive function of language, however, seems to this writer rather unimportant so long as it is realized that at least a very essential (if not the most essential) part of the propositional function is to influence the behavior of others.

Due to the social, ethical, and economic conveniences of employing animal subjects in scientific experiments, much has been said about the "language of animals", and a relatively recent arrival on this experimental scene is the dolphin. It has been found that these creatures have an extraordinary ability to mimic nonsense syllables presented to them, and while this reproduction is not as close to the original as that of mynah birds, for example, Lilly (1967) has shown that dolphins demonstrate remarkable facility in learning long sequences and they show a high degree of persistence in familiar operant conditioning situations. These abilities may represent a rudimentary capacity for communication akin to human vocalization, since dolphins compare quite well to humans with respect to brain size and cortical area and structure, as well as auditory and phonetic capabilities.

It is interesting to note that monkeys, which are considered to be forms of life approaching the evolutionary "missing link" in the phylogenetic chain leading to man, do not have this ability to repeat. The precise reason for this is not known, but it has been postulated that the deficit may be similar to a "conduction aphasia" which can be produced by interrupting the arcuate fasciculus, a myelinated tract of nerve fibers in the brain. It has subsequently been shown, however, that monkeys do possess this structure, and therefore the inability of normal monkeys to mimic sounds is not due to anatomical absence of the arcuate fasciculus. It is also interesting to note that some birds demonstrate rather elaborate patterns of imitation of sounds within their own species. These patterns have some survival value, and according to Thorpe (1967), man is the only other species with this capability. Whether this is absolutely true or not, it would be very interesting to discover a common neuroanatomical structure responsible for this capability in two such widely different organisms.

Studies of lower forms of life have revealed many patterns of behavior which accomplish the basic functions of language. Arthropods and crustaceans demonstrate very specific and stereotyped actions which are involved in sexual activities, and honeybees employ a rich, fixed, and apparently inherited code of behavior to transmit information concerning new living sites. These rigid patterns of behavior have persisted in each species through millions of years because of their value to the survival of the species, but the language of man seems to

be different. Chomsky (1967) is an eloquent spokesman of the view that places human language in a class by itself. He points out that animal communication systems involve point-to-point associations between non-linguistic and linguistic dimensions, and this type of system is said to involve "associative learning." Linguistic (i.e., as in human language) concepts are more abstract. Through a very detailed and technical linguistic analysis he shows that the "surface structure", or relations among successive words (grammatical rules) do not determine the semantic content of a sentence, and he feels that this is evidence that there is linguistic knowledge which cannot be learned through teaching or experience. He postulates the existence of what may be called "rules" which determine the relation of the more abstract linguistic concepts to the formal, grammatical surface structure. Since these rules cannot be learned, it is assumed that the human brain includes some structural and functional system which makes them available to the individual. This system, then, may constitute a uniquely human precondition for learning uniquely human language.

In support of this theory it can be said that congenitally blind children can learn to use a language quite well, and right-handed people can write with their left hand, upside-down, with their eyes closed. Both of these data can be used to support the concept that human language involves something more complex than associative (point-to-point) learning. Studies of hemispheric connections in humans by Sperry and Gazzagina (1967) have shown that comprehension of input

information, including language, can be accomplished by both the major and minor hemispheres, where as only the major one can deal in verbal expression of this information. This has been verified by Geschwind (1967), who demonstrated that despite the ability of right-handers to write with their left hand, this is accomplished through the dominant hemisphere. This information, while refining our thinking on specific types of linguistic operations, does not invalidate Chomsky's general theory. Also worth noting here is the fact that the natural development of language acquisition involves first a few months of relatively slow advancement and then a sudden acceleration of ability. This pattern could be explained by the physiologic maturation of the underlying neurologic system postulated above.

Lenneberg (1967) has formulated a convincing theory linking the innate biological capabilities of man as a species with the development of human languages as they are known throughout the world today. His presentation is lengthy, painstakingly developed, and internally consistent, but it is nevertheless a theory, without significant direct experimental support. A brief summary of his ideas would include the following points: 1) Language is the consequence of the biological peculiarities that make a human type of cognition possible. 2) Certain specializations in peripheral anatomy and physiology account for some of the universal features of natural languages. Cerebral function is the determining factor for language behavior as we know it in contemporary man. 3) Although the nature of our cognitive processes

determines the potential for a language system which must necessarily be of one specific type, environmental conditions must also act to make it possible for language to unfold. Maturation brings cognitive processes to a state that we may call language-readiness. 4) The state called language-readiness is of limited duration, beginning around age two and declining with cerebral maturation in the early teens. 5) In a given state of maturation, exposure to adult language behavior has an excitatory effect upon the actualization process. 6) There are two levels of individual variation: in the formation of the latent structure (biological potential), and in the actualization process from latent to realized structure.

It is reasonable to state, then, that Chomsky and Lenneberg are both pursuing the same general goal--explaining the relationship between the biological nature of man and the functional nature of the languages he uses--through different analytic approaches. Efforts to identify the neurologic structures and mechanisms concerned with language have been going on throughout the last century, and some of the earliest discoveries are still the most well-known and perhaps still the most important. I am referring here to the identification of the cortical areas of the brain known as Broca's area and Wernicke's area. Our ideas concerning the nature of their contribution to speech and language have changed somewhat through the years, but their significance remains unquestioned.

Much excellent work in this field has been done by Penfield and Roberts (1959), whose wide experience with neurologic diseases, and especially brain tumors, has enabled them to investigate the effects of a variety of pathological and surgical lesions on linguistic performance in living human subjects. Their studies have identified three cortical areas which are concerned with "ideational speech mechanisms." These are: 1) a large area in the posterior temporal and posterior-inferior parietal regions (the posterior speech cortex, roughly equivalent to Wernicke's area), 2) a small area in the posterior part of the third frontal convolution, anterior to the motor voice control area (the anterior speech cortex, or Broca's area), and 3) part of the supplementary motor cortex, within the mid-saggital fissure and immediately anterior to the Rolandic motor foot area (the supplementary speech cortex). These three areas will functionally develop in the dominant hemisphere in the great majority of people, and a small lesion in infancy can displace their location somewhat within this hemisphere. Also, a larger lesion in the posterior speech cortex can displace the whole speech apparatus, causing it to be developed in the opposite hemisphere. This may occur without the similar displacement of "handedness".

Ablative surgery has revealed some interesting differences between these three areas, indicating a sort of relative importance of each to normal speech and language function. Some type of aphasia results from removal of each of these areas.

Removal of the supplementary speech cortex results in a rapid return to normal speech after a brief period of aphasia, removal of the anterior speech area is often, and possibly always, followed by return to normal speech, and removal of the posterior speech area permanently precludes return to completely normal speech. Wernicke originally had described a "sensory aphasia" as due to a lesion in the first and second temporal convolutions and a "motor aphasia" due to a lesion in Broca's area, but Penfield and Roberts consider this distinction unwarranted. They feel that results of more recent experimental studies, including their own, do not permit the identification of such pure aphasias. Thus we have the common situation wherein more careful and advanced scientific investigations seem to confuse and complicate initial theories.

Transcortical association tracts have been studied rather extensively, and their importance in integration and elaboration of the processes in the cortical speech areas now seems almost intuitively obvious. However, Professor Joseph Klingler of the University of Basel has developed a special technique of dissection (Penfield and Roberts, 1959, pp. 216-225) which has revealed some potentially important subcortical tracts associated with the cortical speech areas. For example, there are connections between Wernicke's area and the posterolateral nucleus of the thalamus, and Penfield and Roberts feel that this subcortical integration is more important to language function than is transcortical association. They also postu-

late that the thalamic control of speech which is suggested here enables ideational speech to be displaced, in the event of a lesion in the posterior speech area, to another cortical area in the same hemisphere. The importance of subcortical integration is reflected in another theory (Lilly, 1967) which postulates a subcortical system which is concerned with affective, nonverbal communication and is common to many lower animals and man. Verbal communication, and especially symbolism, are seen as originating in the dominant cortex. This more advanced system is not an evolutionary advancement in the subcortical ability to communicate; the systems are basically different.

The natural development of language acquisition in normal children has been described by many writers in almost as many different ways, and I shall now mention only a few of these approaches. Perhaps the main differences found in this literature derive from variances in orientation rather than from substantial disagreements. According to a recent general textbook of psychiatry (Noyes and Kolb, 1963) the earliest communications of infants are basically signals of distress, and such vocalizations are expressions of emotional states. Soon the responses of the mother establish patterns upon which may be built later and more complex communicative systems, and these patterns include a rather elaborate and permanent nonverbal symbolic system. Verbal communication, or language, has its beginning sometime between the first and second year of life, coincident with the adequate development of the

neural and muscular systems employed in speaking. Initially the child persists in expressing his emotional states by using interjections, soon he learns to identify the persons around him with names, and later he begins to designate objects with nouns. The use of verbs comes next, and simple sentences are used by the end of the second year. Then the usage of pronouns, adjectives and adverbs greatly enriches his language experience, and if a child has not learned to speak by the age of three and one-half years, there is very probably some defect in the neuroanatomical structures involved. There may, however, be a failure in the teaching environment, since it has been clearly shown that language does not evolve in a non-speaking environment.

As explained by John and Goldstein (1964), language development in the first two years of a child's life involves increasing comprehension of the speech used around him. After this, the child begins to shift from using words as labels with single referents to using words with multiple referents. This is the beginning of rudimentary categorization, and both of these processes represent the symbolic function of language. The third important development to occur is learning to use words as "mediators". Verbal mediation has been defined as "verbal behavior which facilitates further learning, which controls behavior, and which permits the development of conceptual thinking (John and Goldstein, 1964, p. 272)," and this function is closely related to the individual's ability to solve complex problems. The learning of labels requires

selective attention, or the ability to inhibit or ignore the irrelevant aspects of the environment which surround the referent of the label being learned. A similar situation prevails during learning how to categorize by using words with multiple referents. Here the child must learn the essential properties required to qualify objects as referents for the category label in question. This involves learning to ignore the irrelevant attributes of objects considered. Diamond and Balvin (1963) believe that these inhibitory processes must be related in some way to a neurophysiological system of inhibition in the normal functioning of the central nervous system.

In their studies involving Negro children of different socioeconomic classes, John and Goldstein have found that there are some interesting differences in this process of language development. One of their conclusions is that young children can more readily learn new verbal labels in a relatively invariant environment, i.e., one with a minimum of extraneous features to confuse the identities of the referents, and they note that lower class homes are particularly variable in that they lack scheduling and predictability and tend to have a more transient population than middle class homes. Their investigations also showed that there were types of words which lower class children had particular difficulty using. These were action words, words related to rural living, and words whose referents were rare in low-income homes. Inexperience with the referents can easily explain their poor performance with the latter two, but it was postulated that since lower class children do have adequate experience with actions such

as "tying", their lack of facility with the appropriate labels was due to inadequate verbal interaction, and especially corrective feedback, with adults in their homes. Lower class children are forced to learn most of their language by often confusing receptive exposure, rather than by correction of their own active speech, and this interaction and feedback is also seen as an important factor in learning how to use words as verbal mediators. It was also found that middle class children were more readily able to use category labels than were lower class children, and the same lack of verbal interaction in lower class homes may also account for this.

In a somewhat different approach, W.R. Miller (1964) proposes that children from different groups may not learn the same uses for language, but each child must learn the formal features, or the "code" for his language. He states that usage is reflected in the vocabulary, not in the linguistic structure, and this formal code has two components which must be learned. The first is the sound system, which must be learned in order to represent the vocabulary items of the language. The second is the grammatical system, which is used to place these items into proper relationship in sentences. Learning of the sound system begins about the tenth to the twelfth month of life, and learning of the grammatical system occurs approximately between the second birthday and the time school is begun. The grammatical rules represent a source of economy in learning, since they can be used to produce new sentences which the child has neither used nor heard before.

An example is the formation of plurals, the rules for which are usually learned before the third birthday. Knowledge of the singular enables the child to use the plural without learning it separately (exceptions to the rules are learned somewhat later). Early sentence patterns, as well as early words, represent simplifications and reinterpretations of adults' examples, and incorrect patterns are usually short-lived because they are not reinforced by adults.

Environment and cognitive function

Since the ultimate goal of this paper is to relate the development of language learning to the etiology of mental retardation, it seems appropriate to summarize some of the work which has been done regarding the effects of various other types of environmental factors on the cognitive functioning of lower animals. In a series of studies (Rosenzweig, Bennet, and Diamond, 1967), comparing environmentally deprived rats with litter mates kept in a generally stimulating environment, the latter group was found to have developed significantly heavier and deeper cerebral cortices and to show greater cerebral activities of cholinesterase and acetylcholinesterase than the deprived subjects. It was also found that one month of such differential experience was sufficient to make the enriched-experience animals more successful at problem-solving than their deprived counterparts, and these effects were shown to be reversible to some degree by later placing the subjects in the opposite environments. Perhaps the most important finding in these experiments was a statistically

significant positive correlation between the cerebral measures employed and the problem-solving abilities of the rats.

In an excellent review of the theoretical and experimental factors in intellectual development, Haywood (1967) proposes several conclusions which he feels are supported by the preponderance of present evidence. These conclusions deal with human situations and intelligence as well as with lower animals, and I shall only mention a few of his statements. First of all, he feels that reduced sensory stimulation early in the developmental period of lower animals results in erratic emotional behavior and impaired learning ability. Supernormal sensory stimulation, however, may have two different effects, depending on the time at which it is imposed; in the pre-weaning period it leads to reduced emotionality, while somewhat later it may induce increased learning ability. In the human sphere, he feels that the accident of being born and raised in a cultural environment of minimal stimulation (i.e., lower socioeconomic class) often results in a low level of functional mastery of formal language, and prolonged residence in such an environment, or in a typical institutional environment as well, produces a progressively lower level of general intellectual functioning. He also feels that removal from such environments at a sufficiently early time (which is yet to be well-defined) and placement in a situation providing increasingly complex perceptual experiences will reverse this trend of progressive mental retardation. Finally, he postulates that subsequent intellectual development

may be enhanced by enriched sensorimotor experience during the premobile period, whereas the most beneficial experiences during the preschool period are more verbal in nature. This latter conclusion must be considered a hypothesis, however, since it lacks substantial experimental support at the present time.

Socioeconomic influences on mental retardation

Before discussing in more detail some of the evidence linking socioeconomic class to mental retardation, I shall briefly explain what is meant by cultural-familial retardation. There are three main diagnostic criteria which have been accepted by the American Association on Mental Deficiency (Heber, 1961): 1) the child must be mildly retarded, 2) there must be no evidence of organic cerebral pathology, and 3) there must be evidence of retarded intellectual functioning in at least one parent and in one or more sibling (if the child has any). There have been no vigorous attempts to define the first criterion in terms of a specific range of I.Q. scores. A markedly low I.Q. should be considered presumptive evidence of underlying organic brain damage and in such cases further medical evaluation in indicated. However, this "mild" retardation has been interpreted to include children whose I.Q. scores range from 85 (which, as noted before, falls approximately one standard deviation below the mean) all the way down to 50 (Kugel and Parsons, 1967).

This syndrome closely corresponds with such earlier

classifications as subcultural mental deficiency, endogenous mental deficiency, garden-variety mental deficiency, simple amentia, and familial mental deficiency. The AAMD designation places proper emphasis on the environmental influences, although the third diagnostic criterion would seem to suggest a hereditary etiology for this syndrome. The important point is, of course, that the environmental influences affecting the child in question will almost always have similar effect on others living in a similar setting, i.e., other family members. Objective studies of the family circumstances of these children have been few, and most of them have dealt with institutionalized index cases. The vast majority of these families, however, seem to demonstrate low levels of occupational, economic, and educational achievement, though they may or may not be fraught with enough emotional instability to disqualify them as functional family units. Specific data on the etiology of this syndrome is almost non-existent. It has been proposed by several workers that both heredity and environment play a role, and that the significant etiologic influences are probably multiple and varied.

"A way of classifying a population is a way of thinking about them (S.M. Miller, 1964, p. 139)." Any scientific study dealing with the concept of socioeconomic class must have some criteria to, at the very least, differentiate high from low, and such studies investigating relationships to mental disease have used various types of classification systems which have been designed with varying degrees of scientific circumspection.

Two types of considerations may be used, either alone or concomitantly, to define these systems. The first type of system differentiates groups in terms of "class" characteristics, and this approach lends itself to the use of relatively objectively definable criteria. Such a system was used by Hollingshead and Redlich (1958) in their classic study in New Haven, Conn., and the characteristics they employed were area of residence, occupation, and education. Each of these factors were given a numerical weight which denoted their relative importance (6, 9, and 5 respectively), and the Index of Social Position scores which resulted were partitioned into five groups which were each intended to reflect identifiable socio-economic groups within the community. Whereas the latter scores could have been arbitrarily partitioned into ten groups as well as five, statistical techniques indicated that there were real similarities within each group and real differences among them. Although this type of classification system has an appearance of objectivity to it, not all such studies are prepared with the meticulous care as was that of Hollingshead. These systems still require some degree of value judgements on the part of their designers.

A second approach would define groups in terms of "status" criteria, such as style-of-life, and this type of system may be more accurate in certain cases which would be improperly classified by the first type of system. Not all families or individuals live in the same manner as do their neighbors, or their educational or occupational peers. But this approach

obviously depends too much on value judgements to allow definite scientific conclusions to be drawn from studies employing it. This is not to say, however, that both approaches cannot contribute to our understanding of the causes and consequences of socioeconomic stratification in society. With these basic methodological problems in mind I shall now discuss several recent studies which attempt to explain the relationship between socioeconomic status and intellectual development, including language ability.

Some investigations by Stein and Susser (1962a, 1962b) have provided evidence that "educationally subnormal" children, i.e., those falling between the slow learners who are nevertheless judged to be mentally normal and the ineducable retardates, represent a group which arises largely from socially underpriveleged environments. This group of children generally scored between 50 and 90 on the Stanford-Binet test, and their studies involved classification of schools with respect to social standing. They found that schools of low standing produced a significantly higher percentage of children judged by physicians as educationally subnormal than did schools of high social standing, and they concluded that the use of the formal referral machinery used to identify these children had an effect of minimizing the true magnitude of this difference. Their analysis of this group of children also showed that the ones who showed no signs of brain damage came entirely from homes of lower occupational and educational standing, whereas the children with presumptive evidence of

brain damage come from both higher and lower class homes. In a longitudinal study of intellectual development the latter group showed no improvement of subsequent WAIS scores, while the former group showed an average improvement of eight points. Their general conclusion was that, "It seems probable that cultural factors inimical to intellect delay intellectual maturation of the subjects from demotic subcultures and produce a specific syndrome of cultural deprivation, and it may be appropriate to call this mental retardation (Stein and Susser, 1962b, p. 177)."

Deutsch (1965) has identified what he calls a "cumulative deficit phenomenon" which takes place between the first and fifth grade years. His study was a longitudinal one involving a large sample of children of several racial and class groupings, and it consisted mainly of gathering data about the home backgrounds, language performance, intelligence test scores, and other measures of cognitive performance of these subjects. At the first grade level there was a significant correlation between lower social class status and lower I.Q. scores. At the fifth grade level there was a similar but higher correlation, but here the poorer I.Q. performance was also correlated to race. Deutsch's research was designed around a theoretical model of language development which involves initially labeling, then relating, and finally categorizing, and it was found that the negative effects of social disadvantage were enhanced as the level of complexity increased. The family interaction data gathered showed that there is a lack of

organized family activities, such as regularly scheduled meals, in lower class homes as compared to middle class ones, and it was postulated that this situation deprived the lower class children of valuable experience in learning the more abstract and precise use of language. Deutsch also postulated that the contacts made by a Negro child as he advances in his early school years make him more aware of his inferior caste status, and this has a depressing effect on his performance which is similar to that of his class inferiority. The data showed, however, that while being either Negro or lower class results in lower language performance scores, being both Negro and lower class does not result in disproportionately lower scores.

Riessman (1964) feels that the verbal impoverishment of children from culturally deprived homes is probably most striking when they are faced with highly structured tasks. He notes that the Institute for Developmental Studies, under Deutsch, has found that deprived children express themselves best in spontaneous and unstructured situations. Some other findings of the Institute are: 1) deprived children are poor in the use of verbs, but much better with descriptive adjectives, 2) they seem to understand more language than they speak, and 3) they show a remarkable ability for phantasy.

In a longitudinal study of a low socioeconomic group of Negro children, Pasamanick and Knoblock (1955) found that there were no significant Negro-white differences in either physical growth or behavioral development during the first

eighteen months of life. Upon a third examination at about two years of age, however, there were some notable findings in the Gesell Developmental Examination scores. The Negro infants' language behavior scores were significantly lower than scores in other areas tested. These language scores were also significantly lower than the language scores they achieved on their first examination. These children were tested by a white examiner, and it was concluded that since their scores in other areas of behavior were consistent with white norms, this language deficit was due to lack of verbal responsiveness rather than to poor comprehension of language. This was attributed to the subjects' awareness of racial differences and poor rapport between the white examiner and the Negro subjects.

Golden and Birns (1968) conducted a study with Negro children of age two or younger representing three socioeconomic classes. These subjects were tested by the Cattell Infant Intelligence Scale and the Piaget Object Scale, a relatively new measure of cognitive development. Their main conclusion, in agreement with various previous studies, was that social-class differences in intellectual development are not revealed in infant test scores in the first two years of life. Statistical analysis of their data suggested that the two tests measure different aspects of cognitive functioning. Analysis of verbal performances on the Cattell also showed that there were no significant socioeconomic differences in these scores within each age group. Since the verbal items on the Cattell are

limited to the concrete use of language, this finding does not contradict the theory that social-class differences in the intellectual development of older children may be dependent on the use of abstract language. It may be that social class influences do not affect intellectual development during the first two years of life, or that the effects which are taking place during this time are simply not measured by the infant tests used. The latter hypothesis is consistent with our knowledge that the use of abstract language cannot be tested for (and, indeed, probably is not significantly developed) before the age of two. The value of infant tests in predicting later intellectual development has been questioned in the past (Stott and Ball, 1966).

Another consideration in interpreting intelligence test scores is the possible effect of anxiety on intellectual performance. According to Rabin (1967) the experimental work which has been done on this question has largely involved normal school populations, and the findings generally have shown that the kind and degree of emotional disturbance are important determinants of a variable but significant influence on I.Q. scores. Although anxiety tends to produce a consistent negative influence on normal children's performance, Rabin feels that this is not so in the retarded. This would seem to run somewhat counter to the theory which holds that the structure of intelligence in the retarded does not differ, with the possible exception of the short memory factor, from that in normal individuals. This theory of similarity would

appear especially applicable to cultural-familial retardates, and further experimental studies will probably show that intelligence test scores are negatively influenced by high levels of anxiety in this group of subjects. As a partial explanation, it may be postulated that less intelligent subjects are naturally more anxious in testing situations which are designed to reveal their inadequacies. This general effect could be manifested more specifically through employing tests oriented around the abstract use of language, which presents socioeconomically deprived children with an unfamiliar and especially difficult testing situation. This orientation is a common one, since the development of I.Q. testing historically derives from an effort to predict individuals' future success in school achievement.

Before concluding that the case for relating sociocultural deprivation to mental retardation is virtually ironclad, I should like to point out a recent study which represents a less enthusiastic attitude. Silverstein and Shotwell (1962) have compared the performances of 53 Mexican mental retardates to that of 251 controls on the WAIS, and found that the mean Verbal or Full Scale I.Q.s of the two groups did not significantly differ. But it also was found that whereas there was essentially no difference between the mean Verbal and Performance I.Q.s of the control patients, the Performance I.Q. was significantly the higher score for the Mexican patients. This discrepancy, along with other differences found between the two groups, were so small that the authors concluded that

caution should be used by clinical psychologists in making allowances for cultural factors affecting the intellectual functioning of the mentally retarded. Although this particular study can hardly invalidate the general trend of the many others which have purported to show a closer relationship between such factors, it is well to keep in mind that the tests we use are reported in numerical scores, and as yet we have no good quantitative data defining the effects of socio-cultural factors on these scores.

It is interesting to note that the designers of intelligence tests have recognized for many years a sociocultural influence affecting the results of standard tests, and several special tests have been designed which presumably minimize these influences. In a recent study by Willard (1968) comparing the performance of culturally deprived Negro children on standard intelligence tests with their performance on the Cattell Culture Fair Intelligence Test, it was found that these subjects did not score appreciably better on the latter. This suggests that either there is no particular sociocultural bias in the standard tests used, or not enough is yet known about this bias to do away with it.

Conclusions

In summation, then, I should list the principle conclusions which derive from all the foregoing discussion as the following: 1) There is a relatively distinct and identifiable syndrome of mental subnormality which is known as cultural-familial mental retardation. This syndrome has

multiple determinants, almost all of which are environmental. 2) The level of an individual's performance on test of intellectual capacity is significantly influenced by his socioenvironmental background. 3) One important determinant of this influence is the character of the individual's experience with the formal and abstract use of language.

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