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Date July 31, 1975

A STUDY OF THE PHENOMENOLOGICAL AND NEUROLOGICAL APPROACH TO INTELLIGENCE AND THEIR RELATIONSHIP TO INTELLIGENCE TESTING

by

EVERETT LEE WINBURN

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Head, Major Department

Graduate Dean

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ABSTRACT

A review of the literature was conducted to ascertain the concept of intelligence as proposed by Arthur Combs, the phenomenological approach, and John Ertl, the neurological approach. Their views relative to intelligence testing were also determined, as well as their implications for present day intelligence testing.

Combs' proposed that intelligence can be created and educators have a responsibility to do so. He challenged the workability of behavioral objectives, and in turn was challenged for his views on behavioral objectives.

The literature dealing with the relationship of electrical activity in the brain and test intelligence is contradictory and inconclusive, but there is insufficient evidence to justify rejection of the hypothesis that no relationship exists between intelligence and EEG indices.

The researcher concluded from this study that the phenomenological construct of intelligence is a more positive approach than the behavioral objective approach, which is still a debatable construct.

It was also concluded that research on brain wave activity and intelligence was inconclusive and contradictory, but present evidence does not justify rejection of hypothesis that no relationship exists between these two parameters. Even though methodological problems do exist, the investigator concluded that a relationship does exist between IQ scores and the latency of the visual evoked potential.

Further research should be conducted concerning the efficacy of behavioral objectives and concerning the EEG-Intelligence relationship, with tighter methodological controls.

Chapter 1

INTRODUCTION

The world we live in is a world of change, rapid and vital change. It is a world which refuses to recognize stagnation as an element of the retrogression-progression continuum. "Centering" on this particular continuum is to be shunned and avoided. The educational field has not escaped the force which cries, "Do something!" Some educational concepts have seemingly been in abeyance, stagnating on the retrogression-progression continuum, needing an impetus to move, to change. The concept of intelligence is a case in point. Old concepts of intelligence are being re-examined, re-evaluated; new concepts are being formulated and expounded upon. Arthur Combs (1952) proposes a perceptual point of view based on an individual's phenomenal field. At the same time he redefines intelligence, giving it a new lease on life (1973, 1972). John Ertl (1972) renders a negative definition of intelligence in terms of what it is not.

Intelligence testing the offspring of intelligence, is also undergoing change. There is a national discontent with current modes of intelligence testing. The heated debate between the educational camp which accepts our present testing instruments, and the opposing camp which suggests these instruments should be discarded, continues. Arguments and criticisms abound. Court decisions and legislative actions to ban group intelligence tests in factories and in the public

of certain states have already been handed down, with more such decisions expected (Ertl, 1972).

The cry is to replace the I.Q. test, but the question is, with what? Perhaps the neural efficiency analyzer is the answer, or perhaps a new approach to intelligent behavior, a perceptual model is the answer.

STATEMENT OF THE PROBLEM

The problem of this study was to describe Arthur Combs' phenomenological approach to intelligence and John Ertl's neurological approach and to note the implications of each approach to present day intelligence testing.

APPLICATION AND/OR CONTRIBUTION TO EDUCATIONAL THEORY OR PRODUCT

The investigator's firm belief that: 1) new methods of intelligence testing should be examined and 2) that concept of intelligence, so vital to the educational framework, should be continually re-evaluated and restructured, serves as a basis for the selection of this problem.

It is imperative that any new approach to intelligence should be carefully scrutinized and analyzed to determine if its merits warrant further research and development. Tunnel vision is self-imposed. Imaginary boundaries are erected, self-imposed restrictions become fixed and immutable. A concept becomes set, unchallengeable. The researcher believes the concept of intelligence is such a concept. The need then,

is to view the rooted concept in new settings, from different viewpoints, to try to determine the feasibility of application to the more stringent requirements of today's society.

Such a need also exists in the realm of intelligence testing. Old methods of testing are being challenged. New, culturally unbiased methods of measurement are being researched. It has been proposed that group standardized intelligence, aptitude and achievement tests be eliminated until the completion of a critical review and revision of current testing programs (Zach, 1972).

There is a search for a replacement for intelligence tests. When a new method of intelligence testing is advanced, it behooves the educational society to critically examine that new method.

LIMITATIONS AND/OR DELIMITATIONS

A delimitation foreseen by the researcher is a function of the literature dealing with studies conducted on the relationship of brain wave activity as it relates to intelligence. Some of the studies are in the German language which the researcher cannot read. The need for translation of these studies into English is not apparent at this time.

A review of the literature for this study was conducted at the Montana State University library. Some requests for materials not available in the Montana State University library were made too late to receive these materials.

DEFINITION OF TERMS

The Chopped Speech Test (CST) is a test specially developed as a putative measure of signal detection ability, or the capacity to bring closure to garbled auditory information (Ertl, December 1969).

Evoked potentials are non-random changes in the electrical activity of the brain in response to sensory stimulation (Ertl, 1968).

Average evoked potentials (AEP) are the electrical responses to stimuli (the evoked potentials) summated after a sufficient number of stimuli have been presented (Ertl, 1968).

Neural efficiency is the efficiency with which information is transmitted from one neuron to another in the brain (Ertl, 1972).

The nature of intelligence as viewed from Combs' (Combs, 1952) perceptual or phenomenological point of view is defined as behavior which is a function of the perceptions of the experiences of the individual rather than a simple stimulus-response model. Intelligence, then, is the capacity for effective behavior, based on the individual's perceptive field. Since the richness and variety of his perceptions vary at any given moment, so also will the intelligence vary at any given moment.

The perceptive field is called the Phenomenal Field (Snygg and Combs, 1949) and is defined as the behavior of the individual at any given moment based on his universe of experience as he perceives it at that moment.

The neural efficiency analyzer of John Ertl (1972) is a machine which measures the efficiency and speed with which information is transmitted from one neuron to another in the brain--that is, the speed of information transmission. Two 3-digit numbers are flashed on the analyzer screen at the completion of the test. These numbers are entered on a table, which first gives the neural efficiency score, called the E.I. (Ertl Index) and then predicts what the subject would score on the I.Q. test.

Human intelligence, viewed in the framework of Ertl's neurological or medical model, is a function of the electrical activities of the brain (Ertl, 1972). He states that no one really knows what intelligence is, including himself. However, he states that he does know one thing that it is not, and that is a score on an I.Q. test standardized for a white Anglo-Saxon population.

His intelligence model is based primarily on three factors--speed, power, and creativity. An individual with a high speed factor is verbally extremely glib, yet his thinking processes are usually shallow, even though he would score well on a conventional I.Q. test. A high power factor indicates a person who requires a longer time to assimilate information he receives, but his thinking processes are more profound. Most individuals possess both of these factors to a varying degree, while some fortunate people also possess the creativity factor which Ertl terms "noise" (1972, p. 89) in the brain. Defined another

way, it represents random interconnections between neurons which occur in response to external stimuli.

SUMMARY

This study will be based on a survey of relevant literature related to Arthur Combs' and John Ertl's divergent models of intelligence, the perceptual model and the neurological model respectively. Supportive and critical writings will be cited, and inferences of these two models will be noted relative to existing standardized intelligence tests.

Chapter 2

REVIEW OF THE LITERATURE

A variety of sources were reviewed to ascertain the characteristics of Arthur W. Combs' phenomenological approach to intelligence as well as the neurological approach of John Ertl. As the literature revealed the writings of individuals who opposed their concepts, these works were reviewed. Finally, the supportive literature was reviewed.

The concepts of Combs and Ertl will be described, and the intelligence testing methodology of Ertl will be examined. Supporting and critical literature will be noted. Implications as described by Ertl and Combs for intelligence testing and for the teaching profession will also be considered.

The topical format for the chapter will be as follows: 1) Literature on Arthur Combs' concept of intelligence, 2) Literature on the criticism of Combs' concepts, 3) Literature on John Ertl's concept of intelligence and his neural efficiency analyzer as a means of intelligence testing, 4) Literature on the criticism of Ertl's work, and 5) Literature supporting Ertl's work.

LITERATURE ON ARTHUR COMBS' CONCEPT OF INTELLIGENCE

"Today we know that intelligence itself can be created" (Combs, 1971, p. 349). This theme appears in other writings of Combs (1952, 1974). The idea is exciting indeed, for it means that individuals

working with young people are not the victims of the child's intelligence, but rather partners with the child in creating it. The gifted child, then, is an outstanding accomplishment, and we should discover why we were so successful and how we did it, and proceed to produce more gifted children as quickly as possible (Combs, 1971).

Combs (1973, p. 11) defines intelligent behavior as "effective, efficient, problem solving action contributing to the fulfillment of an individual's own and society's needs." In other works he defines intelligence as the effectiveness of the individual's behavior (1952, 1972) and intelligent individuals as those who "are more open to their experiences and being more open are more likely to have better answers" (1971, p. 353).

Combs (1952) views intelligence as a function of the individual's perceptive field which he and Snygg called The Phenomenal Field and, defined as, "the universe of experience open to the individual at the moment of his behavior" (1952, p. 662). The behavior of the individual is therefore dependent upon the perceptions he makes in his phenomenal field at the moment activity is initiated. The factors which limit the scope and clarity with which he views this field would, therefore, also limit his intelligence. In addition to these limiting factors, which will be discussed later, Combs (1974) lists two other determinants of intelligence or intelligent behavior. The first of

these refers to meanings a person possesses, and the second refers to the individual's freedom to use those meanings.

Perceptions are divided into two types--potential and functional perceptions. He defines potential perceptions as those perceptions existing in one's unique phenomenal field, which could occur at any particular moment given the right circumstances (1952). Potential perceptions are the basis of potential intelligence which intelligence, Combs admits, is impossible to measure by standardized intelligence tests.

Functional perceptions, defined as the perceptions the individual experiences at the moment behavior occurs, can be and are measured by intelligence tests. The functional perceptions measured are the kinds of differentiations an individual makes when confronted with the necessity to do so.

From the perceptual or phenomenological viewpoint of intelligence, the importance of the variety of perceptions as well as the richness of those perceptions is evident, for intelligence is dependent upon these parameters. An awareness of the factors which limit the perceptions is crucial to an understanding of the individual's behavior at any given moment.

Combs (1952, 1971, 1974) lists seven limiting factors upon perception. The first one is included in his earlier writings (1952) but not in his later writings (1971, 1974) as a separate and distinct

factor. These limiting factors will be listed only, without discussion. They are: 1) Goals and values, 2) Opportunity and environment, 3) Human needs, 4) Physiological limitations, 5) Self-concept, 6) Time, and 7) Challenge and threat.

"For a number of generations now, we have been dealing with learning from a false premise," states Combs (1973, p. 39). This false premise is related to conditioning and Pavlov's stimulus and response system of learning, which is not an effective approach to learning as viewed from his phenomenological viewpoint. He sees the behavioral objective concept as an outgrowth of the stimulus-response system.

Combs (1972, 1973) states that he is not opposed to behavioral objectives, nor is the behavioral objectives approach wrong. The danger, as he sees it, lies in the fact that it is only partly right. Behavioral objectives are useful only for dealing with the simplest aspects of education, the acquisition of precisely defined skills, and have limited application when applied to behaviors related to a creative approach to problem solving.

Intelligent behavior must be examined in holistic or global terms (Combs 1972, 1973). It is a gestalt, an integrated whole which should be examined and analyzed as an integrated unit. The behavioral objective approach attempts to break the behavior patterns down into smaller and smaller parts capable of more precise measurement. This approach should be avoided, Combs (1972, 1973) believes. Since he

views intelligence as holistic behavior, objectives should be defined in holistic or gestalt terms, and then determine ways to assess it. In Combs' (1972, p. 12) words, "Measuring what we know how to measure is no satisfactory substitute for measuring what we need to measure."

There are certain hazards in applying the behavioral objectives approach to intelligence within the perceptual framework. Combs (1972) lists six limitations which will be noted without discussion. The inadequacies of behavioral objectives from his perspective are: 1) Behavioral objectives have limited value, and must be confined to acquiring precisely defined skills, 2) Behavioral objectives represent a symptomatic approach to behavior change, 3) Behavioral objectives discourage innovation and stifle creativity in the classroom, 4) Behavioral objectives create a closed system where students have no voice in educational objectives and, therefore, feel no commitment to them, 5) Behavioral objectives restrict the teacher's view until only the narrow goals of education are visible, and 6) Behavioral objectives are demoralizing to teachers.

The phenomenological view as partially expressed here may be true or false, or some degree of each. Even more important are the challenges associated with the perceptual theory of intelligence.

LITERATURE ON THE CRITICISM OF COMBS' CONCEPT

The role of behavioral objectives, although less controversial now than in the past, is still a matter of debate. Combs sparked such

a debate in his booklet entitled Educational Accountability: Beyond Behavioral Objectives (Combs, 1972), and Ware, Newell, and Jester (1973) responded.

The ideas presented in the booklet do little, if anything, to clarify the issue of behavioral objectives. They are, in fact, "a very limited and biased delineation of educational accountability" (Ware, 1973, p. 667).

The six limitations behavioral objectives which Combs describes in this article, and which are listed in the previous section, are discussed point by point in Ware, Newell, and Jester's (1973) response in relation to other literature.

The response admits that several interesting points regarding behavioral objectives were raised in Combs' article, but at the same time they describe four major criticisms of Combs' article.

One of the criticisms is the lack of literature to support the arguments he presents. A second criticism is the lack of differentiation between the terms accountability and behavioral objective, and the third criticism is that Combs equates "measurable" with "narrow" such as specific skills and facts.

The fourth criticism deals with the booklet in general. If we accept the criterion for judging a contribution to science as the degree to which the work may be subjected to public scrutiny, then the alternatives to behavioral objectives which Combs outlines do not

warrant being considered as scientific contributions since the book relies upon constructs which defy observation.

The article is one more in an extensive body of literature which expresses rational argument without the inclusion of any empirical evidence (Ware, Newell, and Jester, 1973).

LITERATURE ON JOHN ERTL AND HIS NEURAL EFFICIENCY ANALYZER AS A MEANS OF INTELLIGENCE TESTING

The Pandora's box of intelligence testing motivated John Ertl (1968) to research a more objective method of measuring human intelligence. He believes a solution lies in measuring electrical responses in the brain. The idea is not new. Ertl (1968) cites Hans Berger's work in 1929 which demonstrates the possibility of measuring the electrical activity of the brain from the human scalp. Attempts to relate variations in electrical activity of the brain to psychological variables have their genesis in this pristine work. The early studies dealt specifically with Electroencephalogram (EEG) variables and human intelligence but the results, according to Ertl (July, 1969) have been inconclusive. Only limited information can be obtained from a standard visual analysis of the EEG. In relation to psychological phenomena, the main variables of the EEG that have been studied are amplitude, frequency, phase relationships, different areas of the brain, and the "alpha rhythm" (Ertl, 1968).

A major breakthrough in the study of human brain activity occurred in the 1950's when the high speed digital computer became more readily available (Ertl, December, 1969). The analysis of complex patterns of electrical activity became feasible when techniques were developed for detecting average evoked potentials (AEP) using these computers.

Ertl (1968, p. 2) defines evoked potentials "as non-random changes in the electrical activity of the brain in response to sensory stimulation." After the presentation of a light flash, an electric shock, or an audible click, a series of evoked potentials or non-random electrical events will occur in the brain. The problem has been in detecting these evoked responses. Due to their small amplitude and their mixing with the ongoing EEG, an electronic averaging device is required to extract these evoked potentials since they cannot be seen with the usual methods of analysis. Ertl (December, 1969) discovered it was possible to reduce the background noise sufficiently to study the electrical signal. Since a feature of the signal (the evoked potential) is its non-random occurrence, which Ertl (1968) labels latency, then it is possible to separate the signal from the noise (the ongoing EEG) by an averaging technique described as follows.

A stimulus is presented to the subject and his brain responds electrically always at approximately the same time after the stimulus. The regular EEG is mixed in with the response but it is not related

time-wise to the stimulation. The averaging device employed adds both the EEG and the evoked response, but since the EEG noise is not related to the stimulus it approaches zero, while signal or evoked response which always occurs at the same time adds up to some maximum value which represents the average evoked potential (AEP) after several identical stimuli have been presented. In this way the average evoked potentials can be detected and studied.

Ertl's hypothesis is that a "possible relationship between the average evoked potential and psychometric intelligence" exists based on the "concensus that the late components of the evoked potential are the electrical signs of information-processing or associative activity in the brain" (1968, p. 3). He postulates from this that a "biologically efficient organism should process information more rapidly than a less efficient organism and that the delay or latency of components of the evoked potential could be a measure of the efficiency of this process" (1968, p. 3). To support this hypothesis, Ertl undertook two studies, one in 1968 with an experimental sample of 573 primary school children who were visually stimulated and one in 1969 involving 213 randomly selected children from the 1968 group receiving visual, tactile and auditory stimulation.

Ertl's (1968) sample was composed of 317 male and 256 female pupils randomly selected from grades 2, 3, 4, 5, 7 and 8 in the thirty-nine schools of the Ottowa separate school system from a population of

8000 children. When a second study in 1969 (Ertl, December, 1969) was initiated, 119 males and 94 females were randomly selected from the original sample of 573 pupils. This number was reduced however, when a change in recording technique from bi-polar to mono-polar yielded unreliable evoked responses in the first 50 - 100 milliseconds of the response. It was therefore impossible to measure the latencies of the early components with any degree of confidence, and all attempts to salvage the data ended in failure. The sample size was reduced and ranged from 36 pupils to 113 pupils depending on electrode placement and the stimulus modality.

In the 1969 work, an additional criterion sample of 46 high I.Q. and 33 low I.Q. pupils was selected from the original 573 pupils. A high I.Q. subject was defined as one scoring 120 or better on two out of the three intelligence tests used, which tests will be discussed shortly. A low I.Q. subject was one which scored 80 or less on two out of these three tests.

The three commonly used intelligence tests administered were the Wechsler Intelligence Scale for Children (WISC), the Primary Mental Abilities Test (PMA), and the Otis Quick-Scoring Mental Ability Test (alpha or beta).

In addition, the 79 control subjects (Ertl, December, 1969) were administered the specially developed Chopped Speech Test (CST). This test was developed to measure the capacity to bring closure to

garbled auditory information. Ertl hypothesized that evoked potential latency would correlate with this measure. Sixty randomly selected two digit numbers at three levels of item difficulty were tape recorded and presented by loudspeaker and the subjects were asked to write down the two digit number they recognized after each presentation. Subjects were scored on the total number of correct digits identified.

Intercorrelations between the CST and scores on the three I.Q. tests administered were small but significant at the 0.01 and 0.05 level. Significant correlation between the CST and academic achievement were also obtained. None of the correlations obtained were high enough to recommend the CST as a new quick test of intelligence (Ertl, December, 1969).

Evoked potential records were then obtained on each subject. The EEG of each subject in the 1968 study was recorded from bipolar scalp contact electrodes 6 centimeters apart, parallel with the midline and astride C4 in the 10-20 international recording system (Jasper, 1958) with ground to the right earlobe. The amplification of the raw EEG to the required voltage is recorded as being in a bandwidth 3 db (decibels) down at 5 and 100 Hz (cycles per second) in one report (Ertl, 1968) and recorded in a second report as 3 db down at 3 and 50 Hz (Ertl, July, 1969). The EEG was recorded on multi-channel FM magnetic tape together with trigger pulses corresponding to the onset of flash stimuli. The subjects sat in a darkened shielded room with

their eyes open and fixating a spot on a reflecting screen five feet away. The photo-stimulator lamp was located outside the room, to eliminate the audible click of the lamp's gas discharge tube, and above and behind the subject. The light stimuli were of micro-second duration and were delivered according to a uniform stimulus interval distribution ranging from 800 to 1800 milliseconds (msec).

In the 1969 study the procedure was very similar, except 400 loudspeaker delivered click stimuli and 400 mechanical taps to the right thumb followed the flash stimuli (Ertl, December 1969). The same time schedules for delivering the stimuli were used in both studies; however, in the 1969 study the evoked response waveforms were averaged by the Enhancetron computer in alternate 500 msec duration sets of 200 responses each and the sequential component peaks were identified by cross-correlation. In the 1968 study the average evoked potentials in response to the 400 stimuli in a 625 msec interval were separated from the EEG by the two methods described below.

Conventional amplitude summation was the first method employed to average the 400 evoked responses of the student in alternate response sets of 200 using the Enhancetron ND-801 digital computer (Ertl, 1968). The amplification brings the data into the volt region required for recording by an analog magnetic tape.

According to Ertl (1968) this method of identifying the AEP component contains much subjectivity; therefore a second technique was

employed called zero-crossing analysis (Ertl, 1965, 1967). In this method the EEG was converted to pulses corresponding to zero-crossings defined as the point where the EEG waveforms passed from positive to negative voltage (Ertl, July 1969). This same technique was used to confirm statistically the presence of sequential AEP components.

The AEP of each subject after amplitude summation of their 400 responses was graphed, and a histogram of zero-crossing occurrences against time, followed the same 400 stimuli, was made by the Enhancetron across its 64 channels and plotted on the same graph. A control histogram was generated by using the same EEG data and triggering the multiscaler 400 times randomly with no stimulation. The chi square test was used to check for the statistical presence of non-random AEP components, since Jasper (1958) experimentally demonstrated that the probability of an EEG zero-crossing occurrence is equal in any given period of time under non-stimulated conditions. Therefore, an equal number of zero-crossing counts in all 64 channels should occur if no evoked potential components were present. This was statistically determined to be the case upon comparing the mean channel count. The standard deviation of the control histogram was calculated and if the number of zero-crossing counts in any channel of the experimental histogram exceeded two standard deviations above its mean, a statistically significant event was identified using the chi square test at the 1 and 5% levels of probability. The peaks of the summated AEP waveform which corresponded to

each statistically significant event were labeled and their latencies from onset of stimulus were measured. On the graph a statistically significant zero-crossing event was always accompanied by a visible component in the AEP record. If a visible peak in the AEP waveform was not supported by as significant zero-crossing event, it was rejected as a sequential component (Ertl, July, 1969).

The above cited latencies associated with the first four sequential AEP components detected were intercorrelated with all the intelligence test scores obtained using the Pearson r correlation coefficient across all the subjects in the study. Ertl (1968, p. 15) believes the results of this correlation definitely illustrate "a relationship between the electrical activity of the human brain and intelligence as measured by standard I.Q. tests." This belief is based on the "observed highly significant inverse correlations between the latency of sequential components of the visual average evoked potential and I.Q. scores" on the WISC, the PMA, and the Otis Test of Mental Ability (1968, p. 15). Ertl believes the AEP component latency is related to some common factor tapped by the standardized intelligence tests.

The AEP component latency-I.Q. intercorrelations are not large--the magnitude is from 0.10 to 0.35, but Ertl states they are highly significant statistically since with an N of 556 Pearson r coefficients of 0.16 are significant at the P = 0.0001 level (Ertl, 1968). A fundamental law could be indicated when a correlation between variables

in the psychological domain and variables in the physiological domain can be shown to be statistically significant. Ertl feels that such is the case with his findings. He proposes that the "latency of sequential components of the visual AEP is an index of neurological efficiency which manifests itself differentially in standardized estimates of intelligent behavior (I.Q. scores)" (1968, p. 18).

Ertl found no significant sex differences in the latency of sequential visual AEP components. He also investigated the relationship between age and the latency of sequential visual AEP components computing Pearson r correlation coefficients between age and latency of the first four AEP components, and found that all correlations were insignificant across the whole sample. An analysis of variance then revealed that neither age nor the interaction between age and intelligence made a significant contribution to the variability in the latency of AEP components.

Ertl (1968) divided the sample into fast, average, and slow responding groups on the basis of the latency of the third sequential AEP component, and t tests were performed to determine if there were I.Q. differences between these three groups. It was determined that fast third sequential latency subjects had higher WISC I.Q. scores than the average or slow latency subjects.

The sample was further divided into high, average, and low I.Q. groups on the basis of WISC full scale I.Q. scores and t tests were

performed to determine the possibility of AEP component latency differences between these groups. It was found that high I.Q. subjects showed shorter latencies than average or low I.Q. subjects, and conversely that fast latency subjects showed higher I.Q.'s than average or slow latency subjects.

The distribution of high, average and low WISC I.Q. subjects was analyzed in relation to the latency of the third sequential visual AEP component. Ertl identified 218 subjects, or 38% of his sample, whose performance on the I.Q. tests administered was not compatible with their AEP latency as predicted by the inverse relationship between these two variables. He called these subjects "anomalous" subjects (1968, p. 21). Ertl assumed AEP latency was a fixed physiological measurement which should predict I.Q., a measurement known to vary with testing instruments. The incompatibility of these findings, therefore, warranted investigation. One hundred and twenty-eight of these subjects were termed "acceptable anomalies," i.e. subjects whose I.Q. performance was lower than would be expected on the basis of their AEP latency, when examination revealed a high percentage of children with English language deficiencies which Ertl postulated lowered their I.Q. scores on the psychometric tests used. Retesting of fifty-nine of the subjects with the Goodenough Draw-a-Man and the Raven Progressive Matrices removed twenty-eight of the students when their higher I.Q. scores on these tests showed congruency with their AEP latency. Of the twenty-nine

subjects tested which did not show a significant increase in I.Q., nineteen were "Italian born and were being reared in a deprived socio-economic climate" (Ertl, 1968, p. 21). Eighty-nine subjects or 15% of the sample were subsequently labeled "non-acceptable anomalies," i.e. subjects whose I.Q. was higher than would be expected on the basis of their AEP latency. A longitudinal follow-up program is in progress to discover a possible explanation of these subjects' I.Q.-AEP latency discrepancy.

When the AEP waveforms of ten high and ten low I.Q. subjects were compared, it was discovered that the two sets of waveforms were different in configuration. The high I.Q. subjects revealed high frequency early components in the first 100 msec which were not present in the AEP's of the low I.Q. subjects. Development of a computer pattern recognition technique which would identify high, average, and low I.Q. subjects by their AEP waveform configurations is in process (Ertl, 1968).

Ertl in his 1968 study concluded that a relationship between the electrical responses of the human brain and intelligence as measured by standard I.Q. tests was clearly demonstrated. He suggested that cross-validation by independent investigators be undertaken. Normative data from this study on visual evoked potential and three widely used psychometric tests of intelligence is now provided for other researchers in this area. Ertl suggested that this study be considered as only the

first step in "identifying the electrophysiological correlates of human intelligence" (1968, p. 23). Ertl visualized a composite index of "neural efficiency" based on data of evoked potential from different critical areas in response to not only photic stimulation, but auditory and tactile stimulation as well. Ertl's project reported in December 1969 and previously noted, was based on this suggestion. That project was fraught with problems, one problem already discussed being the change in recording technique from bi-polar or mono-polar.

Ertl suggested that the unreliability he discovered of the evoked potential in response to tactile and auditory stimulation was due to electrode placement and does not mean these phenomena are themselves unreliable measures of neural efficiency.

The evoked responses from three different areas of the brain--frontal, central, and occipital was analyzed as a result of being stimulated visually, auditorily and with tactile stimuli in this 1969 study. Ertl discovered, as anticipated, that the evoked responses to visual, auditory, and tactile stimulation from the same brain area was different. This was indicated by the low intercorrelations between component latencies. The evoked responses to the same stimulus from different areas of the brain was also different. Again, low intercorrelations between components of the evoked response to the same stimulus in different areas demonstrated the difference. This was an unexpected finding which demonstrated the difference in results

obtained using the bi-polar electrode technique in contrast to the mono-polar electrode. Using bi-polar electrodes, the differences going from occipital to central to frontal regions were much less which indicated the sensitivity of mono-polar electrode placement in terms of exact location on the head (Ertl, December 1969).

In the December 1969 study, Ertl hoped to determine the predictive efficiency of evoked potential in relation to academic achievement scores. The results were far from encouraging. A multiple R of 0.26 was obtained, N of 528, indicating the relatively poor predictor capabilities of the evoked potential measure, when compared with the multiple R of 0.59 yielded by the predictive efficiency of I.Q. scores in relation to academic achievement. Ertl was not discouraged by the results and attempted to explain the difference between the two R's.

Notwithstanding the present I.Q. tests, "an independent and valid criterion of human intelligence has not as yet been established and it is our hope that if such a measure is discovered, its relationship to evoked potential measures will be much better" (Ertl, December, 1969, p. 24). He claimed the high predictive efficiency of I.Q. test scores was probably due to the short time span, and that the predictive efficiency of I.Q. scores decreases as the time span increases. He proposed a longitudinal follow-up program with his subjects, and expected the predictive efficiency of the evoked potential to improve with time.

When only the 79 criterion subjects described previously were considered, I.Q. prediction from latency measures was improved, yielding a multiple R of 0.68. Prediction of academic achievement from the latency component increased to 0.60. Ertl concluded that since the predictive efficiency of the evoked response increased when the middle ranges of intelligence were ignored, and only the high and low I.Q. criterion subjects were considered, it indicated a lack of validity of I.Q. tests in this middle range, which caused the lowering of predictive efficiency of the evoked potential (Ertl, December, 1969).

The literature review revealed the recurring need for developing new methods for harnessing the special purpose computers available. Experts were consulted in solving the complex requirements of extracting evoked potentials from EEG data. The sophisticated analysis procedures required precluded the use of available laboratory instruments. A digital data acquisition and analysis facility was desirable which would allow for the use of the large scale digital computers. Experts solved that need (Ertl, 1968).

A computer method was developed for ordinary linear discriminant analysis in contrast with the stepwise discriminant analysis previously employed (Ertl, December, 1969). A new machine was developed by Ertl and his associates which he calls the "neural efficiency analyzer" (1972, p. 89).

The machine he developed "measures the efficiency and the speed

which information is transmitted from one neuron to another in the brain" (Ertl, 1972, p. 89). His validation criteria for measuring I.Q. lie outside the area of regular I.Q. testing and psychological testing. His criteria is medically based. Ertl cites chemical substances, known to reduce mental acuity, and notes that when these chemical depressants are present, the neural efficiency scores is lower than the individual's normal score, as measured by his machine. When the depressants are removed, the scores are higher.

Small silver electrodes are applied to the scalp with a conductive jelly. An amplifier is used to strengthen the evoked response which is less than $1/1x10^6$ of a volt. A closed-loop feedback system in the analyzer ensures that each subject starts at the same point in the brain-wave phase. One hundred flashes of light are delivered at random by the computer, with an average time of one second between flashes. A monitor ascilloscope amplifies and displays the brain waves, while a computer computes average time between evoked responses. The test requires approximately 100 seconds to completed, and at this time two 3-digit numbers appear on the analyzer screen. A nomograph, or table, gives both the neural efficiency scores and a predicted I.Q. score which the subject would score on a standardized I.Q. test.

Ertl states the test-retest scores on the analyzer are very accurate over a short period of time, and less accurate over a longer

period of time, but the scores are better than test-retest scores on an I.Q. test.

The inventor of the analyzer believes that the machine will have a useful application in the Head Start program and in similar programs. It should be of benefit in the early diagnosis of dysteria and other kinds of learning disabilities. He hopes the analyzer will "permanently dispell the myth of racial inequality in the U.S." (1972, p. 90). The machine should also be used in testing subjects with severe mental disturbances.

LITERATURE ON THE CRITICISM OF ERTL'S WORK

Despite the criticisms directed at the concept of intelligence testing and the use and misuse of intelligence tests, there appears to be a reluctance on the part of educators to accept new methods of intelligence testing.

"When the intelligence test is evaluated solely in terms of its value to meet defined immediate situations, its usefulness has proven itself," states Zach (1972, p. 41). Part of the problem, as he sees it, lies in the vague definition of intelligence by the test makers, and the accepted definition today, namely, intelligence is what intelligence tests measure.

"The perversion of the test results by investigators and social philosophers who use numbers in support of particular far-reaching

positions," (Zach, p. 42) is also part of the problem. Perhaps the I.Q. test should be discarded and replaced by a battery of achievement tests, or a new method of measurement be devised.

Zach (1972) cites several drawbacks to one of the new methods, that of John Ertl's approach. One of the drawbacks is the lack of a theoretical rationale to support Ertl's hypothesis that more intelligent people respond faster to stimulation than people with less intelligence. The results Ertl reports on response may be explained by the fact that some people have greater powers of concentration and can concentrate on the light source better, and may not be due to the greater or lesser strength of the brain.

Correlations of the evoked potential with I.Q. are significant but low as are correlations on retesting with the same subjects. Shultz (1973) also discusses this point and states that, "Ertl is unconcerned about this kind of concurrent validity" (1973, p. 70).

Shultz (1973) sees the genesis of a problem in the fact that since Ertl owns substantial stock in the firm which produces the neural efficiency analyzer, he stands to profit from the sale of those machines.

Both men agree that the new testing method bears watching, but can not be of real use at this time.

The concept of a relationship between intelligence and various parameters of brain electrical activity is not new. A study was conducted to investigate the relation between response time and errors on

a matching-figures task and the results compared to the intelligence, as measured by the Stanford-Binet I.Q. test, of pre-school age children (Lewis, 1968). The study described similar studies of school age children where impulsivity and reflectivity were investigated.

The study was conducted on twenty-three boys and twenty-five girls from southwestern Ohio, who were forty-four months of age at the time. Sex differences were investigated in the study since it was believed by Lewis (1968) that sex differences did exist. Produce-moment correlations for boys and girls were computed separately. There was found to be a significant correlation between errors and response time for boys, but no correlation between errors and I.Q. or response time and I.Q. For the girls, both errors and response time are significantly correlated with I.Q. However, the high-I.Q. girls demonstrated a longer reaction time rather than the shorter reaction time that Ertl would predict.

There was an indication in the data that all three parameters--response time, errors, and I.Q. were correlated, so a partialling procedure was used to correct for this. I.Q. was held constant and errors and response time were compared. Next response time was held constant and I.Q. was compared with errors. Finally, errors were held constant and I.Q. and response time were compared. It was discovered that there was little relationship between response time and I.Q. "The data for S_s across the ages available are fairly consistent and indicate

that RT and I.Q. are not related" (Lewis, 1968, p. 566). In this study S_s signified subjects and RT signified response time.

William Vogel and Donald Broverman (1964) conducted a review of the literature on the relationship of EEG to intelligence test scores. For easier presentation of the material, they presented the material under the heading of 1) Relationships between EEG and test intelligence in mental defectives, 2) Relationships between EEG and test intelligence in children, and 3) Relationships between EEG and test intelligence in normal adults.

Vogel and Broverman (1964) cited the study of a group of unselected feebleminded adults ranging from 1 to 9.8 years MA in which no significant relationship was found between occipital alpha index and MA. The reviewers suggested that the results might well be attributed to the heterogeneous nature of their sample in regards to kind and degree of mental deficiency, as well as age and sex. The second study cited showing the absence of a significant relationship between these two variables, was criticized for the small number of subjects in the study, namely eight.

In the category of normal children, two studies were reviewed. Neither study noted any statistically significant relationships between intelligence and occipital alpha frequency or intelligence and occipital alpha index in children ranging from 5 to 14 years of age. Again the reviewers noted the comparative heterogeneous age grouping. These

results suggested to Vogel and Broverman that EEG-intelligence relationships in children are hidden if CA is not held constant. However, when CA was held constant, I.Q. becomes perfectly correlated to MA, which suggested that EEG is related to MA rather than I.Q. in children. These results are consistent with those on mental defectives.

In studies of normal adults Vogel and Broverman noted a wide range of results when a relationship between alpha frequency and intelligence was studied. Some studies showed a significant relationship and some did not. The study showing a positive, significant relationship used the Wechsler-Bellevue test to measure adult intelligence. The correlations between adult intelligence test and other measures of normal adult intelligence indicate considerable variance unique to each type of intelligence test (Wechsler, 1944). It was hypothesized that "alpha frequency may be significantly correlate with the Wechsler, and the Wechsler significantly correlated with the other intelligence tests, without alpha frequency being correlated with tests of intelligence other than the Wechsler" (Vogel and Broverman, 1964, p. 136).

With only one or two exceptions, Vogel and Broverman have noted that investigators who have studied normal adults have not found significant relationships between EEG tracings and test intelligence.

Ellingson (1966) states that the evidence concerning the relationship between brain waves and intelligence is inconclusive and contradictory. He criticized the techniques of the various studies,

namely the EEG recording methods and the types of intelligence tests used. He also suggested that other measures of electri-cortical activity should be used.

LITERATURE SUPPORTING ERTL'S WORK

The work of W. F. Bennett (1968) supports Ertl's hypothesis of the relationship between intelligence and evoked response. "A relationship between intelligence and the evoked responses of the visual pathway has been demonstrated by a new approach to problems in psychology and Psychiatry--the use of electronic instruments" (Bennett, 1968, p. 1147).

Photic stimulation was used to illicit the evoked response in Bennett's work as well as the study of Whitaker, Osborne, and Nicora (1967), and that of Rhodes, Dustman and Beck (1969). All three studies used the occipital area of the brain for electrode placement. Whitaker et. al. and Rhodes et. al. both used the Grass photic stimular to evoke responses, and both used the Mnemotron Computer of Average Transients (CAT) to sum and extract the visual evoked response from the ongoing EEG. Bennett did not specify light source, and his analysis of the evoked responses was based on the summation of damped sinusoids.

Bennett used 47 subjects for his study, with no age or sex specified. Whitaker's et. al. study did not specify age or sex, but it was based on results of two samples of 21 subjects each. In Rhodes'

et. al. study, however, he worked with two experimental groups of 10- and 11-year-old children equated for age and matched for sex. He grouped the children also by I.Q. scores. One group of 20 bright children had full scale WISC I.Q. scores ranging from 120 to 140 (mean=130). The second group consisted of 20 dull children who had full scale WISC I.Q. scores ranging from 70 to 90 (mean=79). The children were screened to eliminate those who exhibited records of brain damage or emotional disturbance and were not adapted satisfactorily to school.

Upon analysis of the evoked response, Bennett plotted a scatter diagram of frequency of the major damped sinusoid against Wechsler adult intelligence test scores for each individual. The Pearson product moment r computed for his results was 0.593. Bennett commented that "a correlation of this value is generally considered indicative in psychology" (1968, p. 1148).

In the study of Whitaker, Osborne and Nicora (1967), the CAT was set for 512 msec analysis, with photic flashes repeated approximately 75 flashes per subject. A four channel system was used to record the raw EEG signal and all its components on one channel, and one channel each for the alpha, beta and theta periods. On analysis of the data, the researchers discovered that "a relationship with intelligence does exist which is a function of the phase relationship of the period of these three fundamental frequencies" (1967, p. 195).

In Whitaker's et. al. study, the subjects were grouped in three classes according to the relationship of the fundamental frequencies of the analyzed evoked potential. A formula specific for each class yielded a product for each individual. When these products were correlated with psychometric intelligence scores, an r of 0.91 was obtained.

The study of Rhodes et. al. was an attempt to determine whether evoked response amplitude or the latency of wave components were significantly related to the mental age of children. Each child described earlier participated in two experimental record sessions approximately two months apart. Two sets of 100 flashes at a given intensity were presented to each child, with approximately 5 minutes between the two sets. Two months later a second session was held where the 100 flashes at same light intensity were administered and then two additional series of 100 flashes were presented at two different levels of flash intensity. The visual evoked responses were plotted for each set of 100 flashes. Latencies were then computed and amplitudes were measured.

The study did determine that the evoked responses of bright children were larger than those of dull children across all three levels of intensity ($F=7.30$, $df=1/32$, $P< 0.05$) (Rhodes, Dustman and Beck, 1969). It was also found that the latency of wave G (wave of highest amplitude) was significantly earlier for the bright children ($F=12.19$, $df=1/36$, $P< 0.01$). Since amplitude differences related to intelligence are known to occur in the later components, correlations between wave forms

of later components of the visual evoked responses were computer analyzed. It was found that wave form similarity between later components of the central response were significantly higher among bright children than among dull ones ($F=A.32$, $df=1/36$, $P<0.05$).

Ertl (December 1969) tried to replicate these three studies, but succeeded only in corroborating the work of Rhodes, Dustman and Beck (1969). He did not find the significant correlations that Bennett (1968) and Whitaker, Osborne and Nicora (1967) reported in their studies.

Dustman and Beck (1963) also investigated the long-term stability of visually evoked potentials using seven normal male adults. Again they used the Grass photic stimulator lamp to evoke the response. The mono-polar technique of recording was used, and the CAT computer was employed to extract the responses to the light flash, which were plotted by a Mosley X-Y plotter.

An analysis of the data indicated that those components of an individual's AEP "occurring in the first 300 msec were highly reliable over long periods of time, in this instance, intervals separated by a week or longer" (Dustman and Beck, 1963, p. 1481). Test-retest correlations of the AEP of each of the seven subjects were found to range from 0.72 to 0.99, with a median correlation of 0.88.

The critical review of the literature dealing with EEG and test intelligence instigated by Vogel and Broverman (1964) warrants citing.

They concluded that "the bulk of the studies with feebleminded subjects, children, institutionalized geriatric subjects, and brain damaged adults have reported significant EEG-test intelligence relationships" (1964, p. 139). The studies dealing with normal adults have not reported significant relationships between these two parameters. These two reviewers also reported the likelihood that EEG tracings in children, feebleminded, and geriatric subjects were related to MA rather than I.Q.

Vogel and Broverman's review also revealed methodological problems existing "which, potentially, could obscure existing intelligence-EEG relationships" (1964, p. 139). The issues they noted and discussed at length were: 1) The measurement of intelligence, 2) Placement of leads, 3) Condition of EEG recording, 4) Sex, and 5) EEG indices.

SUMMARY

In this chapter the investigator summarized the opinions, constructs, and criticisms from literature which dealt with: 1) Arthur Combs' concept of intelligence, 2) The writings of those who disagree with Combs, 3) John Ertl's concept of intelligence and his neural efficiency analyzer as a means of intelligence testing, 4) The writings of those investigators who disagree with Ertl, and 5) The writings of those investigators who support Ertl.

Chapter 3

DISCUSSION

My interest in the construct of intelligence and intelligence testing goes back several years. I always shuddered when I read the definition that "intelligence is what an intelligence test measures." Not being a behaviorist, it was hard for me to accept the concept that an individual's behavior is primarily a function of the physical stimuli impinging upon the organism, especially if we then define intelligence as the effectiveness of the individual's behavior. So the search continued for a construct of intelligence that would be compatible with my philosophy of life, my frame of reference.

In 1966 an event occurred which added impetus to that search, and stirred feelings of anger within me. I was a counselor at the time on the junior high level, and a child was in my office as a referral from a teacher. I talked to the boy for a while about what was troubling him and made an appointment to see him again. In between appointments I pulled his cumulative record and noted among other things, a WISC I.Q. score of 84 listed, administered at third grade level if I remember correctly. I also noted that prior to that test, his record showed satisfactory progress, but after that year, the record was very negative.

I met with the child three or four times and things didn't add up. His behavior wasn't compatible with my understanding of behavior exhibited by an individual with an I.Q. of 84. I pulled the record

again, checked the calculations, and discovered an arithmetic error had been made and the calculated I.Q. should have been 104. I notified the teachers involved of the error and happily discovered several had also noted the discrepancy between ability and scheduling of classes.

To be sure it was only one example, but to the one it was very sad indeed. He had been labeled, and he functioned as labeled. My search began anew. There had to be a better way of assessing intelligence. It was at this time I was exposed to Arthur Combs and his phenomenological and perceptual view of intelligence. It was an approach that allowed the individual some leeway, it seemed to me, to approach intelligence and intelligence testing in a constructuve way. It lacked the destructive attributes I had just witnessed and disliked, and yet are a fundamental part of our present day model of intelligence and intelligence testing.

The phenomenological model was a positive model which fit my beliefs and my life style. I had always believed intelligence increased continuously throughout life, but eminent psychologists said otherwise, and at last here was a distinguished authority in his own right who published what I believed to be true. Combs' (1942) suggestion that perhaps intelligence is created is mind-blowing. It is fascinating indeed to consider the possibilities of producing intelligent individuals, to speculate on the potentialities of a child whose perceptual field has a minimum of limitations. The concept of intelligence

as a living, changing, alterable construct is exciting and challenging.

Equally challenging is John Ertl's neurological point of view. My interest here is more in his intelligence testing technique rather than his construct of intelligence per se. The idea that there may exist a way to assess intelligence which is culturally independent is intriguing. Equally intriguing is the prospect that questions relative to racial differences may be resolved. The possibilities and applications of such a technique are staggering.

As I reviewed Ertl's studies, I was impressed by the secondary accomplishments that were the result of and by-product of the major function of the study. The development of a computer program for measuring and objectively analyzing evoked potentials was one of these accomplishments (Ertl, 1968). A second accomplishment was the development of the Chopped Speech Test, and the third accomplishment was the development of a computer method for ordinary linear discriminant analysis (Ertl, December 1969).

The review of the literature relating brain wave activity to intelligence revealed an aspect of educational research that troubles me. The number of studies investigating this relationship surprised, confused, and overwhelmed me. I was further amazed at the conflicting studies, at the lack of control of variables in supposedly scientific investigations which yielded conflicting results. Notwithstanding the

many projects completed and reported, the general consensus of opinion is that the results are inconclusive. The disagreements are illustrated by the following articles.

Vogel and Broverman (1964) reviewed the literature on the relationship between EEG and test intelligence. Their conclusions were twofold. First, that a significant relationship was reported by the bulk of the literature for certain groups which they specified, and second, that in these groups it appeared that EEG tracings related to MA rather than I.Q.

Ellingson (1966) responded to that article in a commentary by stating that the evidence was not as convincing as Vogel and Broverman had presented it to be, and that he had serious reservations about the inferences made in the article. Ellingson in the commentary proposed an alternative conclusion to that of Vogel and Broverman. He maintained that the relationship Vogel and Broverman (1964) presented did not exist, and he judged the same data to be contradictory and inconclusive. He further maintained that he would remain pessimistic about finding any significant and important relationships between EEG phenomena and the complex phenomena of intelligence (Ellingson, 1966).

The debate continued as Vogel and Broverman (1966) answered Ellingson's commentary. They reacted to Ellingson's review as an attack against their positive position, and maintained Ellingson misinterpreted their position. They did not propose, as Ellingson claimed, that there

should be a "demonstrable relationship between all cognitive test results and all EEG indices under all conditions" (Vogel and Broverman, 1966, p. 99). [The italics are the emphasis of the present investigator.]

Vogel and Broverman (1966) continued to defend their original conclusions and commented that Ellingson had presented no new evidence that would require their modifying their original conclusions. They then proposed that the scarcity of the evidence relating EEG to intelligence has been due more to the failure to initiate research than due to the failure to find relationships in past studies. Mundy-Castle (1958) supports this conclusion when he commented in his work the assumption that there is no such relationship between EEG and intelligence, particularly EEG and adult intelligence, is the result of inadequate experimentation.

Ellingson and Lathrop (1973) reported further research in this controversy. This study investigated the relationship between intelligence and the alpha frequency of the EEG. Their conclusions stated that their results did not justify rejection of the hypothesis that no relationship exists between intelligence and the alpha frequency. They admitted, however, that the procedures employed in the study were not ideal.

The controversy dealing with the relationship between test intelligence and brain electrical activity continues, and will continue

until methodological problems are resolved, and agreement about conclusions can be reached.

Chapter 4

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF RESEARCH

The literature was reviewed to ascertain the views of Arthur Combs and John Ertl on intelligence and intelligence testing. The supporting and opposing views were also scrutinized.

Intelligence as a construct is undergoing change. For Arthur Combs change means to view intelligence as a function of the individuals' perceptual or phenomenal field. This view of intelligence necessitates a change in how the learning process occurs. It is a change from the stimulus-response system of learning with its behavioral objectives to viewing learning in holistic terms and in terms of one's perceptions. The danger the behavioral objectives approach, according to Combs, is that we foster half-truths, they are only partly right which makes it more difficult to deal with them.

Ware, Newell and Jester take exception to Combs' presentation, classifying his presentation as biased, and they proceeded to delineate four criticisms of his presentation. Their greatest objection was the expression of a rational argument without empirical evidence.

Perceptions are of two types, potential and functional. Intelligence is dependent upon the variety and richness of these two types of perception. Potential intelligence, the basis of potential intelligence is unmeasurable by standardized intelligence tests. Functional

perceptions or differentiations are what we measure with psychometric tests.

Any factor that limits an individual's perceptions would therefore limit his intelligence, and Combs proposed seven limiting factors.

In Combs' model intelligence can be created. We can produce intelligent and gifted children, and we have a responsibility to do so.

Where Combs' model of intelligence is phenomenological, John Ertl is neurological, a medical model. Where Combs' major concern and emphasis was on the concept of intelligence, with little emphasis on intelligence testing, we find Ertl's emphasis reversed, with major emphasis on intelligence testing, and very little emphasis on the construct of intelligence.

Historically, Ertl's work is not new. Hans Berger's study in 1929 demonstrated the possibility of measuring the electrical activity of the brain from electrode placement on the scalp. There have been studies since Berger's work attempting to relate brain wave activity to psychological variables. The early attempts related EEG variables to intelligence, but results were inconclusive.

Then came the high speed digital computers and the picture changed. Complex patterns of electrical activity could be analyzed, the screening of evoked potentials from ongoing EEG pattern was not possible. Ertl hypothesized that a relationship existed between the

average evoked response and I.Q., and instigated two studies to support that hypothesis.

One study used a photic flash as the stimulus to evoke the response, while a later study investigated the evoked potential from three different cortical areas of the brain, in response to photic stimuli, tactile stimuli and auditory stimuli.

Ertl and his colleagues developed a new machine they called the neural efficiency analyzer. The machine gives the neural efficiency score and a predicted I.Q. score which the individual would score on a standardized intelligence test.

The review revealed a controversy waging between three camps. One camp maintains that a relationship does exist between electrical activity of the brain and intelligence. A second camp denies the existence of a relationship between these two parameters and the third camp claims the results are contradictory and inconclusive.

CONCLUSIONS

The following conclusions are presented as a result of this study:

1. The role of behavioral objectives in the learning process is still controversial and open to debate.

2. This investigator believes the phenomenological approach to

intelligence is a more positive treatment of intelligence than the stimulus-response model.

3. The research relating intelligence as measured by standard psychometric tests to electrical activity of the brain is contradictory and inconclusive.

4. Methodological problems in the research to determine relationships between intelligence and brain electrical activity need to be resolved.

5. Rejection of the hypothesis that no relationship exists between intelligence and EEG indices is not justified by research evidence.

6. This investigator concludes that a relationship does exist between the latency of visual evoked potential and I.Q. scores.

RECOMMENDATIONS

The following recommendations are presented as a result of this study:

1. The role of behavioral objectives in education warrants further investigation.

2. More research is needed in the area of intelligence as related to brain wave activity

3. Methodological controls need to be more stringent in future

experimental studies attempting to relate test intelligence to EEG indices.

4. A literature review of current research should be conducted at some future data to determine the extent to which inconsistencies and conflicts have been resolved.

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