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THE UNIVERSITY OF ALBERTA

HYPERACTIVITY, INTROVERSION-EXTRAVERSION AND STRENGTH OF THE NERVOUS SYSTEM IN LEARNING DISABLED CHILDREN

by

© CLEMENT THEODORE KING

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Hyperactivity, Introversion-Extraversion and Strength of the Nervous System in Learning Disabled Children", submitted by Clement Theodore King in partial fulfilment of the requirements for the Degree of Doctor of Philosophy.

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ABSTRACT

This study sought to investigate the relationship between hyperactivity and personality, with special reference to two similar dimensions of personality, namely, introversion-extraversion and strength of the nervous system. The study consisted of two stages, each of which investigated a dimension of personality. A selective review of the empirical research literature revealed that a personality hypothesis of hyperactivity based on these two dimensions of personality had not been previously reported.

The first stage of the study examined the relationships between hyperactivity (HA), as defined by Davids' (1971) Rating Scale of Hyperkinesis (RHS), and the personality variables of extraversion, neuroticism and lie scale, as defined by Eysenck & Eysenck's (1965) Junior Eysenck Personality Inventory (JEPI). Two hundred experimental subjects from the city of Edmonton were selected for the study, including 150 boys aged 9-12 enrolled in classrooms for learning disabilities, and 50 normal matched controls.

The second stage of the study consisted of a simple test of the reaction time to increasing auditory stimulus intensity, an indirect method of determining strength of the nervous system used in the U.S.S.R.

Correlational, graphical, and analysis of variance methods revealed a significant relationship between hyperactivity and extraversion, thus confirming the central hypothesis of this study. Results failed to support the prediction that hyperactivity was significantly related to neuroticism and lie scale. These results are discussed in relation to the chronically lower cortical arousal

levels and lower sensory sensitivity of hyperactives and extraverts. The main hypothesis relating to the second stage of the study was that hyperactivity is related to the strong nervous system type which is characterized, like extraversion, by chronically lower cortical arousal levels and lower sensory sensitivity. The criteria for strength used in the U.S.S.R. were applied to raw reaction time (RT) data. The hypothesis was partially confirmed.

In summary, the results of this investigation pointed to a relationship between hyperactivity, extraversion, and the strong nervous system. Results are discussed with reference to physiological and psychological research findings consistent with a hypothesis of low cortical arousal and low sensory sensitivity of hyperactive children. Results are seen as supporting the utility of personality considerations in hyperactivity research and practice and also as confirming the hypothesized linkage between Eysenck's theory of introversion-extraversion and the theory of strength of the nervous system.

Implications for theory, research, and management of the hyperactive child are discussed and several suggestions made for future research which could test a number of hypotheses arising out of Eysenck's theory in order that new knowledge about hyperactivity might be generated.

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CHAPTER I

INTRODUCTION

There appears to be almost universal acceptance by educators that individual personality differences among students must be taken into account in the attempt to understand and interpret a child's behavior under differing environmental conditions. Yet, in practice, only scant attention is given to personality dynamics. One behavioral characteristic which has received little or no attention from personality research and practice is hyperactivity, an impulsive, distractible, and poorly controlled behavior in children which is a major problem for parents, teachers, and clinicians. Over 5-10% of school-age elementary children are hyperactive (Werry, 1968).

A considerable amount of research effort, much of it medical, has been directed towards establishing some etiological basis for hyperactivity. With few exceptions, and for historical reasons, it still is usually taken as axiomatic that hyperactivity results from some sort of brain dysfunction. As a result of the dominance of this hypothesis, a number of fruitful areas of research has been neglected. One such area is the relationship between hyperactivity and personality type. Apart from the milestone studies by Thomas, Chess & Birch (1968) and Chess & Korn (1970), in which hyperactivity is related to temperamental differences, the research effort on personality and hyperactivity has been virtually neglected. Even these studies were concerned more with the "how" rather than with the "what" or the "why" of hyperactivity. They were concerned about the fact that too little attention was being paid to the behavioral style or temperament and its influence on the child's learning process.

Hyperactivity is a facet of human personality and, as such, should be examined in terms of models of personality concerned with underlying neurological, psychological, and biochemical processes, particularly since research is now showing greater concern for individual differences in psychophysiological responses and their possible relationship with personality variables. Eysenck's (1967) theory of personality and the research on individual differences in personality undertaken by Soviet authors (Pavlov, 1927; Teplov and Nebylitsyn, 1966) seem to fit into this research framework. The rationale for the use of this theory and its relation to HA will be briefly outlined.

This study is designed to investigate the relationship for hyperactivity to introversion - extraversion as defined and hypothesized by Eyzenck (1965), and the theory of strength and sensitivity of the nervous system (Pavlov, 1955; Teplov, 1956; Nebylitsyn, 1956, 1957, 1959). According to Eysenck (1971), there are similarities between the notion of "strong" and "weak" nervous system types and the notion of extraverted and introverted personality types, in that the "weak" type appears to resemble the introvert and the "strong" type the extravert. A number of studies have demonstrated physiological substantiation of this position, for example, Eysenck (1965, 1966, 1967), Eysenck & Eysenck (1964), Gray (1964, 1967, 1968), Haslam (1967), Mangan (1967), Mangan & Farmer (1967) and Nebylitsyn et al. (1965). In this study, the writer predicts that a positive relationship exists between hyperactivity, extraversion, and the strong nervous system type, and that this relationship can be measured by a simple reaction time task. This study also tests a number of specific hypotheses relating to the proposed theory. A thorough search in the research literature on hyperactivity revealed what little systematic effort had been made to date to logically relate HA to personality or to Eysenck's theory in particular.

The design of this study consists of two stages, each independently attempting to explore the hypothesized relationship of HA to personality (extraversion-strength), and each predicting that there is a positive relationship. The first stage is general and exploratory and seeks through regressional and correlational analysis to examine the relationship between hyperactivity, as defined by a Rating Scale of Hyperactivity (RSH - Davids, 1971), and introversion-extraversion, as defined by the Junior Eysenck Personality Inventory (Eysenck & Eysenck, 1965). The second stage is more specific and attempts to compare the performance of high hyperactive and low hyperactive subjects on a simple reaction time task involving increasing auditory stimuli, a method which has proved to be both valid and reliable in measuring the relationship between sensitivity and strength of the nervous system in the U.S.S.R. Contrary to current belief about hyperactivity, therefore, the writer proposes that HA Ss are hyposensitive and cortically underaroused.

If HA Ss are hyposensitive, they should satisfy the statistical criteria for a "strong" nervous system type. Graphical and analysis of variance methods are applied to the tranformed data. Implications of the results for theory, research, and practice are discussed within the framework of the personality hypothesis of hyperactivity.

Chapters two, three and four will review the relevant literature on hyperactivity and personality. The first two chapters will be general and will focus on the syndrome of hyperactivity and the two personality theories upon which this study is based. However, Chapter four will attempt to link chapter two and three in keeping with the hypothesis that a relationship exists between hyperactivity and personality.

CHAPTER II

LITERATURE REVIEW

The Hyperkinetic Syndrome

In this chapter focus will be on the general historical perspective of the hyperkinetic syndrome as well as its correlates and etiology.

Hyperactivity, impulsivity, distractibility, and the other related symptoms of the HA or HK syndrome have always been a management and educational problem for clinicians, parents, and particularly classroom teachers. Equally problematic has been the etiology of the HA syndrome, a subject of considerable research effort much of which is concerned with both the theoretical and practical aspects of the problem. The large volume of conflicting research findings is testimony of the difficulty of research in this area.

The incidence statistics on HA vary widely. The prevalence estimation of the magnitude of the HA problem ranges from a conservative 5% of the elementary school population (Widrow, 1966; Stewart, et al., 1966; Werry, 1968a) to 40% (Rogers, Lilenfield and Pasamanick, 1955). Chess (1960) found that 10% of the children seen in her private practice were referred directly because of HA. Patterson (Patterson et al., 1965) also found that HA was the major cause of referral to child guidance clinics.

According to Cantwell (1975), this large variation in the incidence statistics on HA may be a function of the heterogeneity of the diagnostic criteria employed, the nature of the population studied, and the methods of investigation employed. For example, when rating scales are used the prevalence estimates are relatively higher than when HA had to be demonstrated at an interview or when teacher reports were used as the data source. Cantwell (1975) claims that only two HA Ss were found in a total population of 2,199 children aged 10 to 11 on the Isle of Wight (Rutter et al., 1969). In that study, the significantly low estimate may have been the result of selection criteria which required HA to be demonstrated at the interview setting. Where teachers' reports were used, however, as in the Netherlands (Prechtl and Stemmer, 1962), in Vermont (Huessey, 1967), in St. Louis, Missouri (Stewart et al., 1966), and in Montgomery County, Maryland (Wender, 1971), the prevalence estimates were much higher, ranging from 5% to 20%.

While HA is frequently associated with disorders such as mental retardation (Cromwell, Baumeister, and Hawkins, 1963) and epilepsy (Ounstead, 1955), it can also occur in other children who have none of these conditions but still display the classic symptoms of overactivity, impulsivity, and difficulties in attention. These children of normal or above normal intelligence with no known cause of their HA are generally designated as "pure" HA. With regards to the high ratio of boys to girls, Omenn (1973) reported that the ratio of HA boys to girls varied from 4:1 to as much as 9:1. There is general agreement about this discrepancy. Similarly, there was consensus that HA disappeared with increasing age. However, results from a number of follow-up studies now suggest that this is not so, and that HA Ss continue to be hyperactive and to show moderate to seve [illegible] cits in their general behavior (Laufer, 1962), have s [illegible] mic difficulties (Laufer, 1962; Weiss et al., 1971a), atte [illegible] cits, distractibility, and abnormal activity levels which persist during adolescence and into adulthood (Cantwell, 1975).

Historical Perspective

Historically, the syndrome of HA was identified over 100 years ago. According to Stewart (1970), Heinrich Hoffman had, in 1845, described a case of overactivity which bears close resemblance to the clinical description of hyperactivity. Medically, the earliest reports of HA resulted from direct damage to the brain as a result of encephalitis trauma or anoxia (Ebaugh, 1923; Rosenfeld & Bradley, 1948; Strecker & Ebaugh, 1924). Since then, the organic etiology of HA has prevailed, being strongly influenced by Strauss (Strauss & Lehtinen, 1947) who labelled children with the HA syndrome as "brain damaged" on the basis of behavioral rather than neurological evidence.

Definition

In research literature the attempt to define HA has been associated with considerable ambiguities, so that one is never certain which population is being alluded to. In fact, the term has been used interchangeably with reference to HA of known neurological pathology and HA that is not associated with any organic pathology and for which the cause is unknown. At times only the high activity level is called HA, and at other times the term is used to define the syndrome of HA of which activity level is but one symptom. Thus, for example, Van Osdol & Carlson (1972) defined HA or HK as a total daily motor activity (or movement of the body or any portion of it) which is significantly greater than the norm.

Various diagnostic labels, many of which are based on the organic etiology assumption, have been applied so that HA has been variously labelled as organic driveness (Kahn & Cohen, 1934), hyperkinetic impulse disorder (Laufer, 1971), and minimal brain dysfunction (Clements, 1966; Clements & Peters, 1962). Two less frequently used labels are post-encephalitic behavior disorder (Levy, 1959) and association deficit pathology (Anderson & Playmate, 1962). Recently, there has been a shift away from labels with etiological implications to labels which are more descriptive of the symptomology, such as hyperkinetic syndrome (Burks, 1960; Eisenberg, 1966; Millichap & Boldrey, 1967; Anderson, 1963; Klinkerfuss et al., 1965; Knobel, 1962; Conners, 1970), hyperactive syndrome (Stewart et al., 1966; Werry et al., 1964; Van Osdol & Carlson, 1972), and hyperactivity with reference to the entire syndrome (Parry, 1973; Firestone, 1975; Cohen, 1970; Cantwell, 1975; Sykes et al., 1972). One factor influencing this trend has been the recognition of the heterogeneity of hyperactivity in which various subgroups have been delineated on the basis of reaction to stimulant drugs or EEG criteria.

Another form of labelling which is based on the assumption that all HA children have learning disabilities is now replacing the earlier labelling of all HA children as brain damaged. Indeed, the current attempt is to use the terms hyperactivity and learning disabilities as if they were synonymous. While it is true that many children who are hyperactive have learning disabilities, it is also true that many children with learning disabilities are not hyperactive. In fact, chronic high activity levels, distractibility and impulsivity may also be characteristic of some high achieving individuals. In such cases the term HA is usually replaced by adjectives such as "vigorous", "hard-working", etc. A measure of HA may not, therefore, be a valid measure of learning disabilities as is currently defined, and the assumption of homogeneity of HA is not consistent with recent research findings on HA.

In this study, the term hyperactivity will be used to refer to the HA syndrome of chronic high activity level (hyperactivity), impulsivity, distractibility, and short attention span. It will include children of normal or above normal intelligence (I.Q. 85+) who have no known history of neurological impairment, epilepsy, mental retardation, and for whom no known etiology can be ascribed. These children will also have exhibited the above syndrome from an early age. They are the relatively "pure" HA cases who will be defined both by the nature and extent of their activity level, the main presenting symptom, as well as the associated behavioral correlates.

Correlates of Hyperactivity

Generally, the extensive clinical literature indicates consensus among professionals concerning behavioral correlates of HA. This agreement has been empirically demonstrated by Schrager et al. (1966) in a study which involved psychiatrists, psychologists, pediatricians, and teachers who were requested to indicate the behaviors most frequently associated with HA. The behaviors for which there was consensus were overactivity, impulsivity, low frustration tolerance, distractibility, and aggressiveness, with overactivity as the most important symptom.

Activity Level: In clinical research literature, the HA child has often been described as restless, fidgety, always on the go, and continually shifting from one activity to another (Burks, 1960; Clements & Peters, 1962; Eisenberg, 1957; Laufer & Denhoff, 1957; Chess, 1960; Ounstead, 1955; Werry, Weiss & Douglas, 1964; Werry et al., 1966). However, despite reports of clinical observations of increased quantity and speed of motoric actions, there seems to be limited research evidence of significant quantitative differences in activity levels between HA and normal control subjects. As a result, operational definitions of HA behavior have not been very successful and a number of methods of objective quantification of activity level have been tried. In almost every case the results have been inconclusive. These include the use of ballistographic, mechanical, photoelectric, and ultrasonic devices (Foshee, 1958; Sprague & Toppe, 1966; Schulman & Reisman, 1959; Bell, 1968; Ellis & Pryer, 1959; McFarland, Peacock & Watson, 1966); telemetry and motion pictures (Davis, Sprague & Werry, 1969; Herron & Ramsden, 1967; Lee & Hutt, 1964); and direct observation and ratings by observers (Doubros & Daniels, 1966; Hutt, Jackson & Level, 1966; Ounstead, 1955; Patterson et al., 1965).

Schulman & Reisman (1959) attempted to measure the daily activity levels of HA children by adapting self-winding wristwatches (actometers) to record bodily movements. In another study, Schulman, Kaspar & Throne (1965) attempted to correlate actometer scores with the results of psychodiagnostic examinations, but no significant correlation between these two measures was established. In a similar study, McConnell et al. (1964) were unable to establish a significant correlation between ballistograph scores and nurses' ratings of HA.

Kaspar et al. (1971) measured activity level and distractibility in neurologically handicapped children. Activity level was measured using an actometer on the ankle and wrist of the dominant side. An unstructured situation, consisting of play, and a structured situation, as recommended by Strauss & Lehtinen (1947), were used. Results showed that there was no significant difference between the experimental and control groups in activity levels as measured by the actometer in the unstructured situation (play). However, in the structured situation, the brain damaged children were more active and distractible than the controls. The researchers interpreted this activity as being related to distractibility.

Pope (1970) conducted one of the few studies dealing with HA children which attempted to illustrate the types of activity which comprise activity level. Each child in the experimental and control groups was observed in four different situations, namely, undirected activity in the room, performance on a simple task and on a difficult task, and voluntary inhibition of activity. Activity was measured in two ways. One was to traverse the experimental quadrants; the other was the use of actometer readings. In the undirected activity in the playroom, the researchers reported th total motor activity of the HA group did not differ substantially from the normal controls. In fact, the experimental group spent less time uninvolved than the controls. In the performance of the simple task, there was no difference between groups in total motor activity and attention span. However, the HA children showed significantly more total motor activity during the performance on the difficult task. For the voluntary inhibition of activity task, which involved five minutes without leaving a chair, there was significant difference between the groups in mean total length of time in the chairs in favor of the control group.

Activity level is a quantitative dimension. Yet, because of inconclusive findings, researchers have had to resort to an examination of the qualitative aspects of HA with the hypothesis that it is not just the amount of motor activity but also the character of the activity which defines HA. In other words, the situational or social inappropriateness of the activity is the critical factor (McConnell et al., 1964; McFarland, Peacock & Watson, 1966; Werry, 1968a; Werry, 1968b).

The question of individual differences in activity level was hypothesized by Schulman, Kaspar & Throne in 1965 after having used the actometer to measure activity level. In that study, the authors observed that each individual had a fairly stable daily activity level which they called the mean optimum (daily) activity level. They interpreted this activity level as an inherent property of the organism, with each child having his own individual activity thermostat, the HA child's being presumably set at a higher level. This concept of a continuum of activity level which is consistent, stable, and chronic is consistent with the writer's definition of personality. It should be observed that in a discussion of the research on HA the assumption of stability of the syndrome is always implicit, yet the biological basis for this stability is usually ignored.

Werry and Sprague (1970) also discussed this personality orientation of HA. They observed that HA tends to be viewed in the clinical literature as a stable behavioral or personality dimension, the child being seen as having some kind of internal regulatory mechanism which tends to stabilize in a characteristic fashion in terms of the total amount of movement each day, or the total energy output of the motor system. They lamented the fact that studies devoted to an examination of this concept of inherent activity level were sparse and, with the exception of Schulman, Kaspar & Throne (1965), gave little support to the construct. This obvious neglect is a concern of the present study.

Attention: One characteristic of HA children is their extreme difficulty in maintaining attention. Several authors have found that a major problem with these children is an inability to attend to a stimulus source (Cromwell, Baumeister & Hawkins, 1963; Ounsted, Lindsay & Norman, 1966). Alabisco (1972) defined attention as a multibehavioral process involving the length of time that the subject can spend at a given task (span), his ability to respond correctly (focus), and his ability to make two-stage stimulus discriminations. Alabisco found that the HA child fell short in all of these aspects of attention. Hypothesizing that attention is a learned behavior, he used reinforcement therapy effectively to increase span, focus and selective-attention behavior.

Deficiencies in the characteristics of the orienting response (OR) and its habituation are being used more frequently nowadays as an index of attention. These deficiencies have been related to attentional deficits in mentally retarded children (Luria, 1963), schizophrenics (Bernstein, 1967) young normal children (Luria, 1963), and children diagnosed as having minimal brain dysfunction (Boydstun et al., 1968). These researchers found that such children were characterized by weak orienting response to novel stimuli and that after a few trials they ceased to respond. Since a subject who gives an OR is assumed to be concentrating his attention on a particular stimulus and is no longer attending to incidental stimuli, the OR is now frequently used in research on attention of HA subjects. Findings tend to agree that HA subjects have weak OR's and habituate quickly.

A number of studies using other measures of the ability to sustain attention have supported the existence of attentional deficits in HA children. For example, Cohen (1970) and Sykes, Douglas & Morgenstern (1969) compared the performance of HA Ss and normal controls on visual and auditory Continuous Performance Tasks. They found that the HA Ss made more incorrect responses and that their performance showed greater deterioration over a given period than the control groups. On delayed and choice reaction time (RT) tasks, HAs were slower and displayed more variable RT speeds than controls (Cohen & Douglas, 1972; Dykman et al., 1970). Again, their performance tended to deteriorate rapidly over time. Sykes, Douglas & Morgenstern (1972) have also reported differences between HA and controls on the same Continuous Performance Task (CPT), an experimenter-paced, attention-demanding vigilance task. In contrast, they found no differences between HA and controls when the trials were short and discrete, or when the child and not the experimenter set the pace. When hyperactivity and short attention span and focus interact in a classroom situation, learning problems usually result and this is aggravated when impulsivity is combined with high activity level and attentional problems.

<u>Impulsivity</u>: According to Wender (1971), impulsivity as a dysfunction

is characterized by a decreased ability to inhibit. The HA child has been described as acting and speaking without forethought (Clements & Peters, 1962; Eisenberg, 1966; Laufer, Denhoff & Solomons, 1957). Moreover, HAs have usually demonstrated an inability to tolerate any delay in gratification (Laufer, Denhoff & Solomons, 1957).

One hypothesis of the reason why HA children have learning problems states that they make decisions too rapidly and that one of the effects of rapid decision-making is to reduce the amount of information normally acquired. This impulsive decision-making strategy is alleged to be responsible for poor problem solving. Thus, the HA child might be considered an extreme example of the impulsive children described by Kagan and his collaborators (Kagan, 1965a; Kagan, Pearson & Welch, 1966a, 1966b; Kagan et al., 1964). According to them, impulsivity and reflexivity are related to individual differences in the tendency toward fast or slow decision time. The impulsive child characteristically makes rapid decisions and many errors. Similarly, HA children are considered to lack thoughtfulness, to respond too quickly, to lack the ability to think things through, and to be unable to delay responding.

With regards to cognitive style and impulsivity, Campbell et al. (1971) found that HA children exhibit a more impulsive cognitive style than normal children of the same age and I.Q., and that when compared with a group of anxious (hypoactive) children, HAs were less able to inhibit the magnitude of their voluntary responses to noxious stimuli (Conners & Greenfield, 1966).

Campbell, Douglas & Morgenstern (1971) have confirmed that HA children seem to have difficulty with impulse control. On the

Matching Familiar Figures test (MFF) which measures reflexivity - impulsivity, HAs exhibited a more impulsive cognitive style when compared with normals. Cohen, Weiss & Minde (1973) replicated these results with adolescent HAs. Research evidence of a deficit in inhibitory controls has also come from a number of other studies.

Cohen (1970) found that HAs had more redundant responses on a delayed RT task. Parry (1973) showed how HAs performed poorly compared with normals on the Porteus Mazes Test, a measure involving the ability to plan ahead and affected by impulsive strategy. On choice reaction time tasks, investigators have also reported that HA Ss tended to respond more frequently than normals to incorrect stimuli (Dykman et al., 1971; Stevens, Sachdev & Millstein, 1968) and to vigilance tasks (Sykes et al., 1972).

Distractibility: Perhaps the most common form of attentional deficit associated with HA is a failure in the normal inhibitory process resulting in abnormal distractibility. Kraepelin (1896) used the term "hyperosexia" to denote a state of exaggerated arousal of attention in which the subject found difficulty in ignoring any stimuli in his immediate environment. Since 1918 Popperlreuter had observed this difficulty in isolating a visual figure from a distracting background. He maintained that this type of failure in visual discrimination was due to specific injury to the central visual pathways, rather than to a general feat[illegible] brain damage. Goldstein (1927) disagreed with this specificity hypothesis of the "figure-ground" syndrome as a visual motor defect.

Werner & Strauss (1939) later investigated Goldstein's figure-ground syndrome in much detail and developed a test of distraction for brain damaged children. They found that brain damaged children were unable to inhibit the influence of the distracting background. This means that distractibility is itself a very complex problem, and that much depends on the measuring techniques employed. In many studies, the distracting stimuli are themselves made to be meaningful and are capable of provoking responses. In others, what is termed the "background" is often the dominant feature of the presentation in so far as it occupies more stimulus space than the figure. Therefore, high distraction scores may just be a reflection of the subject's inability to act in accordance with the experimenter's criteria of what is "figure" and what is "ground".

Distractibility has been defined by Strauss as a manifestation of uncontrolled hyperresponsiveness to external stimuli (Strauss & Lehtinen, 1947). This is associated with brain injury. Since HA is one of the symptoms of the alleged brain injured child, distractibility in HA has been directly associated with brain injury also (Cruickshank et al., 1961). Widespread clinical support and acceptance of this point of view have come from Anderson (1963), Bakwin (1949), Benton (1962), Bradley (1955; 1957), Burks (1960), Clements & Peters (1962), Denhoff, Laufer & Holden (1959), Eisenberg (1964), Ingram (1956), Paine (1962), and Rourke (1972).

It should be noted, however, that Cruickshank & Paul (1971) considered distractibility to be the more central characteristic of brain damaged children. They stated that the hyperactivity, disinhibition, impulsivity, and perserveration may all be explained to some extent by the child's distractibility, that is, his inability to filter out extraneous stimuli and focus selectively on a task.

Although HA children have been described as distractible, attempts to disrupt their performance by introducing external distractors have had little success. Campbell et al. (1971) found no difference between the performance of HA and control Ss on the color distraction test. Sykes et al. (1971) reported that white noise did not interfere with RT performance of HA Ss any more than controls. In several other studies, Douglas (1972) and her collaborators found evidence that HA children were not unusually distractible. These children did not differ from controls on a Continuous Performance Task. Results also indicated that HAs detected fewer embedded figures than controls, but that they were not differentially affected by several other kinds of distracting stimuli.

In their review of studies on distractibility and learning disabilities, Tarver & Hallahan (1974) observed that three of the studies on distractibility which they cited contradicted the hypothesis that children with learning disabilities are more distractible than normal controls. These studies were by Alwitt (1966), Browning (1967a), and Douglas (1972). A study by Silverman et al. (1963) was equivocal while another by Kaspar et al. (1971) provided more support for the distractibility hypothesis. Tarver & Hallahan therefore concluded that the evidence strongly indicated that these children were not more highly distracted by flashing lights or extraneous color cues, but that they did seem to be deficient in ability to focus their attention.

Etiology

Introduction: In spite of many speculations about the cause of HA, research literature has centered mainly on three etiological areas, namely, organic, maturational lag or maturational dysfunction, and constitutional. The organic hypothesis is concerned with brain damage and minimal brain dysfunction as a cause of HA and has attracted the greatest amount of research attention for medical - historical reasons. The maturational dysfunction hypothesis, which is based on the assumptions that HA diminishes with age and that there are underlying organic reasons for the lag or dysfunction, has been receiving relatively more attention in the recent research literature on HA. Since Chess (1960) and Thomas et al. (1968) proposed a constitutional hypothesis of HA, only a few studies have examined temperamental factors in hyperactivity. Thus, apart from references here and there in the literature on HA, there has been no systematic attempt to propose and rationalize a personality hypothesis of HA based on theoretical and empirical research on personality. It should also be noted that the same lack of consensus which was reflected in the definition of HA is also evident in the attempt to explain the etiology of HA. A classic example of this is the organic hypothesis of HA.

Organic Hypothesis of HA: Historically, HA has had a long association with medicine. It was observed many years ago that after attacks of encephalitis, epilepsy, head injuries, severe burns, carbon monoxide or lead poisoning, brain laceration or a haemotoma, the classical behavioral symptoms of HA such as high activity level, impulsiveness, short attention span, proneness to distraction, and so on, usually occurred as a noticeable sequelae (Chess, 1969). These symptoms therefore represent factors for which the cause is known and can be diagnosed. However, only a small proportion of the HA population is so affected. For the vast majority of HA Ss, however, no known cause can be ascribed. Yet, the behavioral syndrome is equivalent to those described above. These cases have been the subject of considerable etiological speculation.

Strauss & Werner (1942) were the first to label this group and to suggest some cause for their HA. On the basis of behavioral criteria only, they claimed that the cause was minimal nervous system damage. Any child who displayed the HA syndrome was diagnosed as brain damaged, even in the absence of any neurological diagnosis.

The assumption that the HA syndrome is a direct consequence of brain damage has recently come under scrutiny. Various researchers (Birch, 1964; Eisenberg, 1964; Conners, 1970; Stewart, 1970) now emphasize the paucity of evidence in support of the contention that children who exhibit the "Straussian" pattern are in fact brain damaged. It is now well known that a child who is brain damaged may be either hyperactive or hypoactive. The habit, therefore, of using behavioral indices as the sole criteria for diagnosing an alleged organic deficit is untenable and an oversimplification. To overcome this difficulty, Clements & Peters (1962) suggested a diagnostic evaluation procedure in which physical, psychological, neurological, and EEG evaluation were involved. They claimed that these factors, when studied collectively, were accurate in discriminating brain damaged children from normals, and that there was a considerable chance of misdiagnosing when use was made of only one or two aspects of the diagnostic evaluation. Among the specific signs which they claimed were associated with HA were prenatal and perinatal complications, prematurity, complications of pregnancy, "soft" neurological signs, and abnormal EEG's.

Many studies have indicated that minimal brain damage associated with HA is related to prenatal and perinatal birth complications or injuries (Anderson, 1963; Marten, 1967; Gross & Wilson, 1964; Laufer & Denhoff, 1957; Levy, 1950; Passamanick & Knoblock, 1959; Rosenfeld & Bradley, 1948). Passamanick & Knoblock suggested a continuum of reproductive causality which ranges from fetal death and mental defect to minor dysfunctions such as HA.

The findings on the relationship between prenatal and perinatal complications and HA have not always been positive. In some cases, the birth histories of HA and normal children have shown that the incidence of these complications was either minimal or nonexisten In fact, several studies which included control groups failed to support these claims (Minde, 1968; Stewart, 1970; Stewart et al., 1966; Werry, 1968, Werry et al., 1972). Werry, Weis & Douglas (1964) reported that in the controlled Pond study at a Child Guidance Clinic, no association was found between brain damage and HA, and that in the study by Fraser & Wilks of the fifty babies with neonatal anoxia, no case of HA developed at a later date.

In a prospective study by Graham and Berman (1961), these authors found that although anoxia and other perinatal complications did in fact lead to a higher incidence of cognitive deficits and neurological impairments, these complications were not necessarily associated with HA. Minde, Webb & Sykes (1968), in a literature review, cited numerous investigations which found no such relationship between HA and a high incidence of prenatal and perinatal complications.

Their own study also replicated these findings.

The kind of justification most frequently offered for the use of such terms as minimal brain dysfunction and minimal brain damage is the fact that several studies have reported that HA children have an increased incidence of borderline abnormal EEG tracings and minor neurological findings (soft signs) (Burks, 1960; Clements & Peters, 1962; Capute et al., 1968; Hughes, 1971; Klinkerfuss et al., 1965; Wikler et al., 1970; Wender, 1971). However, the evidence for inferring brain damage or minimal brain dysfunction from EEG abnormalities and minor neurological findings in the absence of other confirming data indicating neurological dysfunction is questionable.

It has been found that normal children w[illegible] behavioral problems have similar EEG tracings and minor neurological abnormalities, that most brain damaged children do not fit the clinical picture of the HA syndrome, and that many HA children have normal EEG and neurological examination findings (Satterfield et al., 1974). [illegible], in spite of these findings, an abnormal EEG is being used by many school authorities as a requirement for admission to special education classes for the so-called brain injured or neurologically impaired children (Satterfield et al., 1974).

Some clinical examinations have revealed a number of minor soft neurological signs such as poor motor coordination and speech problems (Burks, 1960; Clements & Peters, 1962; Laufer et al., 1957; Satterfield, 1973). However, in controlled studies by Stevens, Sachdev & Millstein (1968), Stewart et al. (1966), and Werry et al. (1965), no evidence of these aberrations was found. The conclusion was that HA may exist in children without the accompanying soft neurological signs. Sroufe (1973) referred to these soft signs as being unreliable, since HA may be found in children without such neurological signs.

In summary, then, research literature in support of an organic etiology of HA based on neurological evidence linking HA to brain damage or dysfunction is largely inconclusive. There is evidence that brain damage accompanied by definite loss of tissue will cause HA, but this is the case for only a small minority (Gibbs et al., 1954; Millichap, 1972; Paine et al., 1968; Satterfield, 1973; Wender, 1971). Implicit in a maturational lag or maturational dysfunction hypothesis also is some underlying dysfunction in the nervous system and the speculation that HA disappears with increasing age.

Maturational Lag Hypothesis of HA: The maturational lag hypothesis is strongly influenced by developmental psychology. Specifically, its main proposal is that HA is related to delayed development. Consequently the HA child is described as being generally behind his normal-age mates, slow in developing through the various developmental stages, and behaving like a child a few years younger than he really is. However, as the child develops, the HA supposedly gradually disappears. Support for this position is cited in the observation that HA develops early in childhood and disappears around puberty, so that HA will be found more commonly in elementary school age children (Eisenberg, 1966; Laufer et al., 1957; Lytton & Knobel, 1958; Dykman et al., 1971). Strong support for the maturational lag hypothesis also comes from Werry's (1968a) observation of the disappearance of the syndrome, except for residual social and learning difficulties, as the child approaches adolescence. Further support was provided by

Buchsbaum & Wender (1973), Omenn (1973), and Satterfield (1973). Satterfield showed that the EEG anomalies detected in HA children tended to be fewer in those who were chronologically older.

The higher ratio of male to female HAs has also been used to support the maturational lag hypothesis. The claim is that physical maturation may be a factor in social maturation, since males are known to mature more slowly than females (Omenn, 1973).

Recent findings about this age variable are contrary to previous findings and show that HA does not disappear with age. The findings have weakened the maturational lag hypothesis considerably. Support for this recent position has emerged from a number of longitudinal studies which noted that some symptoms of the HA syndrome such as impulsiveness (Weiss et al., 1971b), difficulties with social behavior (Menkes et al., 1967; Stewart et al., 1966; Weiss et al., 1971b), and poor work habits and underachievement (Mendelson et al., 1971) persist well into adolescence. There has been considerable speculation also about the physiological basis of the maturational lag or maturational dysfunction hypothesis of HA.

Generally, the supporters of this hypothesis have accepted an organic central nervous system dysfunction as causing the lag. While they reject the minimal brain dysfunction on the grounds that it appears to be confusing and non-specific, they suscribe to what they call a functional maturation disturbance cause which posits that HA is caused by a dysmaturation of a localized organ or a dysmaturation of its functioning. When this concept is applied to the brain, the suggestion is that maturation of the brain is delayed and irregular (Abrams, 1968). However, there is no consensus regarding the speci organ or seat of ysfunction. Laufer et al. (1957) suggested that HA results from a diencephalic dysfunction which results in the cortex being unable to deal adequately with an abundance of incoming stimuli, causing the HA behavior.

Apart from the diencephalon, other areas of the brain have been invoked. These include the prefrontal cortex (Lytton & Knobel, 1958) and the caudate nucleus (Pontius, 1973). Immaturity of the frontal lobes have been proposed by Luria (1963, 1966), Miller (1969), and Pontius (1973). They have emphasized that HA children have problems reprogramming an ongoing activity. They associated this with immaturity of the frontal lobes, where the difficulty is not in commencing an activity but in reprogramming an on-going one. This, they claimed, is due to maturational imbalance between the first and second signalling systems. Thus, the chief pathological agent of HA is not an irreversible disturbance of the cortical cells, but, rather, a delayed and irregular maturation of the central nervous system (Luria, 1966b).

CHAPTER III

LITERATURE REVIEW

Personality Theory

This Chapter is directed towards a general review of the two personality theories upon which this study is based. These include Eysenck's Theory and the theory of strength of the nervous system. The importance of these theories lie in their hypothesized relationship with hyperactivity, however, this relationship will be more specifically reviewed in Chapter four.

One of the recurrent themes found in educational research involves the continued attempt to disentagle the complex determinants of academic attainment. Early effort in this direction has concentrated on intelligence as the main explanatory variable which so far is the single most effective prediction of achievement. However, intelligence alone is not a sufficient predictor of achievement, and research, in an attempt to find additional factors, has examined the importance of social factors, early experiences, and the impact of the environment. Even then, the concern was with the way in which these factors affected both the development of intelligence and the level of achievement, and in almost every case the interaction of personality and achievement was ignored. Now, researchers are realizing more and more that any attempt to understand the complete causal chain associated with school attainment must include the effect of personality on the child's work.

One reason given for this hitherto neglect was the lack of suitable personality tests, a factor which seemed to have channelled a great deal of research effort into the cognitive field. However, with the advent of dimensional theories of personality, such as Eysenck's (1965a), and the availability of inventories to quantify them, there has been a change in the picture, but this change is also influenced by a general resurgence of interest in personality research and theory as a result of recent research findings in psychophysiology and neurophysiology.

Definition

Personality, as defined by Allport (1949) and Eysenck (1965a), is the more or less stable organization of a person's emotional, cognitive, intellectual, conceptual, and physiological behavior which determines to a large extent his adjustments to environmental situations. Stability and consistency over time are important characteristics of the concept of personality (Wepman and Heine, 1964). The repetition of a behavioral act is a necessary antecedent to the consideration of that act as a personality characteristic. Yet, stability and consistency are not expected to be perfect. Allowance has to be made for some degree of change as part of development (Bayley, 1949; Bloom, 1965), or as the outcome of such interference as therapy procedures (Rogers & Dymond, 1954; Willett, 1960).

Personality in the sense in which it is used in this study is regarded as biophysical rather than biosocial. It is not dependent on existence in a social situation (Allport, 1949; Vernon, 1964b; Eysenck, 1965a). However, it is recognized that behavior, while determined to a large extent by personality, is also influenced to varying degrees by environmental factors (Bloom, 1965). Personality as used in this study is also be to differentiated from temperament and character. The term temperament in the present context is regarded as a narrower concept than personality. As used by Eysenck (1965a), it refers to emotional responsiveness and is therefore part of the more general concept of personality. Traditionally, the term temperament is used to refer to variables with a high level of hereditary and constitutional determination (Chess, 1960).

With regards to Eysenck's concept of personality, that author has stressed the fact that human conduct is not specific but presents a certain amount of generality, so that conduct in one situation is predictable from conduct in other situations. Different degrees of generality give rise to different levels of personality leading to a hierarchical structure on which the dimension of introversion - extraversion is based. However, Eysenck warns that personality is a powerful inward force and not just a collection of sensations, motives and memories. It is the most co .ete embodiment of wholeness in man (Eysenck, 1955). Hence, it cannot be neglected in any assessment of the child, particularly in the school situation.

Personality Attainment

Attempts at quantifying the impact of personality on school attainment have been made by Cattell, Sealy & Sweeney (1966) who have suggested that ability, temperament, and motivation together contribute about 25% of the achievement variance. They also concluded that up to 25% of the variance may be attributable to the effects of personality. Support for this position has been discussed by Griffiths (1973) who pointed out that Lavin (1965), on the basis of a survey, also concluded that cognitive ability accounted for 35-40%

of the variance in academic achievement, leaving about 50% unaccounted for. To enhance prediction in research, Cattell et al. (1966) have demonstrated the usefulness of adding personality and motivational measures to the intelligence measures. They speculated that these may well account for 75% of the variance in academic achievement. If each variable could account for 25%, this may be supportive of the position held by those authors.

Research on temperament undertaken by Chess (1960) and Thomas, Chess & Birch (1968) supports this position. These authors claim that a child makes a positive adaptation to school and learns optimally when the demands are consonant with his temperamental style and organismic capacities. Conversely, learning is impaired when the demands are dissonant and become a source of stress.

In the Soviet Union, there has been similar concern for individual differences in personality as they interact with performance. Like their British counterpart, Eysenck, Soviet authors have structured their personality theory around the nervous system processes of excitation and inhibition, which are combined to provide a neurophysiological basis of behavior together with individual differences in these forms of behavior. Thus, Soviet authors make use of the basic properties of the nervous system which they assume to be psychologically valid since these basic properties play an unquestionable role in the dynamics of behavior (Nebylitsyn, 1972). Eysenck's typology of extraversion - introversion is paralleled by the Soviet typology of a strong and weak nervous system. Experimental confirmation of the role played by the properties of strength of the nervous system in the determination of personality is found in .

Soviet personality research as well as in the research undertakings of Eysenck & Gray (England), Marton (Hungary), and Mangan and Farmer (Australia).

Because of the correspondence and similarity of these two theories of personality (British and Soviet), both are employed in this study, but for different reasons. Eysenck's theory of personality, and the Soviet theory of strength of the nervous system are both used in generating a personality hypothesis of hyperactivity, as a secondary aim of this study. The primary effort is the reaction time task (RT) which has been used extensively in Soviet research on personality in order to differentiate the strong from the weak nervous system type. It has already been experimentally confirmed that Eysenck's extravert is of the strong type and his introvert the weak type. The central hypothesis of this study is that hyperactivity is related to extraversion and the strong nervous system type. The conception of personality as defined in this section of the study provides the operational framework, and is reviewed in more detail as the section unfolds. In more general terms, it is felt that the use of these personality theories may help to bring about a better understanding of the idiosyncratic behaviors of hyperactive children.

Eysenck's Personality Theory

According to Eysenck (1967), personality is that innate force which integrates the person's behavior, adjusts him to his environment, or activates his feedback response to the reactions of individuals. It is these qualities or characteristics of a person which determine how that person reacts to or is reacted to by other people. Man is a bio-social being with heredity and environment inseparably intertwined in their influence on his behavior. However, psychological research has tended to overemphasize the social and environmental forces and to neglect the biological factors involved in explaining human behavior.

Eysenck's model of personality therefore seeks to redress this shortcoming. His argument is that "the causal links postulated between personality variables on the one hand, and by neurological and physiological discoveries on the other, make his whole model more realistic and take it out of the field of solipsistic speculation in which the school of the "empty organism" thrives (Eysenck, 1967).

Eysenck's model of human personality is, therefore, consonant with current concepts of experimental psychology on the one hand, and physiological and neurological research on the other. Its chief aim is to unravel the much neglected biological explanation of behavior. He claims that there can be no psychosis without a neurosis, that is, no physic or behavioral event without some underlying neurological event. It follows that it is not only sensible but obligatory that the underlying neurological, psychological, biochemical and other causes for observed behavior patterns be explained.

Basically, Eysenck is a type theorist unlike Cattell who is a trait theorist. Eysenck is therefore concerned with dimensions or a small number of orthogonal second order factors rather than many traits. These constitute the descriptive element of the theory and Eysenck has adapted Jung's terminology of extraversion - introversion and employed factor analytical methods. However, unlike Cattell, Eysenck transcended this descriptive facet of the theory by developing a conception of the processes which explain the obtained dimensions. This is the causal element of the theory with a distinctly biological flavoring, rooted in a conception of genetically based differences in the functioning of the nervous system. Eysenck's theory is therefore both biological and descriptive and includes the following four dimensions: introversion - extraversion; stability - neuroticism; stability - psychotism; and intelligence. The most important dimension dealt with in his theory is introversion - extraversion, and this is the direct concern of this investigation.

Eysenck's theory has generated a considerable amount of research with both negative and positive results and, because of the global nature of personality, that research has been spread over a wide area. A major portion of the empirical support for Eysenck's theory of personality is derived from physiological measures, for example, EEG, cortical evoked potentials, vigilance research, conditioning, reaction time, etc. These have employed the hypothetico-deductive theoretical approach based on theoretical deductions which have been behaviorally inferred, measured and tested.

Experiments which support Eysenck's theory include those undertaken by Franks (1956), Brebner (1957), Shagass & Kerenvi (1958), and Symon (1958), all of whom used eyeblink conditioning; Franks (1956) and Vogel (1965) employing GSR conditioning; Eysenck's (1955) employing kinesthetic after-effect; and Eysenck's (1956) on pursuit rotor. However, other studies have failed to show significant differences between extraverts and introverts, for example, Becker (1960), Davidson et al. (1966), Yates & Laslo (1965), and Claridge

(1960), all of whom used similar experimental designs. All of these studies focussed on cortical excitation - inhibition and extraversion - introversion.

Eysenck (1965) later found it necessary to revise his theory in view of the conflicting evidence. He now accepts the occurrence of a correlation between conditioning and personality to be dependent on the suitability of the experimental conditions to evoke cortical inhibition, a requirement which might significantly reduce the range of behaviors to which Eysenck's theory is applicable.

In personality research literature, there now exists an impressive array of models any one of which is capable of dealing with a large proportion of the differences between extraverts and introverts. Some of these include cortical satiation, reactive inhibition, internal inhibition, strength-sensitivity equilibrium, and arousal states. All of these, and others, may occur as explanations of the introversion - extraversion effects. Generally, Eysenck has utilized the cortical excitation - inhibition hypothesis to explain extraversion - introversion, although the more recent tendency is to use arousal states because of the interesting amount of recent research findings on individual differences and arousal. In fact, Brebner & Cooper (1974) reported two broad trends which are evident in the research on introversion - extraversion. The first is the attempt to relate individual differences to the arousal level or "arousability" of the person, and the second is a return to the Pavlovian or neo-Pavlovian explanations of introverted or extraverted behavior patterns (Mangan & Farmer, 1967). This study will reflect both trends.

Extraversion - Introversion

In reviewing the historical antecedents of the concepts of extraversion and introversion, Browne (1971) pointed out that the word extraversion was derived from two words: "extra", meaning "outwards", and "vert-ere", meaning "to turn". Extraversion therefore means a turning outwards. Similarly, introversion means a turning inwards. According to Browne, the use of the term varied with the context in which it was applied. In 1669, Simpson, a physical scientist, used the word extraversion to mean the rendering visible or sensible of latent constituents of a substance. In psychology, Coles (1692 - 1732) used it to mean a turning of one's thoughts upon outward objects.

As operationally defined by Eysenck, introversion and extraversion are descriptive terms denoting two types of behavioral reaction and personality organization. Evtraverted behavior is characterized clinically by the outward expression of feelings and attitudes in words, gestures and acts, in a spontaneous and direct manner little impeded by reflection, indecision or reserve (Eysenck, 1971). High extraversion scorers tend to be outgoing, impulsive and uninhibited, have many social contacts, and frequently take part in group activities. According to Eysenck, the typical male extravert is sociable, likes parties, has many friends, needs to have people to talk to, and does not like reading or studying by himself. He craves excitment, takes chances, often sticks his neck out, acts on the spur of the moment, and is generally an impulsive individual. He prefers to keep moving and doing things, and tends to be aggressive and to lose his temper quickly. Introverted behavior, on the other hand, reveals a tendency to limit or moderate spontaneous outward expression.

The typical male introvert is quiet, retiring, given to introspection, fond of books rather than of people, reserved and distant except to intimate friends. He tends to plan ahead, "looks before he leaps", and distrusts the impulse of the moment. He does not like excitement, and keeps his feelings under close control and seldom behaves in an aggressive manner. He is reliable, somewhat pessimistic, and places great value on ethical standards. Even more operationally defined, the traits of introversion range from calmness, even temperament, carefulness, and passive ness, to moodiness, anxiousness, reserve, and quietude. Whereas, extraverts range from being carefree, lively, outgoing, to being restless, excitable, changeable, impulsive and active. Many of these traits appear similar to those of the hyperactive child who is often described as restless, impulsive and active (Fig. 1).

It should be noted that no one individual is expected to possess all of these traits. Indeed, individuals may possess traits of introversion and extraversion. It is only the preponderance of one or the other which determines the personality type. The explanation of the cause of the difference between the characteristics of extraverts and introverts is given by Eysenck's theory of excitation - inhibition.

Excitation - Inhibition

Eysenck's (1957) theory of excitation - inhibition attempts to relate individual differences in introversion - extraversion to hypothetical inherited differences in the way the nervous system functions. In order to achieve this, he resorted to the Pavlovian concepts of excitation and inhibition, which explanation he modified.

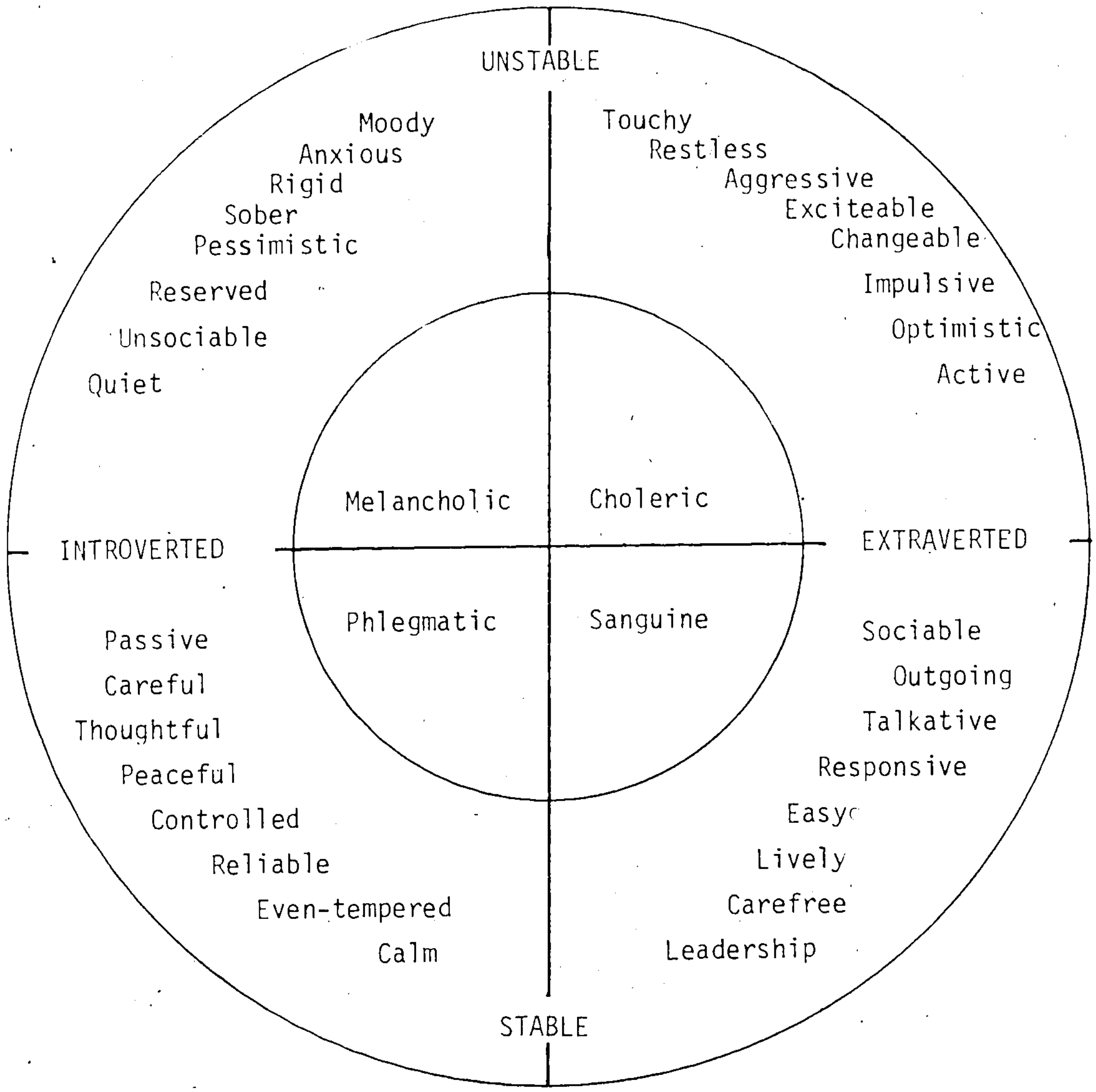

Figure 1. Relationship of Extraversion-Introversion Neuroticism-Stab ity to Early Scheme of Temperament
(Source: Eysenck, 1965a)

The concept of inhibition which Eysenck used is rather more complicated since he derived it from two other concepts (Hull, 1943; and Pavlov, 1927) which had different meanings. Simply defined, cortical inhibition refers to a lowering of arousal in the cortex. This reduces cortical control over lower centers and habit structures and behaviorally leads to less inhibited types of behavior. Thus, high cortical inhibition leads to uninhibited behavior. This is noticeable in the use of alcohol, a depressant drug, which lowers cortical activity thus disinhibiting lower centers leading to uninhibited behavior. The term cortical inhibition, when used in this study, refers to lowering of arousal in the cortex, and is distinguished from overt behavioral inhibition. Like the Soviet studies, this study will center on the excitation aspects of the theory which seem better able to explain the problem of hyperactivity.

The concept of inhibition is central in Eysenck's studies. This is so because Eysenck regards inhibition as lending itself more easily to investigation, since its effects (symptoms) can be more readily recorded than those of the excitatory process. However, Eysenck employed different notions of the inhibitory process which he borrowed from Hull (1943) and Pavlov (1928).

Hull conceived of reactive inhibition as the accumulation of a performance decrement. It is a fatigue-like neural state which occurs as an inevitable consequence of any excitatory process. Reactive inhibition accumulates continually with repetition until it balances the drive and then an involuntary rest pause occurs. In addition, Eysenck used Hull's concept of conditioned inhibition which states that whenever an individual ceases to respond in a situation in which reactive inhibition is present, the reactive inhibition is reduced. The response of rest or cessation of response is rewarded or reinforced by the dissipation of the reactive inhibition, and is called a conditioned inhibition. As reported previously, Eysenck modified Hull's theory.

Briefly, Eysenck's theory of excitation - inhibition states that as soon as a connection is established in the central nervous system between a stimulus and a response, two kinds of changes take place in the nervous system centers responsible for conducting the impulses. The first change is a positive excitatory and facilitating one, and the second is an inhibitory and suppressing one. The positive, facilitatory change is responsible for conditioning of nervous impulses, while the negative one is responsible for deconditioning and extinction and its effect is to hamper conduction of nervous impulses. Eysenck coined the expression "temporal inhibition" to refer to this type of change.

The second part of Eysenck's excitation - inhibition theory was concerned with individual differences with respect to the speed with which reactive inhibition is produced and dissipated and also with the strength of the reactive inhibition produced. Like Hull, Eysenck predicted that extraverts will generate reactive inhibition quickly and dissipate it slowly, whereas introverts will generate it slowly and dissipate it quickly. Extraverted individuals who accumulate reactive inhibition rapidly will also condition slowly because the rapid build up of negative drive detracts from the excitatory potential or total capacity to respond. Franks (1957) directly confirmed this finding. These individual differences in excitation - inhibition potential are assumed to be mediated by differential thresholds to stimulation of the ascending reticular activating system (ARAS) which lead to differential levels of cortical arousal. Introverts are characterized by a higher state of cortical arousal than extraverts who have chronically lower states of cortical arousal. Eysenck's theory is therefore related to cortical arousal, the function of the limbic system in general, and the reticular activating system in particular, as a regulator of sensory stimulation of the cortex.

It seems that the difference between extraverts and introverts is, therefore, a direct function of the level of activity in the ARAS. The higher level of arousal in the introvert is due to higher levels of activity in the ARAS. Extraverts are characterized by chronically lower levels of cortical arousal and lower levels of activity in the ARAS.

With regards to behavioral responses, increased cortical arousal, as in introversion, leads to increased behavioral inhibition and decreased behavioral activity, whereas decreased cortical arousal, as in extraversion, leads to decreased behavioral inhibition and increased behavioral activity, to which hyperactivity may be related. Knowledge of the mechanism of sensory stimulation, the function of the limbic system, and cortical arousal, is essential to Eysenck's theory and the related Soviet theory of strength of the nervous system.

Cortical Arousal and Personality

Arousal, or its synonym "activation", refers to the general response or response readiness of an individual which is modifiable by stimulation and measurable in terms of performance level or psychophysiological activity (Clausen, 1973). Arousal occurs when an input change produces a measurable incrementing of a physiological or behavioral indicator over a baseline. In this context, therefore, arousal refers to variation in the intensity of behavior.

Definitions of arousal are influenced by theoretical context. For example, Hebb (1955) regarded arousal as being synonymous with a general drive state. In his view, motivational factors are important in influencing the level of arousal. Drives are functionally the equivalent of internal stimuli. Theoretical support for this position has come from Lindsley (1951), whose "activation" theory is a theory of emotion, and also from Malmo (1957; 1959) who equates under-arousal with "poor motivation" and over-arousal with "emotional interference". Yet another definition related to neurophysiology is employed with reference to how wide awake the organism is, and how ready it is to react (Berlyne, 1960). The lower pole of this continuum is represented by sleep or coma, whereas the upper pole is attained in states of frantic excitement. Both of these concepts of arousal (Berlyne's, and Clausen's) will be used in this study. The primary goal of the reaction time task to be used in this study is to provide information about the level of arousal and the personality type of hyperactive subjects, as compared to normal controls.

Since hyperactivity is also associated with an attentional deficit, a model which integrates level of activity in the ARAS, attention, information processing, excitation - inhibition, and arousal, seems necessary. Eysenck (1967) believed that a theory resembling that held by the Russian psychologist Sokolov (1963) for the orienting reflex, provided an adequate model. With that model it was possible to treat an organism subject to arousal as an information processing system where input is matched against some residual in the organism.

Sokolov argued that the organism's sensitivity was not just a measure of its threshold, but rather, that sensitivity was a match between input and some neuronal model or a patterned memory trace previously developed in the brain. The basic assumption is that the cortex can retain traces of previous stimuli so that a neuronal model is made up only of the salient features of the stimulus. New stimuli are compared with these neural models present in the cortex. If there is a close match between the new stimuli and the neural traces of a previous stimuli, then inhibitory impulses are sent from the cortex to the reticular activating system. However, in the event of the stimulus being novel, intense, surprising, or complex, that is, if there is a mismatch, the reticular activating system is aroused by the impulse from the cortex and this, in turn, arouses the cortex. There is behavioral evidence for this state (Lynn, 1966). Thus, the match or mismatch between current excitation and representative record guides arousal, attention, and action, and this model has special significance for examining the attentional deficits of hyperactive children as well as their reaction to stimuli and their general state of physiological arousal.

According to Eysenck (1967), Sokolov's model is capable of explaining the dimension of introversion - extraversion. Unimportant stimuli are blocked or attenuated peripherically, and this frees the higher centers of the brain for more important functions. The OR protects the cortex and at the same time sensitizes the thalamo-cortical inhibition system and the brain stem arousal system. Introverts, with their chronically higher cortical arousal level, lower thresholds of arousal, and greater sensitivity, will be expected to have stronger OR's.

One of the most active and exciting areas of neurophysiological research during recent years has been the study of the reticular activating system of the brain stem which, together with related higher structures, appears to govern such functions as sleep, wakefulness and cortical arousal, the modulation or filtering of sensory input, and the orientation of awareness and attention.

As early as 1937, Bremer had shown that cutting the brain stem of a cat above the pons produced a state of coma and a pattern of EEG activity characteristic of normal sleep. However, a tremendous train of research into the role of the ascending reticular activating system was set off by the findings of Moruzzi and Magoun (1949) which showed that direct electrical stimulation of the mid brain reticular formation in the sleeping animal produced immediate behavioral awakening together with the EEG arousal reaction.

Now it seems that the brain-stem reticular formation might well be the master control mechanism in the central nervous system, with integration as its main responsibility. According to French (1960), the formation is now known to be implicated in the arousal response and wakefulness. Secondly, it exerts a critical degree of influence over motor functions concerned with phasic and tonic muscular control. Finally, but most important, it is capable of modifying the reception, conduction and integration of all sensory signals to the degree that some will be perceived and others rejected by the nervous system (Clausen, 1973).

Structurally, the reticular formation is a multisynaptic network of fibres which runs through the lower part of the brain from the bulb to the thalamus. It includes structures such as the bulb, pons, medulla, midbrain, subthalamus, hypothalamus, and thalamus (Samuels, 1959). Among the structures which comprise the reticular formation, it is important to draw a distinction between the thalamic and brain-stem reticular systems (Fig. 2). The main function of the brain stem reticular formation is the non-specific activation of the entire cortex, to respond to first presentations of novel stimuli, and the preparation of the body for energetic action. This involves the overall levels of arousal and is essentially non-specific. Thus, Hebb (1955) defined arousal in terms of the level of non-specific bombardment of the cortex by impulses from the ascending reticular system. The greater this bombardment the greater the level of arousal, until some optimum level is obtained. Malmo's (1959) definition of arousal as a continuum from deep sleep at the low activation end to "excited states" at the high activation end is very largely a function of cortical bombardment by ascending reticular activation system such that the greater the cortical bombardment, the higher the activation.

In contrast, the thalamic reticular system has more specific functions and seems to be involved in the regulation of processes of selective attention. It activates specific areas of the cortex depending on which area is stimulated (Samuels, 1959;

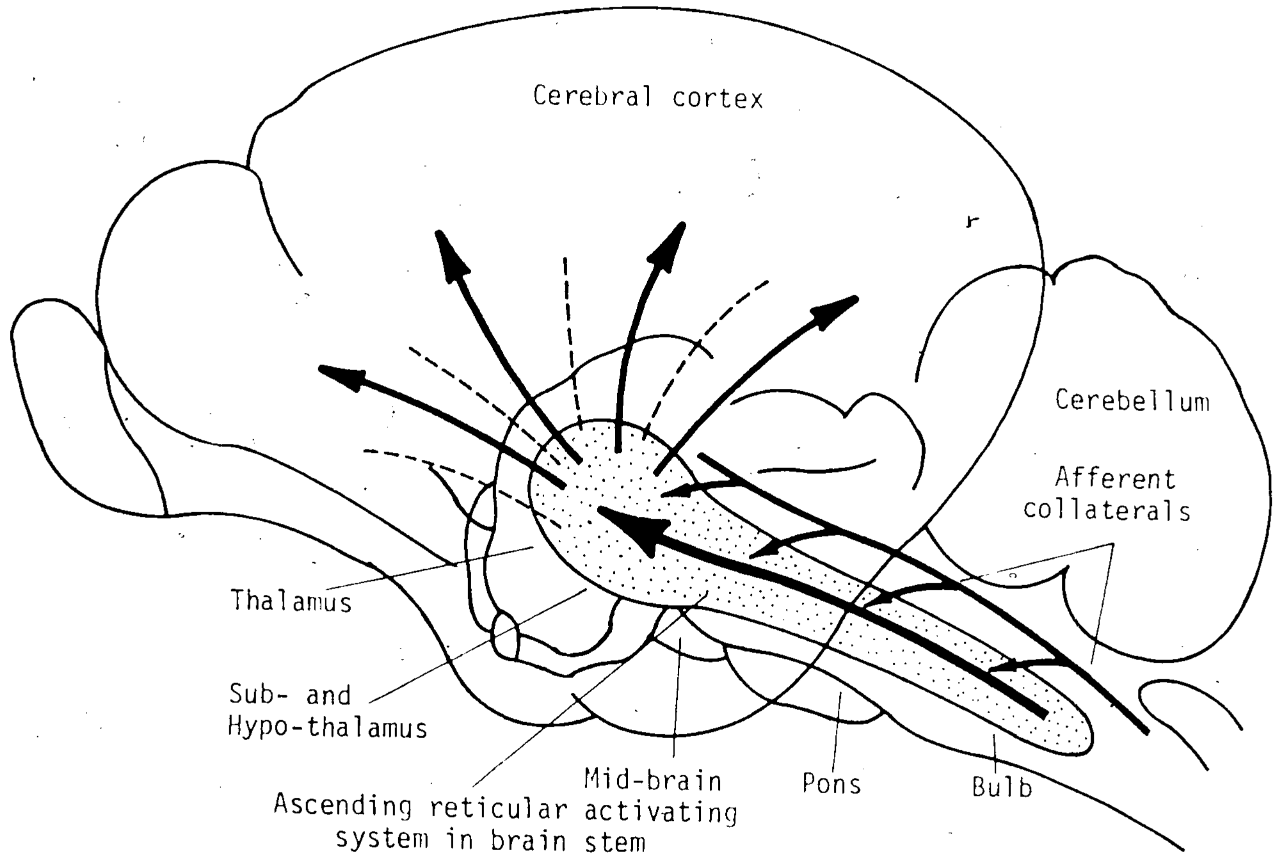

Figure 2. The Reticular Activating System
Outline of a cat's brain, showing distribution of afferent collaterals to reticular arousal system.

(Source: Gray, 1964)

Gastaut & Roger, 1960).

Another functional division of the reticular formation is in terms of its ascending or descending influence. However, because of the importance of the ascending function, the descending reticular activating system (DRAS) is often overlooked. Fibres from the ARAS usually terminate in the neocortical regions. Along these, neural messages or sensations relay to the particular projection areas of the neocortex from which collaterals in turn terminate on the reticular formation. The descending effects are exerted on both motor and vegetative responses (Magoun, 1958; Ward, 1957).

Since this study is mainly concerned with individual differences in personality, the more global functions of the reticular formation on behavior and the neurophysiological mechanisms which control them are of interest. Concentration will therefore be on the effects of the brain stem reticular formation with its non-specific function, particularly the ascending reticular activating system and its effect on extraversion - introversion.

Eysenck (1967) has stated that introverts are characterized by a reticular formation whose activating system has a relatively low threshold of arousal while the recruiting (synchronizing) part has a relatively high threshold of arousal. Under identical conditions, therefore, cortical arousal will be higher in introverts and lower in extraverts, whreas cortical inhibition will be lower in introverts and higher in extraverts.

Because of this generally higher arousal in introverts, it is to be expected that the reticular formation would relay far more information sensations to the cortex than is the case for the cortically inhibited extravert. With regards to efficiency of the reticular formation, the system of the extravert would be considered less efficient because it filters out through the inhibitory process, much sensory stimulation, resulting in less sensitivity of the system. Because of the relatively greater efficiency of the introvert's reticular formation, introverts are characterized by greater sensitivity to external stimulation, resulting in lower absolute sensory thresholds. These same relationships also apply to the theory of strength of the nervous system.

Strength of the Nervous System

The general Pavlovian theory of strength of the nervous system is based on the concept of two nervous system processes of excitation and inhibition, as is Eysenck's theory. This Soviet theory posits three dimensions along which nervous activity, and hence, behavior are conceived to vary. These include strength of nervous activity, mobility of nervous activity, and equilibrium between processes of excitation and inhibition. This study is concerned with only one of these dimensions, namely, strength of nervous activity.

The synonym for strength of nervous activity is strength of the nervous system, and this is the term which will be used throughout this study. Pavlov (1928) had used these terms with reference to both the excitatory and inhibitory processes, as did Eysenck. However, Teplov's research was mainly concerned with the excitatory process, and this will also be the orientation of this study. In all cases in which the terms "strength" and "strong" are used, the opposites are "weakness" and "weak", terms denoting low degrees of strength.

According to Gray (1964), strength of the nervous system is defined as the working capacity of the cerebral cells. It is the capacity of the cells to endure stimulation that is extreme in its duration and intensity. This working capacity of the cortical cells and, consequently, the strength of the nervous system, can be determined by the amount of work which the cells can perform in response to the single application of a stimulus. The criterion of working capacity, then, is the maximum time that cells continue working in response to the continual or repeated application of a stimulus. This is the temporal criterion of working capacity.

In practice, an operational definition of working capacity is provided by various thresholds, the chief of which is transmarginal inhibition. This is the stage at which the cortical cell passes into an inhibitory state when subjected to long and concentrated excitation. It is a state of protective inhibition in that this state protects the cell from damage in the event of continued response to stimulation.

Sensitivity is measured through absolute visual and auditory thresholds, whereas strength can be measured through simple reaction time (RT) to increasing stimulus intensity. The greater the intensity at which protective inhibition starts to develop, the greater the working capacity and therefore the strength of the nervous system. The weak nervous system type therefore reaches its limit of working capacity at a lower stimulus intensity than the strong nervous system type because of its lower threshold of transmarginal inhibition, a condition which makes it more sensitive and, therefore, closer to its limit of working capacity than the strong nervous system type.

The strong nervous system type is more stable, less sensitive, has a higher threshold of transmarginal inhibition, is better able to withstand extreme stimulus intensities and, because of less sensitivity, displays slower reaction times. There are also differences with regards to levels of cortical arousal.

Since level of cortical arousal is a positive function of the degree to which the cerebral cortex is bombarded by stimuli, it is expected that the level of arousal for the weak and more sensitive nervous system will be chronically higher than that of the strong nervous system type. Individuals who score low on this dimension of arousability correspond to the strong nervous system type, and those who score high correspond to the weak nervous system type. This is true for any given stimulus situation. Thus, there may be a strong relationship between this personality theory of strength of the nervous system and Eysenck's theory of excitation - inhibition.

Extraversion - Introversion and Strength of the ous System

Eysenck's theory of excitation - inhibition and the theory of strength of the nervous system are both based on the Pavlovian school of thought and, therefore, have very much in common. At a symposium dedicated to Teplov, the Soviet psychologist, Eysenck and his followers from the West met with researchers of the nervous system type from the East, and undertook an examination of the relationship between the concept of extraversion - introversion and Pavlov's theory of strength of the nervous system. It was there that Eysenck hypothesized that Pavlov's "strong" and "weak" types are very similar to the extraversion - introversion types of personality. The weak personality type appears to resemble the introvert, and the strong personality type the extravert (Eysenck, 1966a, p. 133). However, Eysenck warned that similarity was not the same as identity. Yet, even if this is admitted, it is certainly strange to find that two quite independent approaches should result in such closely related concepts.

Gray (1964) has translated the concepts used by Pavlov and his successor, Teplov, into the language of current neurophysiology and was thus able to confirm the close relationship between Eysenck's theory and that of the Soviets. Gray has shown that different degrees of arousal of the reticular formation can mediate all or most of the experimentally ascertained differences between "weak" and "strong" nervous systems. Similarly, Eysenck has suggested a close relationship between the reticular formation, arousal thresholds, and introversion - extraversion. Low thresholds of the ascending reticular activating system would be characteristic of the introvert and the "weak" nervous system type, while the extravert and the "strong" nervous system type will have higher thresholds of the ARAS.

Gray (1964) also pointed out that the "weak" nervous system was more sensitive, less stable, more excitable, and acted as if it amplified stimulation. It was more easily and more highly aroused than the "strong" nervous system which acted as if it damped down stimulation. Gray summarized the characteristics of the "weak" nervous system as including low sensory thresholds, low thresholds of transmarginal (protective) inhibition, maximum working capacity reached at lower stimulus input, low stimulation thresholds to stimulant drugs. Thus, intraverts, he claimed were more prone than extraverts to find stimulation excessive and distressing. Hence, they would tend to avoid excessive stimulation. They would also exhibit faster reaction time to increasing stimulus intensity than the "strong" nervous system extraverted type.

Sensory Thresholds

According to Eysenck (1965), predictions about sensory thresholds are made entirely in terms of excitation, although reactive inhibition cannot be ruled out entirely. This is of particular concern to this study because of the hypothesized relationship between hyperactivity and environmental stimulation. One of Eysenck's hypotheses, which is of interest to this study, therefore, is that of the differential stimulation-seeking habits of extraverts and introverts.

Eysenck (1963; 1967) has proposed that the amount of stimulation an individual strives to receive from his environment is in part a function of his position on the dimension of extraversion - introversion. Specifically, he postulates that due to the greater inhibitory properties of their nervous systems and low level of cortical arousal, extraverts function under a kind of "stimulus hunger" and therefore strive for relatively high amounts of stimulation. Introverts, on the other hand, are assumed to have weak inhibitory potential and higher cortical arousal levels. Consequently, they require less stimulation from the environment. In fact, the higher level of cortical arousal and excitation in introverts would be expected to increase sensory sensitization, resulting in "stimulation avoidance". Whereas, the lower level of cortical arousal and excitation (i.e., the higher level of cortical inhibition) in extraverts would be responsible for sensory repression, resulting in "stimulation hunger".

While Eysenck emphasized individual differences in the need for stimulation, Berlyne (1960; 1971) focussed on certain external properties including complexity, novelty, ambiguity, etc. which, as was previously noted, affected the OR and were assumed to affect the cortical arousal of all individuals who encountered them. Complex stimuli can generate conflict which raises cortical arousal, and the level of cortical arousal generated corresponds roughly to the amount of conflict instigated by the complex stimulus pattern. It was hypothesized that extraverts, because of their greater need for sensory stimulation and their chronically lower state of cortical arousal, will prefer more complex stimuli.

Support for this idea comes from the findings of Bartol and Martin (1974) who found that extraverts demonstrated monotonically increasing preference for complex polygons as a function of complexity compared with introverts who preferred more simple polygons. Those authors interpreted their findings in terms of the cortical excitation - inhibition theory and the level of cortical arousal potential in stimulus complexity.

Research findings on sensory sensitivity have generally supported Eysenck's hypothesis. Smith (1968) claimed that his results supported Eysenck's contention that introverts were marked by higher levels of activation or arousal than extraverts and were therefore more easily aroused by stimulation. Smith reasoned that the relative lack of sensitivity in extraverts accounted in part for the preference shown by them in his study for strong sensations. They were b[illegible]ter able to tolerate very high levels of sensations. He interpreted his results in terms of physiological differences in the nervous system between extraverts and introverts.

Phillip & Wilde (1970) found that extraverts had significantly higher initial and overall response rates in stimulation - seeking behaviors than introverts. Their study was a test of Eysenck's hypothesis of higher optimal arousal thresholds and greater need for stimulation for extraverts. Their findings therefore supported previous findings that extraverts have a higher need for stimulation becaus[illegible] levels of cortical arousal.

[illegible]dies which support Eysenck's are Bakan & Leckart (1966), [illegible] 1966), Farley & Farley (1967), Skrzypek (1969), Bartol (1973), and several others (in Eysenck, 1963). Extending this concept to abnormal behavior, Quay (1965) and Hare (1970) suggested that psychopathic behavior eq[illegible]alent to Eysenck's extraversion might be classified as pathological stimulation - seeking due to some malfunction or underactivity of the RAS.

Using high and low frequency conditions to test Eysenck's hypothesis, Stellmack & Campbell (1974) found that the extravert's sensitivity greatly increased under high frequency conditions where they were more sensitive than the introverts. The greater level of cortical arousal or excitation of the introvert led not only to the prediction of greater sensitivity to low intensity stimulation, but also to the expectation that introverts would manifest lower intensity levels of optimal or pre[illegible]erred stimulation. The extraverts, on the other hand, were seen as preferring stronger, more intense levels of stimulation. Similarly, Guilford (1954) found that those individuals who preferred low levels of intensity also preferred low frequency sound, and they usually were introverts.

One rival theory of sensation seeking is that of Petrie (1967) who proposed a general theory of individual differences in the style of stimulus intensity modulation using the kinesthetic figural after-effect task (KFA). She suggested that in terms of stimulus intensity modulation the non-pathological adult population could be characterized as either sensory augmenters, sensory reducers, or moderates. Sensory reducers tend to react by underestimating the size of a stimulus object subsequently touched. Whereas, sensory augmenters tend to increase it. Petrie also noted a strong relationship between extraversion and the tendency to reduce or underestimate. Her results were explained in terms of reducers in the normal population being less sensitive and therefore more likely to be sensation seekers. With regards to the relationship of Petrie's findings and Pavlovian typology, Gray (1964) pointed out that weak nervous system type subjects tend to augment incoming stimuli as do introverts, whereas strong subjects tend to reduce such inputs. The implication is that subjects with strong nervous systems would have a greater need for sensory stimulation than weak nervous system types, a situation which is characteristic of extraversion and introversion.

Pavlov had made a similar observation with his "strong" type dogs. He found them extremely hyperactive when free, in their attempt to expose themselves to environmental stimulation. However, these same dogs exhibited a pronounced somnolence when placed on the experimental stand. Similarly, Satterfield and Dawson (1971) observed that two of the HA Ss did fall asleep when required to sit quietly during the experimental sessions, whereas none of the normal subjects fell asleep under similar circumstances. They suggested that the subjects were unable to increase their proprioceptive and exteroceptive sensory input, and that this lowered their already chronically reduced RAS excitation.

Petrie (1967) also reported on sensory deprivation in another experiment. She found that reducers (extraverts) tended to be worst tolerators of sensory deprivation, behaving their worst during a period of restriction. She argued that, because reducers were already underaroused and already living under sensory deprived conditions cortically, a further reduction of sensation should be more painful than for augmenters.

However, research findings on tolerance for sensory deprivation have not always been supportive of Eysenck's hypothesis. Tranel (1962), and Rossi & Solomon (1965) found that introverts, rather than extraverts, experienced more discomfort during isolation. A review of the literature on personality correlates of tolerance for sensory deprivation was conducted by Leon & Frank (1966) who concluded that the overall findings failed to establish any significant relationship.

The effect of noise on personality and existing arousal states was also investigated by Davies & Hockey (1966) who found that under quiet conditions the vigilance performance of introverts was superior to that of extraverts. In fact, extraverts actually showed a performance decrement under those conditions. However, when noise (which they claimed was cortically arousing) was added, extraverts improved significantly. Noise had no significant effect on the performance of introverts at either of the frequencies used. The authors concluded that their results best suited an interpretation in terms of differential arousal states of extraverts and introverts.

In another study which examined the relationship between varied auditory stimulation (VAS) and vigilance, Davies et al. (1969) found that significantly more extraverts than introverts selected VAS when given the opportunity to do so, whereas significantly more introverts than extraverts chose silence when presented with a background of VAS. They interpreted their findings as support for the "stimulus hunger" hypothesis (Eysenck, 1967).

In summary, one can conclude that as a group, extraverts differ from introverts in basal arousal levels and that one of the effects of this difference is the need to seek stimulation. Research literature provides support for Eysenck's hypothesis of stimulation hunger behavior for extraverts, which seems to be in keeping with the clinical description of this personality type. The selective review of research on hyperactivity and personality explores this relationship further in the attempt to link extraversion with hyperactivity.

Reaction Time as a Dependent Variable

In research on perceptual-motor behavior, the time lag or latency period between a stimulus and a response has been well documented and the measurement of this time lag or latency is one of the most available response variables for research in experimental psychology. It takes time to perform any act, and acts that have been completely mastered take less time to perform.

In defining reaction time (RT), Woodworth & Schlosberg (1954) stressed that the term might be misleading since it is commonly interpreted as the time taken to perform an act. They argued that, on the contrary, RT was the time taken to get the response initiated. It was that crucial interval between a stimulus and a response. The stimulus simply triggered the process which continued in a hidden or latent form until it was terminated by some overt motor response, such as the pressing of a response button. RT is this latency or interval time lag which can be accurately measured.

One important consideration, therefore, might be the factors which influence the duration of the latency (RT). Without entering into a detailed analysis of this neurophysiological process, it is generally accepted that the sense organs must first be aroused to activity; that the nerves much c[illegible]ct to the brain which, in turn, must send messages by way [illegible] cert[illegible]n nerves to the muscles, before the overt response terminates the process to give a measure called reaction time, or RT. Thus, [illegible]is simplistic paradigm, both muscle time and brain time are involved. RT is therefore a function of the efficient functioning of these systems. In this study, the prediction is that there are individual differences in the way these systems function, resulting in groups of people with chronically longer or shorter latencies.

It is in the above context that RT is regarded as a dependent variable, since it mirrors the operation of a number of internal processes. According to Teichner (1954), simple RT is defined as the time interval between the onset of the stimulus and the initiation of the response under the condition that the subject was instructed beforehand that he was to respond as quickly as possi... Thus, a single response is made as quickly as possible to a single stimulus. However, there are many factors which might influence the speed of the RT response. These factors have been reviewed by Baumeister & Kellas (1968), Teichner (1954), and Woodsworth & Schlosberg (1954).

Figure 3 depicts the essential features of the RT task. In this paradigm there are three critical phases involved in the sequence of a RT measure. These features are the presentation of a warning signal (WS) for some length of time, a blank interval wh is often referred to as a warning interval (WI) and which follows the warning signal, and finally the reaction signal (RS).

Simple RT as used in this study is a modification of similar research effort undertaken in the U.S.S.R. and in western countries. Soviet researchers have investigated basic personality differences through the use of reaction time to varying stimulus intensities as a function of the strength of the nervous system (Nebylitsyn, 1972). Thus, nervous system types may be strong or weak depending on whether or not they have long latencies (strong) or short latencies (weak). ...arly, extraverts can be distinguished from introverts on the basis of RT to varying stimulus intensities (Gray, 1964). Basic personality differences, therefore, may be related to physiological variables.

Since RT is such a sensitive measure of these internal states, the next important question concerns its reliability. According to Baumeister & Kellas (1968), RT is a highly reliable measure with coefficients ranging from 0.80 to 0.95. RT also remains relatively

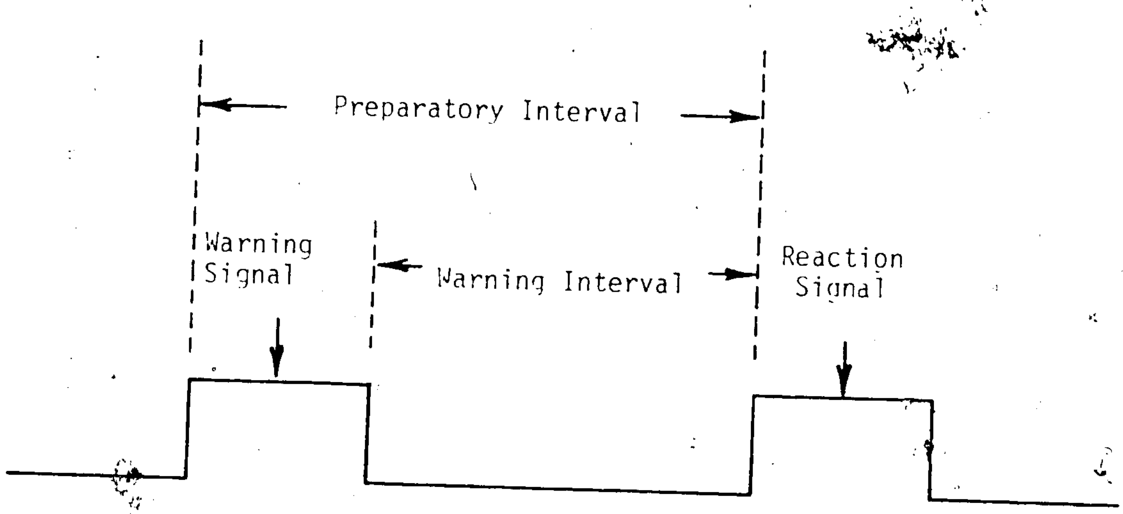

Figure 3. Reaction Time Paradigm

constant and stable under controlled environmental conditions over considerable time periods. Thus, RT is useful for making within-subject comparisons of treatment without introducing critical interpretation difficulties. It is an extremely reliable context in which to study the interactive effects of environmental and personality variables.

CHAPTER IV

LITERATURE REVIEW

Hyperactivity and Personality

Overview

As previously noted. one of the results of the brain-damage hypothesis of hyperactivity is that is precludes the generation of an alternative hypothesis which could apply to the majority rather than the minority of HA children. The field of HA has suffered as a result of the lack of a unifying theoretical concept which could serve as an umbrella for the diverse research findings. Consequently, the main purpose of this selective literature review is to provide this framework since it seems that there may be sufficient data which could be pieced together to generate a personality hypothesis of HA. There appears to be conceptual similarities between HA and extraversion, judging from the correspondence of research findings in both areas.

The main strategy of this chapter, therefore, will be an examination of the literature on extraversion and HA, with a view to demonstrating circumstantially that some relationship may exist between them.

In keeping with the definition of personality previously supplied, this selective review will attempt to point out that HA is not a transient phenomenon which disappears at the end of the elementary school years, as is commonly believed, but that it continues well into adulthood, modified, of course, by normal human development. Like extraversion, it is characterized by stability and consistency over time, thus illustrating an interaction of both biological and environmental factors. Within this context, recent research findings on the age variable as well as genetic-familial research on HA will be reviewed. It should be pointed out that such studies are few but impressive enough to indicate that there may be a relationship between genetic familial variables and HA. However, this is not definitive.

Similarly, there is some correspondence between research findings on arousal and sensory thresholds in both HA and extraversion. This review will attempt to illustrate this. Briefly, the findings are that like extraverts, HA children are chronically underaroused, have relatively high sensory thresholds, and are described as sensation seekers because of alleged sensation "hunger". Both are characterized, as a result, by relatively high behavioral activity. For both, the effects of stimulant medication are in the same direction, and the physiological rationale invoked as the basis of extraverted and hyperactive characteristics is the activity of the ascending reticular activating system (ARAS). Accordingly, this review will center on variables in HA and extraversion such as age, genetic-familial factors, arousal, sensory thresholds, and drugs. Use will also be made of autonomic and other types of data sources to indicate some correspondence between HA and extraversion.

Age Variable in Hyperactivity

Early studies on hyperactivity have all stressed the almost axiomatic notion that the syndrome disappeared as the child grew older (Laufer, Denhoff & Solomons, 1957; Bakwin & Bakwin, 1966; Eisenberg, 1966; Cromwell, Baumeister & Hawkins, 1963; and Laufer, 1962). This position was influenced by the formulations of Strauss

(1947) and Strauss & Kephart (1955) who claimed that the behavioral consequences of brain injury in children diminished and disappeared as they grew older. Numerous reports in the literature subsequently supported this view.

Now it seems that on the basis of more recent research findings that, while some of the symptoms are much less acute as age increases as a result of normal maturation, the symptoms persist to the extent that they may be regarded as traits in a personality conceptualization. Cantwell (1975), in a review of the literature on the age variable in HA, pointed out that while hyperactivity (activity level) per se seemed to diminish with age, restlessness, excitability, impulsivity, and distractibility still continued to be relatively higher compared with the same in controls. He also noted that attentional and concentration difficulties remained central problems and that severe underachievement in almost all academic areas persisted. The impact of frustration and failure also continued to manifest itself in poor self-esteem and depression. Cantwell cited a number of follow-up studies which supported his conclusions (Menkes et al., 1967; Stewart, 1970; and Weiss et al., 1971b).

Stewart (1970), in a follow-up study, reported that only 5 of the 45 teenage HA Ss in a sample could be described as being free from the original symptoms. He found that most of the teenagers were still notably restless, unable to concentrate or finish jobs, overtalkative, and performed poorly in academic work. Stewart interpreted his findings in terms of inborn difficulties.

Menkes et al. (1967) followed up 14 HA children with a mean age of 7 years when first seen. The follow-up interval had a mean of 24 years. Apart from many other problems encountered, 3 Ss were still restless and distractible, and one in particular continued to be so to the age of twenty-four.

Minde et al. (1971) followed up 64 HA children (60 boys and 4 girls) seen between 4 to 6 years after initial referral. Their ages ranged from 6 to 13 at the initial interview. Again, results showed that, compared with a normal control group, HA Ss were more hyperactive, distractible, and excitable, but that these characteristics had abated somewhat. Minde et al. (1972), in yet another follow-up study of 91 HA children found that, as a group, there was a significant decrease in distractibility, excitability, and hyperactivity, but that these symptoms were still significantly higher than those of the normal control group. Laufer (1971) and Denhoff (1973), in a follow up of 100 HA children with a mean age of 8 at initial interview and 20 years at follow-up, reported that HA was still persistent in two-thirds of the group. Generally, then, HA observed at an early age tends to persist well into adulthood, with some modifications as a result of maturation. This condition meets the criteria of stability and consistency which characterize personality traits.

Eysenck (1967) observed that Thomas et al. (1968) had discussed these crtieria of consistency and stability and had furnished strong evidence to suggest that even in the first two years of life, infants show consistent behavior patterns. Of the 80 children studied, 92% maintained a consistent pattern of responses in mood, 88% in intensity, and 28% in activity. Rutter & Brown (1966) have demonstrated how these consistent patterns of response have a genetic basis. Eysenck noted that while prenatal, paranatal, and early life experiences cannot be entirely ruled out, the evidence so far certainly was consistent with a genetic constitutional point of view.

In recent years, there has been a growing interest in individual characteristics of infants and in their effects on personality development, since an infant's innate characteristics (such as activity level) influence his interaction with the environment.

Juliano & Gentile (1975) noted how HA may be noticeable as early as infancy, some of the typical behaviors being climbing out of the crib, early running rather than walking, and seldom sitting still. Cantwell (1975) reported that mothers often described babies (who turned out to be hyperactive later) as being unusually active, hyperalert, and different. Nonetheless, he noted that the diagnosis of HA was difficult to make in infancy and early pre-school years.

Stewart (1970) found that HA had started at ery early age, and claimed that about 80% of the mothers interviewed in his study had begun to notice that their HA child was unusually active before it was two years old.

In the Fels longitudinal study, it was found that overactive behaviors in infancy and early childhood were a forerunner to later problems in concentration and attention. The researchers noted that HA behavior in children 3 - 6 years of age was inversely correlated with involvement in intellectual activity during adolescence and adulthood (Kagan & Moss, 1962). Kagan noted also that Schaefer & Bayley's (1963) classic longitudinal study determined that HA infants tested later at 5 and 6 years of age were still inattentive to intellectual problems. This empirical support for persisting levels of HA which starts at a very early age, shows a strong biological, rather than environmental, basis for HA. This is particularly significant for the large majority of HA children in whom known organic causes have been ruled out.

Genetic - Constitutional Factor

Compared with the emphasis given to research on psychiatric disorders of children, the familial factor in HA has received relatively little attention due, probably, to preoccupation with the organic etiology. In keeping with our personality hypothesis of HA which, according to our hypothesis, has a genetic-familial basis as in extraversion - introversion, this section will examine the rather small but mounting evidence which supports our contention. The position is that HA has a genetic-constitutional (genotypic) aspect as well as a behavioral (phenotypic) aspect, so that the interaction of both heredity and environment provides the basis for HA behaviors. Firstly, Eysenck's theory, relative to this position, will be applied to the review.

Eysenck's theory has a definite biological basis which he defended as an attempt to give some weight to a rather neglected facet of personality research and theory. He noted that very much emphasis has always been placed on environmental variables but very little on genetic-co[illegible] tutional variables in personality. The biological bias, therefore, is not an attempt to play down environmental variables which are crucial to any consideration of an individual's personality, but an attempt at providing a balanced consideration of variables that are crucial. Similarly, in HA research the environmental aspect has been stressed at the expense of the genetic-constitutional, so that Eysenck's bias will be emulated and reflected in this study as well.

It is common knowledge that the genetic constitution of an individual determines, to a large extent, that individual's norm of reaction to the environment. We also know that no behavior is the product of environment alone or of heredity alone. It is not sufficient, therefore, to divide the variance with respect a a behavioral characteristic into genetic and environmental alone either, because in doing so we tend to lose the most important part of the variance, namely, the heredity-environment interaction. The conceptualization of the HA child as a biosocial individual is central to this study.

According to Eysenck (1967), there are two facets of the personality of an individual which are important, namely, the phenotypic or behavioral aspect as seen in everyday activities and which is observable, and the genotypic or constitutional aspect. The theoretical construct of excitation-inhibition is applied to this genotypic aspect and the hypothetical conception of it is that personality is a function of the predominance of excitatory or inhibitory potential in an individual. This is the Level 1 stage, the most basic and fundamental level, involved solely with the balance between excitation and inhibition in the individual (Figure 4). A tilt in this balance in one direction or the other will give rise to constitutional genotypic differences in extraversion -- introversion. The genotypic aspect of behavior can be measured in a lab in terms of vigilance, reaction time, sensory thresholds, etc., and this lab phenomena stage is Level 2.

The third level is phenotypic, and is concerned with everyday

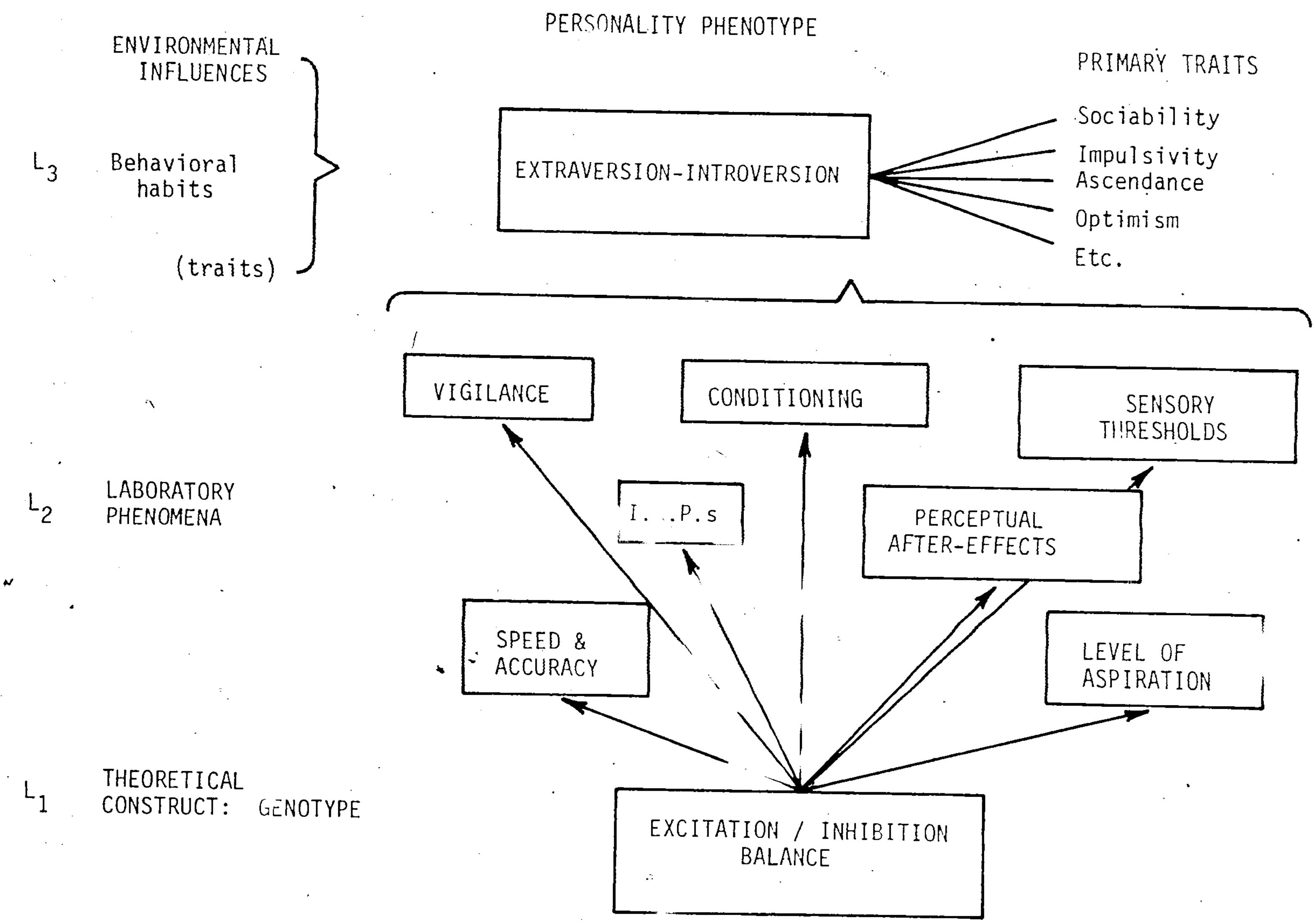

Figure 4. Relation of Personality Phenotype to Genotype and Environment (Source: Eysenck, 1967)

observable behaviors which are a function of the genetic - constitutional make up of the child reacting with the environment. This stage, therefore, constitutes the phenotypic aspect of extraversion - introversion and it includes traits such as impulsivity, activity level, etc. Eysenck claims that these traits can best be measured by means of inventories such as the Junior Eysenck Personality Inventory (JEPI) which will also be used in this study. In fact, in this study the genotypic - constitutional aspect will also be measured by means of a reaction time (RT) task in a lab situation (Fig. 5).

The physiological and empirical basis for Eysenck's hierarchical structure of personality has also been given. Physiologically, Eysenck claims that the extraversion factor is closely related to the degree of excitation and inhibition prevalent in the central nervous system. This largely inherited balance may be mediated by the Ascending Reticular Activating System (Eysenck, 1967). The relatively strong influence of heredity on extraversion has been demonstrated empirically by several studies but, according to Eysenck, the study by Shields (1962) was the clearest. That study found that identical twins brought up separately correlated highly in both extraversion and neuroticism. A considerable number of twin studies, among others, therefore influenced Eysenck's conclusion that genetic factors contribute more to individual differences in personality than do environmental ones (Eysenck, 1967).

A review of the literature on hereditary factors in normal personality traits as measured by inventories (Vandenberg, 1962) concluded that there were considerable hereditary components in personality. Of the variables studied, Vandenberg found a strong hereditary

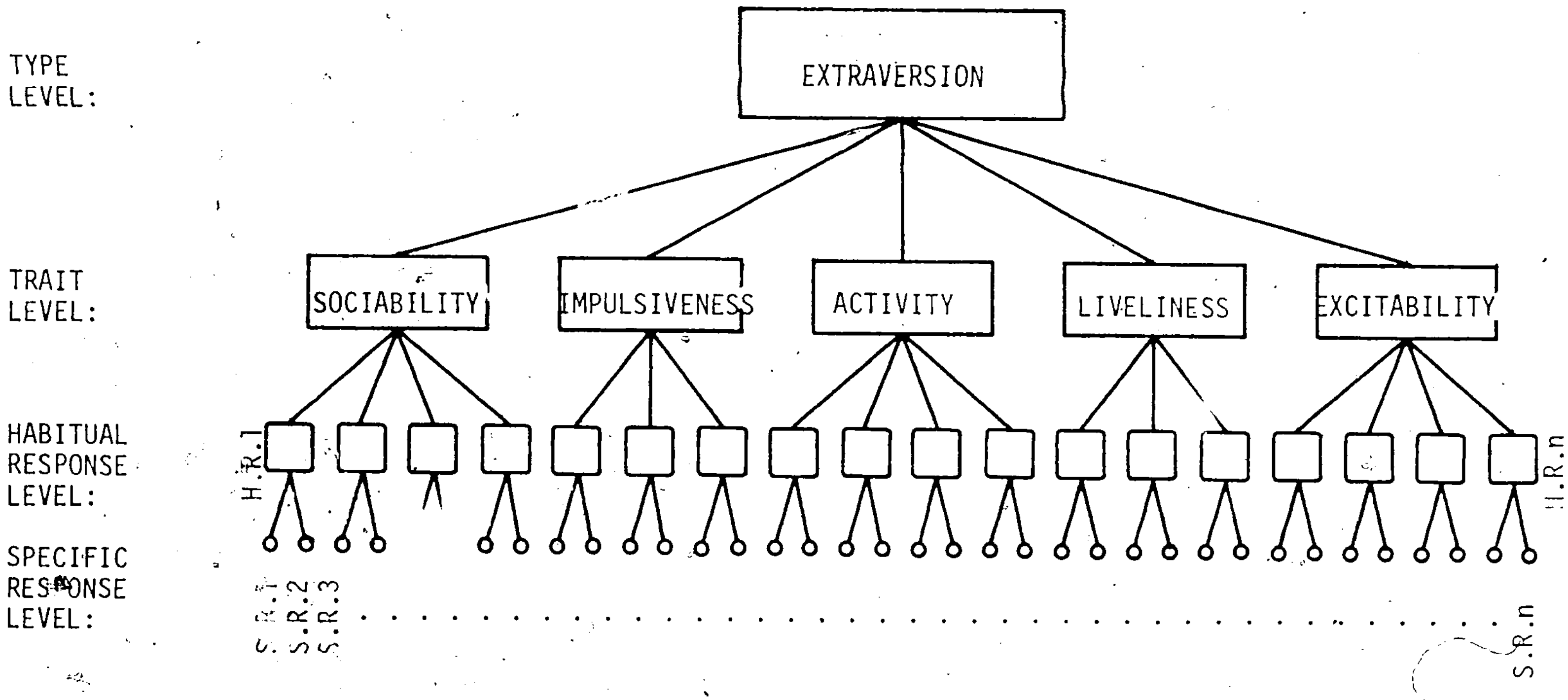

Figure 5. Hierarchical Model of Personality. Types are Supraordinate Cr
Built up on the Observed Intercorrelations Between Traits

(Source: Eysenck, 1967)

component in what he called sociability, or extroversion, and its opposite introversion.

Similarly, research on activity level in animals and human beings has also suggested a strong genetic influence. McClearn (1970) pointed out that there was considerable evidence from animal studies indicating that activity level can be genetically transmitted. Rats can be selectively bred for high or low activity levels. The idea that human activity level might have a genetic component has also been suggested by a number of other authors, for example, Cromwell et al. (1963), Thomas, Chess & Birch (1968). However, very few family studies on this subject have been reported. One of the few, conducted by Schulman et al. (1965), also regarded activity level as an inherent property of the child, with each child having his own individual activity thermostat.

While family and twin studies [illegible]ating the genetic etiology hypothesis of HA are too few [illegible] to a conclusion, there is a recent general trend towards research on the hypothesis that genetic factors play an important role in the HA child syndrome. Genetic - familial research on HA has involved three different methodologies. These are: (1) the frequency of HA in first degree relatives, e.g. parents, siblings, and children; (2) twin studies, monozygotic versus dizygotic concordance and adoption studies involving half-sibs; and (3) monozygotic twins reared apart and biological and adoptive parents and relatives of probands.

As in epilepsy, depression, or alcoholism, the first degree relatives of affected subjects, such as parents, siblings, and children, generally have a higher risk than the general population of becoming affected with the same disorder. Applying this methodology to HA, Morrison & Stewart (1971) interviewed the parents of 59 HA children and 41 controls and found a statistically significant excess of psychiatric disorders among the parents of the affected children and noted that there was an excess of parents who were alcoholic or hysteric. Review of childhood histories of parents and aunts and uncles also indicated a highly significant excess of HA behavior in these relatives of affected children, compared to the control families. Abnormal behavior in aunts and uncles was found as commonly in families where the affected adult had little or no control with the child, as in families where the HA child had lived with the affected adult. Statistical analysis of the data revealed that one-third of the parents of the HA children had some psychiatric diagnosis, whereas over 80% of the control parents were free of any psychiatric diagnosis. Twenty per cent of the fathers of the HA children were given a diagnosis of alcoholism. Of interest, also, is the fact that 20% of the HA children had a parent who had been retrospectively diagnosed as a HA child. In contrast, only 4% of the parents of the control children were so diagnosed (Cantwell, 1975).

In a similar study, Cantwell (1972) interviewed the parents of 50 HA children and 50 matched controls and found that most of the parents of the control group were free from any psychiatric illness, whereas nearly 50% of the parents of the HA children had some form of psychiatric diagnosis. As in the Morrison study, Cantwell found that the specific differences in the groups were in the prevalence of alcoholism, sociopathy, and hysteria in the parents of the HA child. Thirty per cent of the parents of the HA children were diagnosed as alcoholic, while 16% were given a diagnosis of sociopathy. Eight per cent of the mothers of the HA children were diagnosed as alcoholic, and 16% had a diagnosis of hysteria. With regards to the fathers, it was found that 16% of the fathers of the HA children were thought to have been HA children themselves (Cantwell, 1975). Similar results were reported by Wender (1971), Stewart et al. (1966), and Mendelson et al. (1971).

These family studies all indicated that when the criterion of frequency in first degree relatives (parents) is applied, the genetic relationship of HA to psychiatric disorders such as alcoholism and hysteria, is very positive. Males, particularly fathers, seem more at risk. Generally, the data suggest that a significant number of parents of HA children were themselves HA as children. It is difficult to interpret the Morrison findings because it seems that no attempt was made by him to disentangle genetic from environmental influences.

Studies of sibships and half-sibships of HA children have been investigated with a view to establishing some genetic relationship in HA. One such important study was reported by Safer (1973) who investigated the status of sibs and half-sibs of 14 minimally brain damaged children raised in foster homes. Safer found that 50% of the full sibs and 14% of the half-sibs were also hyperactive, indicating that genetic factors were operative. Similar studies by Wender (1971) and Hallgren (1950) had found that genetic factors appeared to be similarly important in dyslexia.

One useful way of disentangling the effects of nature from nurture is through a study comparing identical (MZ) twins with fraternal (DZ) twins. If one twin is affected, the probability that the other may also be affected is higher for MZ twins if genetic factors are operative. The concordance in DZ twins would be lower, similar to that for ordinary siblings (Omenn, 1973). Conversely, the extent to which MZ twins are discordant is, to a large extent, an indication of the influence of environmental factors. These criteria have been applied to twin studies of HA Ss but, unfortunately, these studies have been limited. This points the way for much needed research in this area.

Lopez (1965) evaluated 10 pairs of twins at least one of whom had the HA syndrome. Four pairs of MZ twins were all concordant, while only one of the DZ pairs was concordant. Willerman (1973) studied the mothers of 93 sets of same sexed twins rated on an activity rating scale (Werry et al., 1970). There were 28 MZ and 28 DZ male pairs, and 26 MZ female pairs. The heritability estimate was found to be .82 for the males and .58 for the females, but .77 for the combined group of males and females. These data were interpreted as a substantial genetic component for activity level in twins.

In another activity level study, Vandenberg (1962) reported that the twins whom he studied had supported the notion of a genetic bias to human activity level. He used the Thurstone Temperament Schedule and found a heritability of .67 for activity level with adolescent twins. Scarr (1966) studied twin girls between the ages of 6 and 10 on a variety of experimental observational methods related to activity level. In general, the findings indicated a significant heritability component for activity level.

These activity level studies involving twins suggest that HA may have a genetic basis. Similar conclusions were drawn by Werry et al. (1970) and Cromwell et al. (1963). On the basis of these findings, Willerman suggested that there was little need to posit a discontinuity between so-called normal activity level and HA since HA seems to be at the extreme end of the activity continuum as measured by activity scales and also had a substantial heritability component estimate of .71.

Adoption studies provide another method of distinguishing genetic from intrafamilial environmental factors. This is the study of individuals raised from an early age by individuals who are not the biological parents. Such studies include the comparison of MZ twins reared together versus MZ twins reared apart. One can also study the incidence of a disorder in the biologic versus the adoptive relatives of affected probands who were adopted early in life or who are half-sibs.

Morrison & Stewart (1973) used this adoption method to test the hypothesis that the HA child syndrome is genetically transmitted from generation to generation and that there was a genetic relationship between the HA child syndrome and the psychiatric disorders of alcoholism, sociopathy, and hysteria. These hypotheses were tested by studying the non-biological parents of adopted HA children. The reasoning was that if the non-biological parents did not show the same increased prevalence rates for the HA child syndrome as well as the other hypothesized psychiatric disorders found in the biological parents, then this would strongly support a genetic factor operating in the HA syndrome.

Data from this study were consistent with both hypotheses.

The prevalence rates for the syndrome found in the adopted relatives were not significantly greater than those of the relatives of the control group. Thus, there was no excess of psychopathology among the foster families of HA adopted children. However, the authors warned that the results of the studies did not permit inferences about the exact mechanism of such genetic effects. One speculation about such a mechanism of transmission is polygenetic, which is similarly posited for extraversion. The findings on the low arousal state of the hyperactive child, the effect of sensory stimulation, and the effect of stimulant drugs are consistent with the findings on extraversion and the strong nervous system type.

Arousal and Hyperactivity

The literature on arousal states of hyperactive children is divided on the question of whether or not arousal states are high or low in these children. Some investigators postulate that the inattentiveness exhibited by hyperactive children is the result of their being in a chronically high state of physiological arousal (Freibergs & Douglas, [illegible]9; Laufer, Denhoff & Solomons, 1957). Their postulation is based on the observed behavioral characteristics of overactivity, restlessness, overreactivity, and a general state of overt behavioral excitation. Within this hypothesis, it was argued that stimulant medication which reduced these behavioral manifestations acted in a paradoxical manner.

Current interest in probing the correlates of hyperactivity has been heightened by psychophysiological activation research (Duffy, 1972) which, contrary to existing belief, now finds that the hyperactive child is chronically underaroused and that the behavioral high activity level usually exhibited an attempt to keep the cortex at the proper tonus.

Two early milestone studies which have paved the way for an underarousal hypothesis of hyperactivity are those of Satterfield & Dawson (1971), and Cohen & Douglas (1972). Satterfield and Dawson predicted that hyperactive children would be overroused. They based their predictions on the observed behavioral symptoms of these children. The purpose of their research undertaking was to test several deductions from this hypothesis using electrodermal indices of arousal. Firstly, they predicted that basal skin conductance level (SCL) would be significantly higher in the HA child than it would be in normal subjects. This prediction was based on the generally accepted view that high SCL is an index of high excitation (Duffy, 1972; Woodworth & Schlosberg, 1954). Their second prediction was based on findings that there was a positive correlation between frequency of non-specific galvanic skin responses (GSR) and level of arousal. The prediction was that the frequency and magnitude of spontaneous non-specific GSRs would be significantly greater in HA than in normal subjects. Their third prediction was that specific GSR response to a novel stimulus would be significantly greater in HA subjects since they are supposed to be overaroused. Moreover, it was predicted that stimulant drugs like dextroamphetamine or methyphenidate would significantly reduce the hypothesized electrodermal differences between HA and normals. This was based on clinical reports that these stimulant drugs had a paradoxical calming effect on HA subjects. These drugs should therefore decrease SCL, decrease the number and magnitude of non-specific GSRs, and decrease the magnitude of specific GSRs to stimuli.

Contrary to predictions, Satterfield and Dawson (1971) found that under resting conditions and during simple tone stimulation, HAs differed from normal controls by their lower skin conductance level, smaller amounts of non-specific GSRs, and smaller magnitude of specific GSRs, all of which are characteristic of low arousal states. Specifically, they reported that 50% of the HA children in the study had abnormally low central nervous system (CNS) arousal levels as indicated by low skin conductance levels, while only 8% had abnormally high arousal levels. With respect to stimulant medication, they found that these drugs raised the CNS arousal levels as indicated by increased SCL, and they interpreted this as the effect of stimulant medication stimulating the CNS. Therefore, the calming effect of such medication was not paradoxical, as was earlier hypothesized.

In another study by Satterfield et al. (1972) which included resting EEG, sensory evoked cortical response, and skin conductance level, more evidence was found of low pre-treatment CNS arousal levels in HA subjects. HA subjects also were the best responders to methyphenidate treatment in that they showed a significant increase in CNS arousal. Thus, methyphenidate was found to produce both a greater change in CNS arousal and greater behavioral improvement in low-aroused HA children. Again, results of the study are indicative of low CNS arousal states. These states include lower skin conductance levels, higher mean EEG amplitudes, more energy in the low frequency band of the resting EEG, and larger evoked cortical response amplitudes.

In a further study by Satterfield et al. (1974) which investigated the relationship between skin conductance levels and certain items of maladaptive classroom behaviors, evidence was again found of low arousal levels. HA children with the lowest SCL arousal levels had the highest overall classroom behavioral disturbance and, again, these same children had the best response to methyphenidate.

Support for the low arousal findings also has come from Grunewald-Zuberbier et al. (1975) who, like Satterfield & Dawson (1971), related the overt behavioral symptoms of hyperactivity to high central nervous system arousal. They set out to investigate whether the behavioral arousal of hyperactive children corresponded to a heightened EEG arousal and also whether the hyperactive child's deficit in attention might be reflected in certain properties of the EEG orienting response to different stimuli. The investigators found that: (1) in periods free from stimulation, hyperactive children had higher alpha and beta amplitudes, more alpha waves, and a smaller amount of beta waves, indicating a lower state of EEG arousal in the hyperactives; (2) the amplitude reduction to tone developed more slowly in the hyperactive group, and this group difference increased over the experimental situations; (3) the arousal responses to tone, in terms of the level of maximum amplitude reduction, became comparably weaker in the hyperactives across the experiments; (4) under all experimental conditions the hyperactives exhibited s[illegible]ter arousal responses to the light stimulus than the non-hyperactive children; (5) reaction time performance of the groups was clearly different, hyperactives showing longer latencies; and (6) although conditional changes in the arousal reaction to both stimuli were reliably demonstrable in all children, the groups showed no difference in the corresponding measures. Grunewald-Zuberbier and his co-researchers concluded that the hyperactive subjects were underaroused or under-arousable under their experimental conditions.

Spring t al. (1974) also obtained results indicating that hyperactives are less aroused than normal subjects. They referred to the suggestion of Satterfield & Dawson (1971) that hyperactivity is secondary to a condition of low arousal and represents the low-aroused child's attempt to increase proprioceptive and exteroceptive sensory input, a suggestion which is similar to Quay's (1965) description of stimulation-seeking behavior of the primary sociopath as a coping device to increase abnormally low arousal. Berlyne (1960) also noted that different levels of arousal might have a negative effect on learning. There is an optimum influx of arousal potential which every organism strives to maintain, and any reduction of this influx will be aversive and drive-inducing. However, Jones (1950) explained that inverse relationship differently. He suggested that low arousal is secondary to child rearing practices and that hyperactive children whom he found to have very small electrodermal responses were not adequately taught to inhibit impulsive behavior as normal children were taught. Williams (1976) also found that the hyperactive children in his study were physiologically under-aroused. However, he interpreted this low cortical arousal as a lack of central nervous system inhibitor.

Many investigators have stressed that hyperactivity cannot be viewed simply in terms of high or low physiological arousal alone, but should also consider situational factors as well. The view that arousal is a unidimensional continuum ranging from coma to highly disorganized emotional states has been challenged by experiments which demonstrate that EEG and autonomic measures can be manipulated by the subject, that is, they can be dissociated. Also, no single measure is the "best" indicator or arousal (Cohen, 1970). Emphasis has therefore shifted to autonomic response patterning between various types of stimulus situations making use of the size and persistence of both tonic and phasic components of the orienting response.

As previously noted, Soviet investigators consider that an orienting response continues to be activated until a stable internal model which reflects the characteristics of the stimulus situation is formed (Sokolov, 1963). After this model is developed, it can be used to predict what may happen and at the same time help the subject to adjust to the environment. Hyperactive children are inefficient at forming these models because their orienting responses are weak, and they may need external sources of guidance or continuous reinforcement to maintain a fair level of performance.

Deficiencies in characteristics of the OR and its habituation apart from an interpretation in terms of low arousal levels have also been discussed with regards to attentional deficiencies. Groups of children who exhibit persistently lower levels of arousal, attentional deficits, and impulse control problems, have been shown to have deficient OR's. These include mentally retarded children (Luria, 1963), schizophrenics (Bernstein, 1967), young normal children (Luria, 1963), and children diagnosed as having minimal brain dysfunction (Boydstun et al., 1968). These subjects typically give weak OR's to novel stimuli and habituate quickly. Similarly, hyperactive subjects habituate quickly and give weaker OR's than normal subjects.

Cohen & Douglas (1972) also examined the relationship between OR and hyperactivity. Characteristics of the skin conductance orienting response to nonsignal and signal stimuli in 20 hyperactive and 20 normal children were compared. They found that when the 30 nonsignal tone stimuli of 6-second duration and 70 db intensity were presented, attributes of the OR to stimulus onset and its habituation were similar for both groups. However, when the task demands increased and the subjects were required to make an active response to discrete stimuli in a delayed reaction time task, the controls exhibited a significant increase in both tonic and phasic OR measures, while hyperactives remained relatively unresponsive. Performance on the reaction time task was also clearly deficient in the hyperactives. Compared to the controls, hyperactives exhibited slower reaction times and a greater amount of variability in performance. The investigators suggested that for the hyperactives, the warning signal given at the onset of each reaction time trial did not have the intended effect of alerting the subject and preparing him to respond to the reaction signal. In fact, the responses obtained might well have been a function of the low arousal state of their hyperactive subjects.

Similar findings were reported by Luria (1963) who observed that mentally retarded children whom he described as being hyperactive and having difficulties with attention and impulsivity gave weak OR's to a novel stimulus and even ceased to respond at all after a few trials.

Studies of autonomic response characteristics in normal adults classified as field-dependent have been found to be similar to those observed with inattentive and impulsive children (Witkin et al., 1962). These findings involving field-dependent subjects are particularly relevant to what might be expected with hyperactive children, since hyperactive children have been shown to be more field dependent than normal controls of the same I.Q. (Campbell et al., 1971). In addition, in similar fashion to hyperactive subjects, the field dependent subject habituated faster and had less pronounced skin conductance orienting responses.

In summary, all indices of physiological arousal point to persistently low levels of arousal for hyperactive children, a situation which is similar to that of extraversion and which is mediated by the reticular formation. Since cortical arousal and sensory thresholds are related, implications for theory and research on sensory thresholds, stimulation seeking, and sensory modulation are reviewed in order to provide additional links between hyperactivity, extraversion, and the strength of the nervous system.

Sensory Stimulation & Deprivation

According to Eysenck (1965), individuals differ in the amount of stimulation they need to keep the cortex at optimum levels of arousal. Because of their persistently low arousal level, extraverts seem to require relatively more and varied environmental stimulation than introverts. Schultz (1965) coined the term "sensoristasis" to describe this concept of a drive state for cortical arousal, which impels the organism in a waking state to obtain an optimal level of sensory variation. It is a drive to maintain constant range of varied sensory input in order to maintain cortical arousal at an optimum level.

The result is that individuals who have a higher optimal sensoristatic level have a greater "need" for varied stimulation. Because of this, extraverts have been characterized as stimulation "hungry" or stimulation "seeking". Behaviorally, this is manifested in higher than normal activity levels. This abnormal amount of activity is central to the definition of HA used in this study, so that there is conceptually a relationship between HA, extraversion, and the need for sensory stimulation since, empirically, both hyperactives and extraverts are known to be relatively underaroused.

In research literature on HA, support for this hypothesis of sensation seeking has come from Satterfield and Dawson (1971) who were puzzled by their finding of an inverse relationship between arousal and HA. Contrary to their predictions, they had found that HAs had reduced amounts of reticular activating system (RAS) arousal yet, behaviorally, they were exhibiting increased amounts of motor activity. Satterfield and Dawson then suggested that this increased motor behavior was secondary to lowered levels of RAS excitation and that it was an attempt on the part of the child to increase his propioceptive and exteroceptive sensory input. They also observed that children with already low levels of RAS excitation, when deprived of sensory input or motor activity, were more likely to fall asleep than was the case with normal controls. In the laboratory situation two of the HA Ss fell asleep. In this context, the effect of stimulant medication was not paradoxical. It increased low cortical arousal, and consequently, produced the observed calming down effect on the overt behavior of the HA child.

With regards to the difference between the behavioral manifestation of low RAS excitability in children and adults, Fish (1975) noted that when adult arousal level was low and they were tired, they tended to slow down. Because of this experience, adults tended to misinterpret and so misunderstand the behavioral indicators of low arousal and tiredness in children, particularly infants. Fish reminded us that when children become tired and irritable, they tend to scream, cry, and become very active. They thrash around, contrary to their parents who, under similar conditions, tend to collapse. Therefore, high activity level and restlessness may not necessarily always be a sign of high central nervous system arousal, as is commonly believed.

The relationship between attention and the need for stimulation has also been studied. Indeed, certain types of stimulation may facilitate attention. Gardner, Cromwell and Foshee (1959) investigated the effects of varying amounts of distal stimulation on the activity levels of groups of retarded subjects. The most noteworthy finding of their study was the observation that both groups of retardates (brain injured; and familial mentally retarded) were significantly more active under conditions of reduced stimulation than under conditions of high stimulation.

In the second part of that same study, a hyperactive group and a hypoactive group underwent the same experimental treatment as before. Again, both groups were significantly more active under conditions of reduced stimulation. Gardner and his colleagues then concluded that the increased activity level attempted to compensate by initiating propioceptive stimulation when the amount of exteroceptive stimulation received was not enough. Studies by

Hermelin & O'Connor (1963), and Tizard (1968a; 1968b) support these findings.

Berlyne (1950) used this Hullian paradigm to predict that stimulus intensity was dire[illegible]tly related to attention span. In two experiments, he presented subjects with two identical stimuli that varied only in size and brightness (intensity). He reported that the subjects demonstrated a significant attention preference for the larger, brighter stimulus. His conclusion was that a[illegible] might be a function of stimulus intensity.

Alabisco (1972) reported that, although both visual and auditory attention spans have been investigated, the most clear-cut findings have emerged from studies of visual attention span. He summarized these and noted that certain stimulus characteristics such as intensity and complexity functioned to increase visual attention span. In addition, minimal stimulation has been found to disrupt span, while increased stimulation has resulted in longer task attenuation. There is a strong relationship among stimulus variables, attention span, arousal, and activity level. We have also noted previously that stimulus variables such as complexity are cortically arousing.

With regards to similar conditions in research on distractibility, Browning (1967b) found that, contrary to Strauss' (1947) hypothesis of hyperresponsiveness, the distracting condition of peripheral visual stimuli interferred with discrimination learning in non-brain injured Ss, but failed to have this effect with brain injured subjects. When task-irrelevant visual stimuli, such as the interfering effect of flashing multicolored lights, were used, the results failed to support the hypothesis that a task-irrelevant distracting condition of peripheral visual stimuli would affect the performance of brain injured Ss more than they would the performance of non-brain injured Ss. Browning suggested that the stimulus intensity of the flashing lights, etc., was sufficient to alert the children with learning disabilities, resulting in increased responsiveness and improved performance. Similar results were reported by Alwitt (1966), Browning (1967a), and Douglas (1972).

In summarizing the literature on attention span, distractibility and the need for stimulation, what seems to be important is that in low stimuli conditions, particularly for low aroused Ss, it seems necessary that more, not less, stimulus intensity be given to alert hyperactive children.

Prevailing theory and practice, influenced by Strauss & Lehtinen (1947), have recommended the reduction, rather than the increase, of stimulation for HA subjects. This recommendation has had its basis in the assumption by Strauss that HA and distractible behavior were due to over-stimulation rather than under-stimulation. Accordingly, HA children were regarded as hyperresponsive to stimulation, and educational and management interventions were to be so designed as to shield these children from excessive stimulation in order to maximize their performance. They considered that this idiosyncratic behavior (HA) was the definite consequence of brain injury since, as they claimed, all lesions no matter where they were localized were followed by a similar kind of disordered behavior. This concept of hyperresponsiveness with a definite physiological basis has since received considerable clinical confirmation from such authors as Anderson (1968), Bakwin (1949), Benton (1962), Bradley (1955), Bradley (1957), Burks (1961), Clements & Peters (1962), Denhoff, Laufer & Holden (1959), Eisenberg (1964), Ingram (1956), Laufer & Denhoff (1957), Laufer, Denhoff & Solomons (1957), Michael-Smith (1964), Ounstead (1955), and Paine (1962).

Follownq Strauss & Lehtinen (1947), Strauss & Kephart (1955) and Cruickshank (1961) developed special educational programs detailing classroom routines and structure designed in such a way as to minimize distractible behaviors through the reduction of stimuli. Those authors argued that distractibility was a manifestation of exaggerated response to stimuli and was the primary cause of the HA child's learning deficit.

In translating theory into practice, Cruickshank et al. (1961) developed educational procedures on the basis of reduced space, a structured school program, reduction of environmental stimuli, and paradoxically, an increase in the stimulus value (intensity) of the teaching materials. They conducted a 3-year pilot study to test Strauss' hypothesis, comparing the traditional special education classroom structure and curriculum with the experimental one recommended by Strauss. The results of that study showed that the experimental group which received the structured program made significant improvement compared with the control group which received the traditional treatment. Cruickshank claims that no other investigator had since carried out such an extensive research project as his which, according to him, was by far the most thorough assessment of the Strauss-Lehtinen-Cruickshank teaching procedure (Cruickshank, 1971, p. 240). Browning's (1967) observation that there has been little experimental evidence supporting the hypothesis that brain injure children are excessively responsive to external stimulation is therefore substantiated by Cruickshank's statement.

This selective review of the literature on HA seems to support the personality hypothesis of HA which is central to this study. The fact that there seems to be a genetic-familial relationship between HA and extraversion, that HA does not go away with age, that HA Ss are chronically underaroused, that like extraverts they have high sensory thresholds, and that characteristics such as activity level have a constitutional basis, all point to a close relationship between HA and extraversion. All of these findings are in keeping with the main hypothesis of this study which predicts the existence of a strong positive relationship between HA and extraversion.

Stimulant Drugs, Hyperactivity and Extraversion

Of the drug treatments for hyperactivity, the most widely studied have been methylphenidate and dextroamphetamine. Barkley (1977), in a recent review of the effects of stimulant drugs on hyperactivity, claimed that about 75% of the hyperactive children placed on stimulant medication appear to improve. The high activity level was generally reduced; there was increased concentration and attention span; and impulsivity in responding increased. Barkley therefore suggested that the behavioral and cognitive improvements observed as a result of the medication might well be a function of the energizing effect of the drugs on central nervous system responsivity in that the medication tended to raise the low level of cortical arousal characteristic of the hyperactive child and reduce the high behavioral activity response to low arousal.

There have been similar findings regarding the effect of caffeine on hyperactivity although such studies are few, indicating a need for much more research. Schnackenberg (1973) investigated the possibility of caffeine as a substitute for stimulant medication in managing hyperactivity and found that it was a suitable substitute. Caffeine had a beneficial effect on activity level, attention span, and other symptoms of the HA syndrome. Reichard and Elder (1977) investigated the effects of caffeine on reaction time in hyperactives and normal children and found that caffeine produced an increase in the accuracy of stimulus identification and processing, and a decrease in lapses of attention in the hyperactive group. Those authors also noted that there had been growing concern recently about several unfavorable side effects of the stimulant drugs, the most alarming being the inhibition of growth in height caused by long term use (2 years or more) of these drugs (Safer, Allen & Barr, 1972; Safer & Allen, 1973). They discussed the need for an alternate chemical therapy free from such side effects, hence the purpose of their investigation.

Barkley (1977) reported that a number of studies investigating reaction time as a measure of attention span in hyperactive children found that stimulant drugs significantly reduced reaction time (Barkley, Ullman & Browne, 1976; Cohen, Douglas & Morgenstern, 1971; Conners et al., 1967; Conners & Rothschild, 1968; Sprague et al., 1970; Spring et al., 1973; Sroufe et al., 1973; Sykes, Douglas & Morgenstern, 1972; Zahn et al., 1975). Only Bradley & Bowen (1940) found no significant changes in reaction time. On the contrary, Campbell, Douglas & Morgenstern (1971) observed reaction time to decrease or become faster while hyperactive children were on stimulants. Barkley interpreted these findings as the effect of the stimulant medication in energizing the central nervous system. In terms of Eysenck's theory, the drugs were in fact raising the low cortical arousal level of the hyperactive children, thereby reducing behavioral activity and improving cognitive performance.

Eysenck (1967) also reviewed a number of drug studies which tested the effects of drugs on introverts and extraverts. His main hypothesis was that depressant drugs generally tended to increase cortical inhibition and decrease cortical excitation, thereby producing extraverted behavior patterns. On the other hand, stimulant drugs tended to decrease cortical inhibition and increase cortical excitation, thereby producing introverted behavior patterns. Eysenck's postulate resulted in a large number of testable hypotheses. The effects of stimulant and depressant drugs have been tested with conditioning paradigms (Franks & Laverty, 1955; Franks & Trouton, 1958; Willett, 1960), visual after effects (Holland, 1963; Eysenck & Aiba, 1957), pursuit rotor performance (Eysenck, Casey & Trouton, 1957), and verbal learning (Eysenck, 1957, 1960). Results of the above studies support the hypothesis that there are personality differences in the effects of these drugs, with the stimulant drugs leading to greater arousal and to more introverted behavior, and the depressant drugs to greater inhibition and hence more extraverted behavior. Nebylitsyn & Gray (1972) also found that depressant drugs (sodium amobarbital and alcohol) had an extraverting effect on behavior.

In an attempt to link Eysenck's theory of extraversion-introversion with the theory of strength of the nervous system, Nebylitsyn

& Gray (1972) observed that there was a striking similarity between the role played by caffeine in the theory of strength of the nervous system and the role played by stimulant drugs in the theory of extraversion-introversion. They noted that caffeine moved people towards the "weak" end of the dimension of strength. Stimulant drugs therefore had an introverting effect. It is this effect which has special implications for hyperactivity. Since hyperactivity is characterized by low cortical arousal, the effect of stimulant drugs is introverting, resulting in reduced behavioral activity. The authors noted the same effect for subjects with a strong nervous system.

In summary, the management of the hyperactive child is strongly influenced by the temporary effects of drug therapy in the short run, and behavior modification techniques for long term change. There is evidence that personality should not be ignored in the recommendation of drug therapy to hyperactive children and extraverts.

CHAPTER V

RATIONALE AND HYPOTHESES

The Problem

This study attempts to investigate the relationship between hyperactivity (HA) and personality, particularly with reference to Eysenck's (1967) theory of personality and to the theory of strength of the Nervous System (Pavlov, 1955; Teplov, 1956; Neblitsyn, 1966, 1957, 1959). Since these two theories are reported to be strikingly stimilar, it is expected that the main hypothesis of this study would be better confirmed if it could be demonstrated that hyperactivity is related to these two dimensions of personality. Consequently, a number of interrelated questions arise:

<u>Question 1</u>. Is hyperactivity (HA), as defined by the Rating Scale of Hyperactivity (RSH -- Davids, 1971), positively related to extraversion, as defined by the Junior Eysenck Personality Inventory (JEPI -- Eysenck & Eysenck, 1965)?

<u>Question 2</u>. What is the relationship of hyperactivity to Neuroticism (emotionality) and to Lie Scale?

<u>Question 3</u>. Can performance on a simple reaction time task (RT) to increasing auditory stimulus intensity differentiate groups of low and high hyperactive subjects?

<u>Question 4</u>. What is the relationship of hyperactivity to the dimension of strength-sensitivity of the nervous system? In other words, do subjects with high levels of hyperactivity perform similarly to those with strong nervous systems (and vice versa) on simple RT tasks involving RT to increasing auditory stimulus intensity?

Questions 1 & 2 Definitions

Hyperactivity

The term hyperactivity (HA) is used in this study to refer to the hyperactive syndrome of chronic high activity levels (hyperactivity) as well as impulsivity, distractibility, variability, irritability, explosiveness, and short attention span. In this context, the entire syndrome is involved, hence the term is used interchangeably with hyperkinesis which also applies to the same syndrome of behaviors. The operational definition is embodied in the rating scale of hyperkinesis (Appendix 3).

Junior Eysenck Personality Inventory

Before operationally defining the variables of the Junior Eysenck Personality Inventory (JEPI), Eysenck and Eysenck's (1975) observations concerning their interpretation should be noted. These include a reminder that one is dealing with normal behaviors and not with pathological symptoms. The concern is with personality variables underlying behaviors which might only be categorized as pathological in very extreme cases. The scale is therefore appropriate for use with normal non-pathological samples of a population. Eysenck and Eysenck also suggested that the term "emotionality" may be substituted for "neuroticism" particularly when in communication with persons not familiar with the underlying theory. An operational definition of Eysenck's scales are embodied in the JEPI (Appendix 4) and appropriate descriptions of Extraversion, Neuroticism, and Lie Scale are given.

1. Extraversion. As previously stated, Eysenck and Eysenck

(1975) described the typical extravert as one who is sociable, likes parties, has many friends, needs to have people to talk to, craves excitement, acts on the spur of the moment, and is generally an impulsive individual. Extraverts also like change and prefer to be always moving and doing something different. They tend to be aggressive and lose their temper easily. At the other end of the dimension is the typical introvert who tends to be quiet, introspective, and reflexive rather than impulsive. Introverts do not seem to care for much excitement, and tend to live a well ordered mode of life with their feelings under close control.

2. Neuroticism (Emotionality). The typical highly neurotic individual may be described as an anxious, worrying individual, moody and frequently depressed. Such an individual is likely to sleep badly and suffer from various psychosomatic disorders. Neurotic individuals tend to be very emotional, reacting very strongly to all kinds of stimuli and have difficulty settling down after an emotionally arousing experience. These strong emotional reactions often lead to irrational and rigid actions. According to Eysenck, the behavior of the neurotic individual can be summarized in one word, "worrier". When neuroticism interacts with extraversion one gets the neurotic extravert who tends to be touchy and restless, excitable and even aggressive. On the other hand, the stable extravert tends to respond emotionally in a slow and weak manner and returns to baseline quickly after an emotionally arousing episode.

3. Lie Scale. According to Eysenck (1975), the function of the lie scale in a personality inventory such as the JEPI is to measure intentional faking caused by individuals trying to keep

inventory responses within the levels of social desirability. Social desirability has often been shown to interfere with truthful answering of questions in personality inventories. However, other causes can contribyte to dissimulation making lie score interpretation difficult.

Questions 1 & 2 Rationale

Both from a theoretical and empirical standpoint, there are similarities between hyperactivity and extraversion. Examination of the rating scale of hyperactivity (RHS) and the JEPI point to behavioral similarities between hyperactivity and extraversion (Fig. 1). In these measures they are both characterized as restless, excitable, changeable, impulsive, active, lively, and sociable. For both variables, the cause of those behaviors is sometimes hypothesized as arising from low cortical arousal of the ascending reticular activating system (ARAS). Stimulant medication has the same effect on both variables. That is, it tends to reduce rather than increase behavioral activity by increasing cortical arousal levels. In studies on stimulation seeking, findings reveal that both hyperactive subjects and extraverts have the tendency to seek rather than avoid stimulation. On the basis of these relationships it seemed that there was sufficient justification for a personality hypothesis of hyperactivity based on the above findings.

Moreover, if the hypothesis of a relationship between HA and personality is confirmed, there will be implications for management and education of the hyperactive child since the assumption on which present management of the HA child is based is one of high cortical arousal and oversensitivity to stimulation. Hence the hypotheses of this study of chronically lower cortical arousal levels of the HA child and chronically higher sensory thresholds are contrary to existing assumptions and practice. Ever since Strauss and Lehtinen (1947) hypothesized that HA, disinhibition, and distractibility should be regarded as a manifestation of exaggerated responsiveness to stimuli due to brain injury (which may not be incorrect), their findings and the suggestions for management have been generalized to all types of hyperactivity irrespective of etiology. There seemed to be a need for further research aimed at providing more knowledge about this problem, particularly with respect to special subgroups of HA subjects. Consequently, hypotheses relating to Questions 1 and 2 were formulated.

Questions 1 & 2 Hypotheses

Hypothesis 1.1. Hyperactivity is positively and significantly related to extraversion.

Hypothesis 1.2. The relationship among HA and neuroticism and lie scale variables will be positively linear.

Hypothesis 1.3. There are significant mean differences among the three HA subgroups (Low hyperactive or LHA: Middle hyperactive or MHA; and high hyperactive or HHA) and the control group on the measures of extraversion, neuroticism, and lie scale.

Hypothesis 1.4. The high HA group will have significantly higher mean extraverted, neurotic, and lie scale scores than each of the LHA, MHA, and control groups.

Questions 3 & 4 Definitions

Simple Reaction Time (RT)

Simple reaction time is the time interval between the onset of a stimulus and the initiation of a response under the condition that the subject has been instructed to respond as rapidly as possible. Reaction time is also referred to as latency or response latency.

Strength of the Nervous System

This is the name given to a Soviet dimension of personality similar to the dimension of introversion-extraversion used in Western countries. At the lower end of the continuum are individuals with weak nervous system strength similar to introverts. At the upper end of the dimension are individuals with a strong nervous system similar to extraverts.

Weak Nervous System

An individual with a weak nervous system is characterized as having chronically higher levels of cortical arousal and greater sensitivity to sensory stimulation than an individual with a strong nervous system. The weak nervous system individual has a lower sensory threshold than the strong one, therefore responds at stimulus intensities which normally would be too weak to generate a similar response in an individual with a strong nervous system. Across any stimulus intensity continuum the weak nervous system individual will tend to have responses which are closer to their maximum ability of response, and will also tend to arrive at this maximum response faster than that of a strong nervous system individual. In reaction time (RT) tasks, therefore, the individual with a weak nervous system will tend to have faster reaction time (RTs) particularly at weaker stimulus intensities, because of higher levels of arousal and greater sensitivity to sensory stimulation.

Strong Nervous System

The strong nervous system individual is characterized by lower levels of cortical arousal and relatively lower sensitivity to sensory stimulation thatn the weak nervous system individual. Such an individual has chronically higher sensory thresholds and consequently is able to withstand more extreme intensities of stimulation. Throughout the stimulus intensity continuum, the response of the strong nervous system individual are further from the maximum levels of responding, particularly at the lower stimulus intensities. On a reaction time task, the lower arousal levels, higher sensory thresholds and lower sensitivity to sensory stimulation are factors which influence the slower reaction times (RTs) which are characteristic of the individual with a strong nervous system.

$T/t_{min.}$ Ratio

$T/t_{min.}$ is defined as the ratio between RT at each of the lower intensities (in simple to increasing stimulus intensity) to RT at the highest stimulus intensity. The RTs to the lower stimulus intensities are the "t" in the ratio, and in this study these intensities are 10, 30, 50 and 70 db. The RT to the highest stimulus intensity is the "$t_{min.}$" of the ratio, and the highest intensity in this study is 90 db. The transformation of raw RT data in milliseconds to $t/t_{min.}$ ratios was justified on empirical grounds by Nebylitsyn (1972) and will also be examined in more detail in the following chapters.

Questions 3 & 4 Rationale

With regards to the third and fourth questions of this study, there are research findings in support of the hypothesis that the RT of the hyperactive child is slower and more variable when compared with normal controls (Dykman et al., 1972; Firestone, 1975; Porges, 1975; Grunewald-Zuberbier, 1975; and Cohen, 1970). However, these findings were not based on simple reaction time to increasing auditory stimulation, as used in this study.

With respect to introversion - extraversion, the use of simple RT to increasing sensory stimulation to differentiate between introverts and extraverts is almost non-existent. Whenever simple RT to increasing stimulus intensity was used to link the theories of strength of the nervous system and introversion - extraversion, the findings were conflicting. Some studies failed to confirm the correspondence between the two theories (Mangan, 1967; Mangan & Farmer, 1967; Zhorov & Yermolayeva-Tomina, 1972). However, Frigon (1976) used the EEG index rather than simple RT and succeeded in confirming the hypothesized relationship.

It should be noted, however, that the simple RT method to increasing stimulation has been well validated with respect to research on the strength of the nervous system in the Soviet Union (Nebylitsyn, 1972; Nebylitsyn et al., 1965; Olshannikova & Aleksandrova, 1969; Ravich-Shcherbo, 1969) where it is considered as an indirect index of nervous system strength.

Because of these conflicting findings, there seemed to be a need for further research studies in order to validate the use of simple RT to increasing auditory stimulus intensity in differentiating various groups defined on the basis of Eysenck's introversion - extraversion dimension, hence the rationale for this study with hyperactive subjects.

Questions 3 & 4 Hypotheses

Hypothesis 2.1. There are significant differences between degrees of hyperactivity on a simple reaction time task to increasing auditory stimulus intensity, with the high hyperactive group having slower reaction times than the low hyperactive group.

Hypothesis 2.2. The greatest mean RT differences between the low and high hyperactive groups will be at the minimal intensities of the auditory stimulus, that is, at 10 db and 30 db.

Hypothesis 2.3. Reaction time to the minimal intensities of the auditory stimulus will be slower for the high hyperactive group and faster for the low hyperactive group.

Hypothesis 2.4. There will be differences between the shapes of the curves relating reaction time to increasing auditory stimulus intensity. That is, the curve for the high HA group will have a steeper and sharper gradient (slope) from the lowest to the highest auditory stimulus intensity when compared with the curve for the low HA group.

Statistical Analyses Related to the Hypotheses

1. Means analyses and descriptive statistics related to each step of the data analysis.

2. Concerning Hypotheses 1.1, 1.2, 1.3, and 1.4:

   i) Product moment correlation.

   ii) Linear regression analyses.

   iii) Graphical analysis.

   iv) One-way analyses of variance.

   v) Two-way analysis of variance.

3. Concerning Hypotheses 2.1, 2.2, 2.3, and 2.4 (n = 32):

   i) Means and graphical analysis of the raw RT data in milliseconds.

   ii) Graphical and means analysis of RT data transformed into mean Log_e and $t/t_{min.}$ ratios.

   iii) Linear regression analysis of $t/t_{min.}$ ratios.

   iv) Analysis of variance methods with repeated measures on the stimulus intensity factor based on mean Log_e and $t/t_{min.}$ transformed RT data (Winer, 1962; Nebylitsyn, 1972).

CHAPTER VI

METHOD

Overview of Sampling

The sample is comprised of 200 boys ranging in chronological age from 9-12 years. The experimental group comprised 150 learning disabled subjects and 50 normal control subjects. The cumulative records for over 300 boys were examined for initial screening. The criteria for sample selection were the following.

1. Chronological age 9-12 years.
2. Lorge-Thorndike IQ of 85 or higher.
3. No gross evidence of epilepsy, visual or auditory acuity problems. Two hundred ninety seven boys meeting these criteria were found and their parents were contacted for permission to participate. Teachers were instructed to administer the Rating Scale of Hyperactivity (RSH) for those boys whose parents had given permission. On the basis of RSH scores and criteria, this group was then subdivided into three HA subgroups, namely, low, middle and high. It was from these that the final groups were drawn with 50 in each subgroup. Similar screening criteria were applied to the normal control group. The reaction time task (RT) was administered to a select sample of 32 subjects (16 Low; 16 High) whose hyperactivity scores were extreme. This sample was drawn from the low and high hyperactive experimental subgroups.

Sampling

The 200 boys comprised of 150 learning disabled boys, and 50 normal control subjects, were drawn from several elementary schools in the

Edmonton Catholic and Edmonton Public school systems. The 150 hyperactive or experimental subjects were selected from classrooms for children with learning disabilities including Resource Rooms, Learning Centers, and Adaptation Rooms. The 50 control subjects were drawn from regular classrooms. Chronological age of the entire sample ranged from 9 to 12 years, and full scale Lorge-Thorndike IQ was 85 or above. The normally high incidence of hyperactive boys relative to girls was the influencing factor in selecting boys only for the study.

Selection of the experimental and control sample proceeded in various stages. Prior to the study, preliminary screening for selection of these samples took place through the use of data obtained from the students' cumulative records located in the central offices of the two school systems and in the general offices of the schools. Initially, the records of all boys in the special classrooms were examined with respect to the screening criteria adopted for this study. Control criteria included CA between 9 and 12 and a full scale Lorge-Thorndike IQ of 85 or higher. Other selection criteria included no evidence of hearing or visual acuity problems, epilepsy or brain insult. At this stage, all boys who did not meet these criteria were not considered for selection. Classroom teachers further assisted in the screening process by supplying information that was not included in the students' cumulative record.

Letters w[illegible] [illegible]ent through the schools to the parents of those boys who passed [illegible] [illegible]iminary screening (Appendix 1). These letters sought permissio[illegible] [illegible]heir sons to participate in the study (Appendix 2). Classroom [illegible] were then requested to complete the

Davids' Rating Scale for Hyperactivity (RSH -- Appendix 3) for each of those boys whose parents had given consent. Teachers were not requested to complete the RSH for the control sample. At this stage there were 297 names. However, this number was greatly reduced as a result of the refusal of some parents to grant permission for their son to participate, of children failing to take the letters of permission home, of teachers forgetting to send the letters to the parents or not completing the rating scales and of some principals refusing to take part in the study.

Finally, the RSH scoring criteria were applied in order to divide the experimental sample into three categories of hyperactivity, namely, low (LHA), middle (MHA), and high (HHA). It was from these three groups that the final experimental sample of 50 low, 50 middle, and 50 high hyperactive groups was randomly drawn. The control sample of 50 boys was also randomly drawn from 70 subjects selected who had satisfied the age, IQ and sex requirements for inclusion in this study.

In addition to these groups, subgroups (n = 25) of subjects from the LHA and HHA groups who scored extremely low and extremely high on the RSH were selected for the reaction time (RT) task. A further eight of these subjects were subsequently eliminated from the study for reasons related to the selection criteria of the RT task. They included inability to pass the screening test and excessive movement or inattention resulting in missing data. From the remaining 42 subjects, then, a final sample of 16 extreme LHA and 16 extreme HHA subjects (n = 32) was randomly selected for the RT data analysis in order to have equal n's for the 2 by 4 ANOVA.

In summary, the study involved four equal groups of 50 subjects per group comprised of three hyperactive (HA) or experimental groups and one normal control group. For the purpose of the RT task, both the low HA and high HA groups were further sampled to provide two extreme HA groups of 16 subjects per group.

Instruments

Junior Eysenck Personality Inventory

The Junior Eysenck Personality Inventory (JEPI -- Eysenck, 1965) was designed to extend downwards Eysenck's method of personality measurement in order to meet the needs of children between the ages of 7 and 15 (Appendix 4). Through factor analytic methods, Sybil and Hans Eysenck hypothesized that there were three important uncorrelated and distinct dimensions underlying human behavior. These are extraversion (E), neuroticism (N), and psychotism (P). They developed and used quite extensively since 1959 a number of questionnaires to measure these three dimensions. The JEPI was one of these.

The JEPI was designed to serve the particular needs of children, especially British children and in Britain it is regarded as the only questionnaire for children that has undergone the most rigorous standardization. Recently, the Eysenck Personality Questionnaire (EPQ -- Eysenck & Eysenck, 1975) for juniors and adults has been published.

The JEPI contains 60 items of which 24 measure extraversion (E), 24 measure neuroticism (N), and 12 constitute a lie scale (L). With regards to the extraversion scale, extraverts are those who score from 19 to 24 on the questionnaire, ambiverts score between 7 and 18, and introverts score between 1 and 6. The JEPI is based largely on British standardization although norms have been developed for North America. These norms suggest that comparable North American groups do not differ appreciably from the British groups.

The JEPI is designed for use with both boys and girls and norms are available for groupings on the basis of age and sex. According to the norms, boys appear to be relatively more extraverted than girls who, in turn, are more neurotic than boys and generally have higher lie scale scores. With regards to extraversion, there is a notable increase with age for extraversion in boys, but less of an increase for girls. Contrarily, there is an increase in neuroticism with age for girls, but no similar change for boys.

The split-half reliabilities of the scale indicate that they are reasonable for group comparisons at the younger age. There is considerable increase in reliability with age as far as extraversion is concerned. The increase of reliability with age for extraversion ranges from approximately 0.65 for the 9-year-old group to values approaching 0.9 for the 15-year-old group. The JEPI has internal reliability coefficients of about 0.8 at 14 years and test-retest reliability coefficients of 0.7 at age 13 (Eysenck, 1965). The test-retest reliability coefficients are a little lower than the split-half reliabilities, however.

<u>Rating Scale of Hyperkinesis</u>

A number of rating scales of children's behavior are available for completion by parents and teachers. These have been reviewed by

Conners (1971). One of these is Davids' (1971) Rating Scale of Hyperkinesis (RSH).

In 1958, in collaboration with Laufer and Denhoff, Davids designed a series of rating scales which could be used for assessing the specific traits and behaviors which were found to be of prime importance in the syndrome called hyperkinesis. These researchers were seeking to develop some valid and reliable procedure for assessing hyperkinesis in both normal and disturbed children. Their effort resulted in the RSH. In several unpublished studies conducted in the late 1950s and 1960s, they found that the RSH had adequate reliability and considerable clinical utility (Davids, 1971, p. 444).

The RSH (Appendix 3) consists of six well-defined categories, namely: hyperactivity; short attention span; variability; impulsiveness; irritability; and explosiveness. Each item is rated on a 6-point discrete graphic scale ranging from 1 (much less than most children) to 6 (much more than most children). Summated ratings therefore range from 6 to 36. Davids states that scores of 24 or more suggest the presence of hyperkinesis in the child; that scores ranging from 19 to 23 were suspicious; and that scores of 18 or less were indicative of the absence of significant hyperkinesis (Davids, 1971, p. 501).

With regard to data on the reliability of the RSH, Burns & Lehman (1974) reported that correlation between summated ratings, that is, test-retest reliability of total ratings between administrations of the test, was 0.922 so that the six categories which comprised the RSH were relatively consistent for each administration. The coefficients for the first and second administrations of the RSH were 0.865 and 0.941.

Generally, the RSH has proved to be a relatively reliable measure although it is not immune from some of the drawbacks that are inherent in rating scales in general. These include errors of leniency, central tendency, halo effect, and, most importantly, the normative nature of the ratings limits intercategory comparisons, thus limiting their use for individual considerations. In order to overcome this drawback, pair comparison data which indicate individual rating on each category may be made, especially since the result of such comparisons can supply data as the basis of individual strategies of remediation for hyperactive children. These data state which components of the HK syndrome should receive primary remedial consideration. In a recent factor analysis of Davids' rating scale, Williams (1976) reported that the six behaviors of the scale loaded on one factor, hence increasing the value of the scale as a good unitary measure of HA. He found that the variable with the least discriminative strength was short attention span (0.777) as compared with the better discriminators, explosiveness (2.5022) and impulsivity (2.4863).

Reaction Time Apparatus

The simple RT method employed in this study involved reaction at a fixed preparatory interval (PI) to five levels of auditory stimulation, 10, 30, 50, 70 and 90 db (ANSI). The rationale for selecting these intensities was the attempt to use similar intensities used by Nebylitsyn (1972) in studies on the strength of the nervous system using reaction time.

Each subject was given a total of 125 trials made up of five blocks of 25 trials each. In turn, each of the 25 trials contained five of each of the 10, 30, 50, 70, and 90 db stimulus intensities presented in random order. Each student therefore provided RT data based on the same five blocks of 25 randomized trials (Appendix 5).

A Maico MA-19 diagnostic audiometer was used to present auditory stimuli for the RT task experiment. Timing of presentations of the pure tones (10, 30, 50, 70, and 90 db) was automatically controlled by interval timers and a warning light (7.5 watts) signal box specially constructed for the experiment. A digital clock timer was used to record reaction time (RT) in milliseconds.

The Maico MA-19 audiometer was used in conjunction with an "Audiocup" headset with standard headband and a TDH 39 receiver equipped with MX 41/AR cushions. This audiometer has discrete attenuation settings in 5 db steps from 0 to 100 db (ANSI). For the purpose of this study, the audiometer was calibrated to ANSI standardization by Roberts Audio Analysis Laboratories of Edmonton, Alberta.

The control panel on the audiometer included a hearing threshold level control (HTL) which varied the intensities of the tones. Numbers representing these intensities could be viewed through a small window near the center of the panel. A frequency control (FC) was also available although no adjustments were necessary since the frequency was fixed at 1,000 Hz for the purposes of this study.

Interval timers were used to control the various time intervals called for in the experiment. They switched the tone, clock, and warning light on and off automatically and regulated the various intervals. The function of the examiner was simply to select the intensity according to the prearranged randomized sequence for each block of 25 trials, and to record the RT on the data sheet. The remainder of the sequence, that is, the switching on and off of the red warning light, and ensuring that it stayed on for the fixed interval for each trial (1 second) was automatic. The tones were fed through the left earphones to the left ear. This sequence leading to the RT measure is illustrated in Figure 6.

Procedure

JEPI Data Collecting and Recording

The Junior Eysenck Personality Inventory was administered to groups of children at their schools during the period April 12-30, 1977. The RT testing was conducted during May 3-15, 1977 at the University of Alberta. Three students were tested each morning and three each afternoon. All were transported to the University by the examiner following permission from parents, teachers, and central school administration authorities.

All JEPI and RT testing was done by the examiner with the aid of a graduate teaching assistant. Another graduate assistant aided in the administration of RT testing and supervision of the children since only one child could be tested at a time. For the administration of the JEPI, the commonly accepted procedure suggested by Eysenck and Eysenck (1975) was adhered to. Central to this was

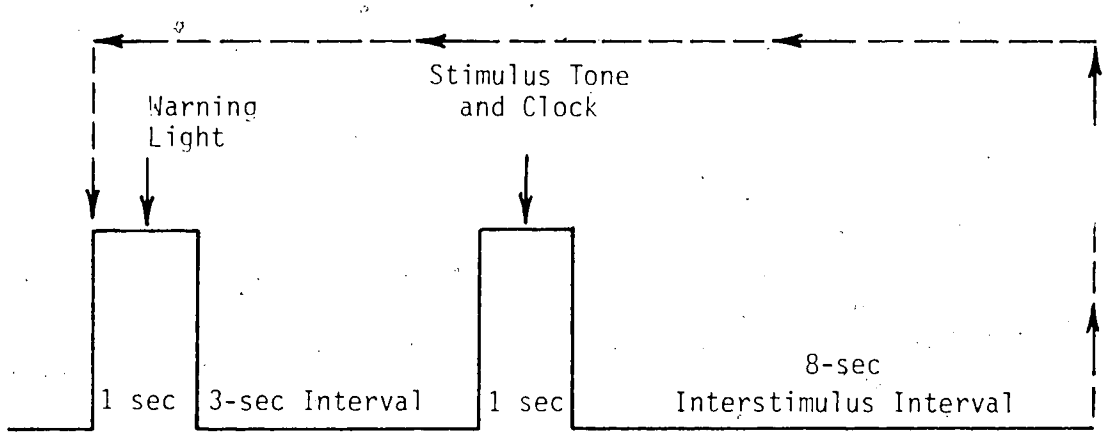

Figure 6. Structure of Reaction Time Sequences

that all instructions were to be read aloud to groups of subjects and not be amplified or altered in any way. Moreover, the instructions were that no attempt was to be made to change the wording of the questions, nor amplify or interpret them, nor give advice to the subjects on how best to answer them. No testing was done in the subject's classroom or in the presence of his teacher or any other persons except the examiner and his assistant.

As suggested by Eysenck & Eysenck (1975), for children with reading difficulties, the examiner read out each item in turn, while the assistant invigilated to ensure that all the items were answered as read and that there was no copying. The items were similarly read aloud for the control sample. Unfinished inventories were completed at the end. The assistant drew attention to omissions or missing answers. Generally, the inventory was completed in fifteen minutes.

Total testing time was more than fifteen minutes, however, because additional time was needed to allow the children to become relaxed before testing began. Each session was introduced by the examiner who stressed, in a general way, the importance of the research and reassured the children that their answers would be confidential and that the test results would not be entered into their school records. It was observed that the children appeared to take the test seriousl_ and were at ease with the personal nature of the questions asked in the inventory. Children were not allowed to talk to each other about the questions and answers during testing. They were quite cooperative and seemed to enjoy the session. Similar cooperation was obtained from school administrators, teachers, principals, and school secretaries who worked closely with parents to ensure that the testing schedule was not interrupted. Parents were also extremely cooperative and expressed interest in the outcome of the study.

Reaction Time (RT) Data Collecting and Recording

Interval timers were used to control the various time intervals automatically. They switched the tone, clock, and warning light on and off and regulated the preparatory and intertrial intervals. The function of the examiners was simply to select the required stimulus intensity on the preordered sequence and record the RT on the data sheets provided for the purpose (Appendix 6). The other sequences were automatically controlled by the interval timers (see Fig. 6).

The examiner started the sequence by pressing a switch which activated a timer to start the sequence. The first stimulus to appear was a red forewarning light which stayed on for one second. Exactly three seconds after the forewarning light went off, and interval timer activated both the stimulus tone from the sound generator and the digital clock simultaneously. The clock was situated in the adjoining room and the tone could be heard on the earphones worn by the subject. The tone was timed to remain on for one second, but the clock continued until it was stopped by the subject. During this period the subject pressed the response button situated on the arm of the chair. This action immediately stopped the clock and the examiner recorded the RT displayed on the clock's face. A blank 8-second intertrial interval followed the cessation of the tone and the stopping of the clock. The instrument automatically reset itself and the sequence was repeated with the initiation of the forewarning light.

Reaction time testing was conducted in a moderately illuminated soundproof laboratory located at the Speech and Hearing Center of the Faculty of Education, University of Alberta. Immediately adjacent to, but in front of, the laboratory was the examiner's control room which contained the sound generator, clock, and interval timers (Appendix 7). Thus, the subject and the examiners were separated by the insulated front wall of the laboratory which contained a 2' by 3' two-way glass window mounted in the center of the wall. Once the laboratory door was shut, communication between subject and examiners was through an intercom system especially installed for the purpose.

The fan-cooled laboratory temperature was between 20°C and 22°C with a constant ambient illumination of 1.5 lux. The stimuli in the laboratory included a chair, a microphone stand on which the black warning-light box was mounted, and the response button which was attached to the armrest of the chair on the same side as the subject's preferred hand (Appendix 8).

Each subject was taken into the soundproof room and seated on the chair with his back to the viewing window at an angle of 30°. Three feet away from the chair was the red warning light which consisted of a 1-inch diameter red lightbulb. The response button the armrest of the chair was adjustable to the subject's comfort position and preferred hand.

Standard instructions were read to the child and included the following:

> "This is a little game that tells you how fast you are. The first thing you have to do is to keep your fingers on this button and press it as quickly as you can when you hear a beep or

> sound. The sound will come through the left ear only. You will know a sound is coming because this red light will warn you. It will always come on before the sound to warn you that you must listen. Some of the sounds will not be very loud so you will have to listen carefully or you will miss them and lose points in the game. Your fingers must always be in place ready to press the bar. Once again, don't press this bar when you see the light. When the light comes on wait to hear the tone. Then press the bar as quickly as you can. After pressing, keep your hand and finger near the bar and be ready to press again. After doing this a few times you will have a short break and will continue to do the same thing again until the game is over. Each time you will be told when it is time for a break over the intercom. Any questions? O.K., let's go!"

Following these instructions and some indication from S that he was comfortable and relaxed, the headset was placed in position, care being taken to ensure that the left earphone was placed on the left ear and that S's hair did not fall between the cushions and his ear. The examiner then left the test laboratory and entered the control room in order to begin a practice session consisting of five trials of randomized intensities at 5, 10, 15, 30, and 50 db at 1,000 Hz. These practice trials were given in order to obtain some indication of the subject's basal hearing threshold level and also to familiarize S with the use of the apparatus. The practice session was then merged into the experimental trials if the practice trials were successful. The total time expected to be taken for all trials was approximately 35 minutes per subject, and this consisted of:

25 trials, each of 13 seconds duration	= 5.42 minutes
5 blocks of 25 trials per block	= 27.1 minutes
4 two-minute rest periods	= 8.0 minutes
Total time taken for 125 trials	= 35.1 minutes

CHAPTER VII

RESULTS

Introduction

To provide ease in following the presentation of the results this chapter is divided into sections each of which reflects the specific type of analysis used to answer questions raised in this study and to test the relevant hypotheses associated with those questions. Each section of the analysis starts with a review of the relevant questions and hypotheses and is followed by a descriptive overview of the characteristics of the sample involving means and standard deviations. Finally, the results of the analyses performed on the data are discussed. These include correlational analysis and analysis of variance methods. An overview of the hypotheses and the summary of the findings will precede the analysis and presentation of the results.

Overview of Results

Hypothesis 1.1. Hyperactivity is positively and significantly related to extraversion. This hypothesis was confirmed in that a statistically significant positive relationship was found between hyperactivity and extraversion.

Hypothesis 1.2. The relationship among HA and neuroticism and lie scale variables will be positively linear. This hypothesis was not confirmed by the data, thus ruling out neuroticism as a confounding variable in the investigation of the relationship between hyperactivity and extraversion.

Hypothesis 1.3. There are significant mean differences among the three HA groups (low hyperactive or LHA; middle hyperactive or MHA; and high hyperactive or HHA) and the control group on the measures of extraversion, neuroticism, and lie scale. This hypothesis was confirmed for extraversion and lie scale but not for neuroticism, thus further confirming hypotheses 1.1 and 1.2.

Hypothesis 1.4. The high HA group will have significantly higher mean extraverted, neurotic, and lie scale scores than each of the LHA, MHA, and control groups. This hypothesis was confirmed for extraversion only but not for neuroticism or lie scale.

Hypothesis 2.1. There are significant differences between degrees of hyperactivity on a simple reaction time task to increasing auditory stimulus intensity, with the high hyperactive group having slower reaction times than the low hyperactive group. This hypothesis was confirmed on the basis of raw reaction time (RT) scores in milliseconds and $\log_e$ transformed scores. It was found that the high hyperactive group had slower reaction time scores across all levels of stimulus intensity.

Hypothesis 2.2. The greatest mean RT differences between the low and high hyperactive groups will be at the minimal intensities of the auditory stimulus, that is, at 10 db and 30 db (ANSI). This hypothesis was confirmed.

Hypothesis 2.3. Reaction time to the minimal intensities of the auditory stimulus will be slower for the high hyperactive group and faster for the low hyperactive group. This hypothesis was confirmed when a $\log_e$ transformation of the raw data was used, but was not confirmed when $t/t_{min.}$ data transformation was used.

Hypothesis 2.4. There will be differences between the shapes of the curves relating reaction time to increasing auditory stimulus intensity. That is, the curve for the high HA group will have a steeper and sharper gradient (slope) from the lowest to the highest auditory stimulus intensity when compared with the curve for the low HA group. This hypothesis was partially confirmed. Graphically, the results met Nebylitsyn's criteria for a strong nervous system. However, on the basis of $t/t_{min.}$ transformation, differences obtained were not significant.

Descriptive Statistics

The mean chronological age of the hyperactive sample (n=150) was approximately 127 months, with a standard deviation of 13.15. The mean IQ of the same sample was 93.48 with a standard deviation of 10.13. Statistical comparison between the hyperactive or experimental group and the control group (n=50) as a whole indicated that with respect to chronological age the two groups were not statistically significantly different ($t=0.005$; $p>0.05$). However, they were significantly different with regard to IQ ($t=3.19$; $p>0.05$), as Table 1 shows.

When LHA, MHA, and HHA subgroups are compared with the control group on the basis of chronological age and IQ (Table 2), differences among groups are not significant ($F[3/196] = 0.79$; $p>0.05$) with regard to chronological age, but there were significant differences with respect to IQ ($F[3/196] = 3.77$; $p>0.01$). It should be noted, however, that when comparisons are made within the experimental groups, no statistically significant differences are found on the basis of either chronological age (CA) or IQ ($p>0.05$). Thus, the three HA

Table 1

Sample Characteristics: Descriptive Data

Variable	HA Group (n = 150)		Control Group (n = 50)	
	Mean	SD	Mean	SD
Hyperactivity	21.42	8.84	--	--
Age (months)	126.99	13.15	126.98	10.28
IQ (LT-full scale)	93.48	10.13	99.36	12.40
Extraversion	15.62	3.48	17.04	3.39
Neuroticism	14.01	5.00	14.72	3.63
Lie Scale	4.06	2.53	2.78	1.89

groups were essentially equivalent in terms of the factors of sex, age and IQ. It can be concluded, therefore, that the boys from special classes have a relatively lower and less variable IQ than their normal counterparts. Later, however, an F test will be used to ascertain more clearly where HA group differences exist.

Table 2 reveals this lack of significant difference in that the mean chronological ages of LHA, MHA, and HHA groups were 125.3, 126.9, and 126.3 months respectively, with corresponding standard deviations of 12.8, 12.5, and 13.7 respectively. The mean IQs of the same groups were 93.1, 94.18, and 93.18 respectively, with standard deviations of 9.37, 10.99, and 9.33 respectively. As a group, HA Ss (n=150) were less variable (see Table 1). However, as experimental groups they were slightly more variable (Table 2).

Table 2

Means and Standard Deviations of Three HA Subgroups and the Control Group

Variable	LHA (N = 50)		MHA (N = 50)		HHA (N = 50)		Control (N = 50)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Hyperactivity	11.78	2.70	20.04	1.44	32.44	3.03	--	--
Age (months)	125.30	12.98	129.10	12.72	126.58	13.84	126.98	10.38
IQ (LT - full scale)	93.10	9.47	94.18	11.10	93.18	10.03	99.36	12.53
Extraversion	13.40	2.69	15.56	3.60	17.92	2.52	17.04	3.42
Neuroticism	14.78	4.76	14.34	5.27	12.92	4.93	14.72	3.67
Lie Scale	4.48	2.50	3.54	2.62	4.18	2.48	2.78	1.90

For the control subjects, the mean chronological age was 126.98 months with a standard deviation of 10.38. The mean IQ of the same group was 99.36 with a standard deviation of 12.53 which is close to the expected mean of 100.

At this preliminary inspection of the data, both mean CA and IQ are not statistically different among the HA groups, and this finding will later be supported by correlation and analysis of variance methods.

The results of subgroup means analyzed by one-way ANOVA confirmed previous findings of no statistically significant differences among the four groups on the measure of CA ($F[3/196] = 0.79$; $p > 0.05$). As prevously mentioned, the one-way ANOVA for IQ revealed a significant F ($F[3/196] = 3.77$; $p < 0.01$). When this indication of significant group differences was further analyzed using the Scheffé method for making multiple comparisons, it was found that among the experimental groups the differences were not statistically significant. However, when the control group is compared with the hyperactive groups, the results indicated significant differences ($p < 0.05$) among the control and low HA and high HA groups respectively. The difference between the control and middle HA group did not reach significance ($p \leq 0.13$). These results are tabulated in Table 3.

In summary, the analysis of sample data indicated that the variables of chronological age and IQ were not statistically significant among the experimental groups, so that it can be concluded that these variables were adequately controlled in this study and are therefore not likely to be biasing factors in the investigation of the relationship between HA and personality. Further support for

Table 3

Summary of One-way ANOVA and Scheffé Test for Three HA Groups and the Control Group on the Variables of Age and IQ

Age

ANOVA

Source	SS	MS	DF	F	P
Groups	0.3720	124.00	3	0.79	0.502
Error	0.3087	157.51	196		

IQ

ANOVA

Source	SS	MS	DF	F	P
Groups	0.13300	443.33	3	3.77	0.011
Error	0.23074	117.72	196		

Probability Matrix for SCHEFFE

Multiple Comparison of Means

	1	2	3	4
1. Low HA	1.0000	0.9695	1.0000	0.0426
2. Middle HA	0.9695	1.0000	0.9755	0.1310
3. High HA	1.0000	0.9755	1.0000	0.0467
4. Normal-Control	0.0426	0.1310	0.0467	1.0000

this conclusion comes from the low Pearson product-moment correlations found between HA and age (f = 0.015) and HA and IQ (r = 0.002).

It might be noted, however, that with respect to HA, the critical variable of this study, the means of the three HA groups were 11.78, 20.40, and 32.44, respectively. These groups were all statistically significantly different to start with because of the procedure used for their definition on the measure of HA, but they were not different on age or IQ. It might also be noted that the mean score of 21.42 for the entire HA sample (n = 150) is consistent with the expected mean score of 20.00 for the rating scale of hyperactivity (Davids, 1971).

Correlational Analysis

A Test of Hypotheses 1.1 and 1.2

The purpose of this analysis was to examine the relationship between hyperactivity and each of the personality dimensions of extraversion, neuroticism, and lie scale. The particular focus of interest was the hypothesized positive relationship between hyperactivity and extraversion.

The total sample of hyperactive subjects (n = 150) was involved in this phase of the data analysis. Table 1 showed that the mean scores on the JEPI for all subjects were 15.62 for extraversion, 14.01 for neuroticism, and 4.06 for lie scale. Standard deviations were 3.48, 5.00, and 2.53, respectively. These scores compare with mean scores of 17.04 for extraversion, 14.72 for neuroticism, and 2.78 for lie scale for the control group, standard deviations being 3.39, 3.63, and 1.89, respectively (JEPI manual). Das, Manos & Kanungo (1975) reported extraversion means of 17.87 and 17.07 for high and low SES amples of Edmonton whites respectively, with standard deviations of 2.91 and 3.33.

Pearson product-moment correlations were calculated on the raw scores of each of the following pairs of variables for the entire sample of hyperactive subjects: (1) hyperactivity and extraversion; (2) hyperactivity and neuroticism; and (3) hyperactivity and lie scale. By way of interest the correlations between hyperactivity and bot chronological age and IQ were also performed. Table 4 presents the Pearson product-moment correlations between hyperactivity and the inventory variables, and also between hyperactivity and age and IQ. In the analyses to follow, statistical significance implies a probability level of 0.05 or less.

Inspection of Table 4 reveals that only two of the correlations of hyperactivity with the inventory variables were statistically significant. This included the correlation between hyperactivity and extraversion ($r = +0.517$; $p < 0.001$), the main relationship of interest. With regard to the predictions of this phase of the analysis, these results offer support for the hypothesis that a positive relationship exists between hyperactivity and extraversion. On the basis of this evidence it seems reasonable to conclude that there is a positive relationship between HA and extraversion in this sample of elementary school children, with the more HA boys having higher levels of extraversion.

Inspection of Table 4 also reveals that the predicted positive relationship between HA and N is not supported. Neuroticism can therefore be eliminated as a confounding variable in this investigation of the relationship between HA and extraversion. Subsequent results

Table 4

Pearson Product Moment Intercorrelation Coefficients Between Hyperactivity and the Inventory Variables Including Age and IQ

	1	2	3	4	5	6
1. Age	--	-0.129	0.015	0.071	-0.053	-0.156
2. IQ	-0.129	--	0.002	-0.033	-0.060	-0.031
3. Hyperactivity	0.015	0.002	--	0.517	-0.131	-0.007
4. Extraversion	0.071	-0.033	0.517	--	-0.109	-0.944
5. Neuroticism	-0.053	-0.060	-0.131	-0.109	--	-0.279
6. Lie Scale	-0.156	-0.031	-0.007	-0.094	-0.279	--

will confirm these findings.

With regard to the relationships between neuroticism and the other inventory variables, it must be noted that the correlation between N and extraversion was only -0.109 (Table 4), indicating that the two dimensions of pers ity are relatively independent. This finding is in line with deductions from Eysenck's theory of personality and are supported by normative data from the manual of the JEPI (Eysenck & Eysenck, 1975) which reported a correlation between extraversion and neuroticism of 0.13 at age 10. These findings are also in good accord with previous research results. For example, Eysenck, Nias & Eysenck (1971) reported a correlation of 0.16 between extraversion and neuroticism. Eysenck & Cookson (1969) also found that neuroticism scale correlated negatively with extraversion to the extent of only -0.21.

As in the case of the results of the correlation between HA and N, the statistical analysis of the lie scale data does not support the prediction of a positive relationship between HA and lie scale score. This finding is in agreement with normative data from the JEPI which reported a correlation between the two variables of -0.09.

By way of interest, it should be noted that Table 4 reveals that the correlation betwen N and lie scale is the only other correlation in the matrix of intercorrelations to reach statistical significance ($r = -0.279$; $t = -3.535$; $p < 0.05$), but this was not predicted. However, the finding of a negative correlation between neuroticism and lie scale is in accordance with previous research findings and is supported by JEPI test manual normative data which reported a correlation of -0.30. Eysenck, Nias, & Eysenck (1971) also found a low negative correlation between neuroticism and lie scale of -0.16. They reported that diagnosed neurotics who have low N scores also tended to have high L scores and that correlations between lie scale and N were always negative. Finlayson (1971) found that neuroticism was negatively related to the lie scale in all schools and groups which he studied. At the Grammar School level, the correlation between N and lie scale was -0.394 ($p < 0.01$), whereas at the Grammar Technical School level, the correlation was -0.215 ($p < 0.05$). Entwistle & Cunningham (1968) reported a negative correlation of neuroticism and lie scale for boys and girls of -0.221 ($p < 0.05$) and -0.173 ($p < 0.05$) respectively.

Correlations of chronological age with the other variables were not expected to be high because of the attempt to control for age by selecting a very narrow age range for this study. As expected, the correlation between hyperactivity and age was non-significant ($r = 0.015$; $p > 0.05$), and so also was the correlation between age and extraversion ($r = 0.071$; $p > 0.05$). However, there was a slight negative correlation of age with neuroticism ($r = -0.053$). The JEPI reported correlations of 0.06 between age and extraversion and -0.03 between age and neuroticism. Table 4 shows that age has a slight negative correlation with lie scale and an insignificant positive correlation with hyperactivity.

As with the correlations of age and the other variables, none of the correlations of IQ with the other variables reached statistical significance ($p > 0.05$). Correlations of IQ with N and extraversion were -0.06 and -0.03 respectively. These results are similar to those reported in the JEPI test manual where the correlations between IQ and extraversion and neuroticism were 0.00 and -0.05 respectively. Eysenck, Nias & Eysenck (1971) also found that the Ravens Progressive Matrices correlated with neuroticism and extraversion to the extent of r = -0.03 and r = 0.05 respectively.

In summary, the relationships of the personality variables to one another are all accordant with previous research and normative data from the JEPI test manual. Having investigated the extent of the relationships between HA and the personality variables, analysis of the nature of such relationships was next undertaken.

The nature of the positive relationship between HA and extraversion which was obtained from the Pearson product-moment correlation was further probed through regression analysis. The linear formula and the corresponding regression lines were calculated so as to provide the best possible "fit" to the trends indicated by the scatter diagrams. The regression lines were then imposed on the scatter diagram of scores generated by the computer on the variables of hyperactivity and extraversion, hyperactivity and neuroticism, and hyperactivity and lie scale. It was hypothesized that the relationship between HA and extraversion would be positive and linear. Regression analysis was based on the linear prediction formula for any straight line, namely Y = b X + a, the value of the constant "b" reflecting the slope of the line or the rate of increase in Y as X increased, and the value of the constant "a" being the point at which the regression line crossed the Y-axis. In this analysis, a significant linear trend would indicate a systematic linear relationship between the variables under investigation.

Figure 7 graphically illustrates a positive linear relationship

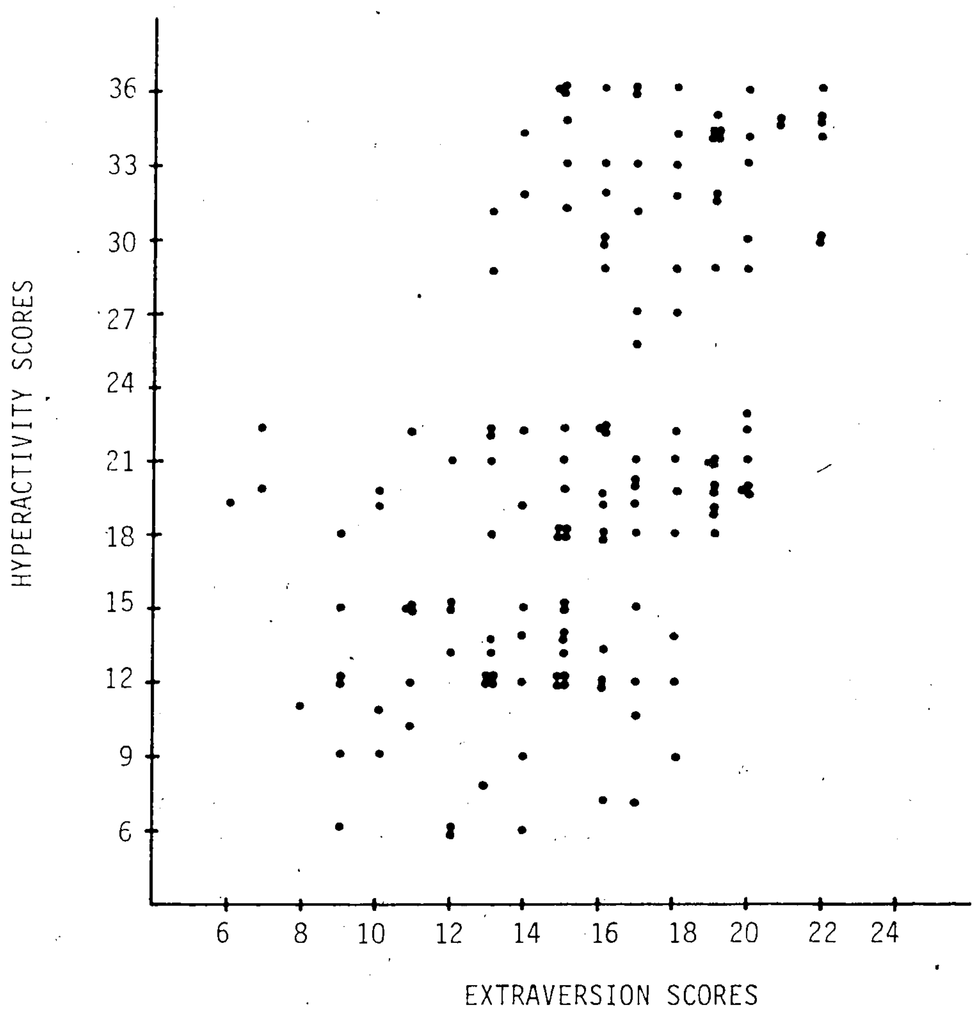

Figure 7. A Scatterdiagram of HA Scores as Compared With Extraversion Scores

between the variables of hyperactivity and extraversion, which is the central concern of this study. This finding is in the predicted direction and confirms the finding of a positive Pearson product-moment correlation of r = 0.517.. Thus, both the extent and nature of the relationship are in the hypothesized direction. The scatter-diagram in Figure 8 also illustrates the relationship of HA to neuroticism. In this case, the scatter of dots is more or less evenly and widely dispersed but with a slight negative trend, which is consistent with previous results showing a slightly negative relationship between HA and N of r = -0.131.

Scatterdiagrams of the relationships between HA and the other variables of lie scale, age and IQ revealed a general non-linear relationship for each, the dots being sparsely dispersed in all directions, consistent with the weak product-moment correlations obtained (Table 4). However, these have not been graphically illustrated. These scatter diagram indications of linear and non-linear trends were further examined more directly through the superimposition of regression lines on the data.

Examination of the regression line fitted to the scatter diagram in Figure 9 confirms the finding that the nature of the relationship between HA and extraversion is clearly linear and positive. The apparent clustering of dots on the graph resulted from the omission of scores at the cut-off points for the low and high HA groups. Deviation of scores from the regression line is fairly uniform. However, for the relationship between HA and N, the graph (Figure 10) shows that the regression line is only slightly deviated from parallelness with the X-axis in a negative direction. This relationship is

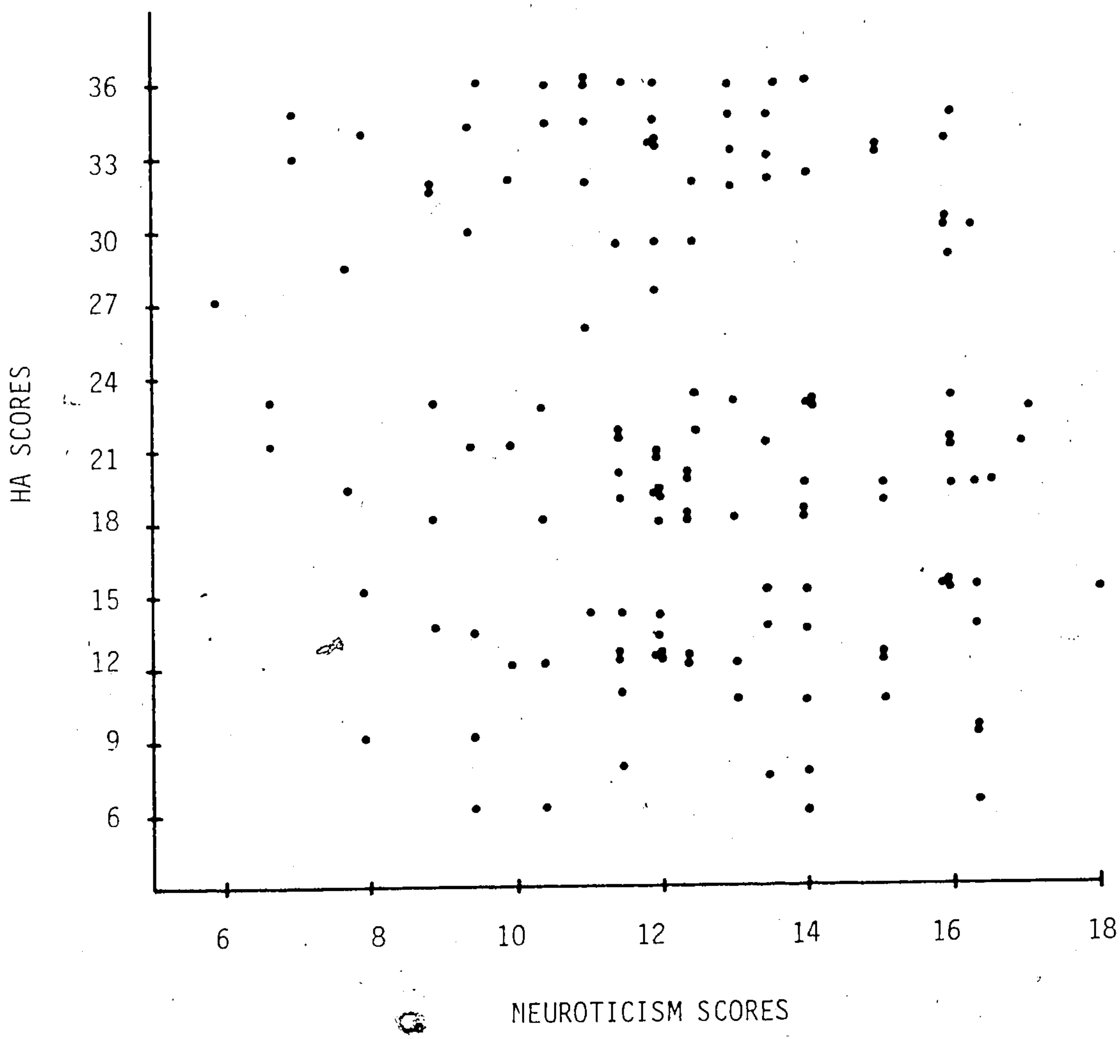

Figure 8. A Scatterdiagram of HA Scores as Compared With Neuroticism Scores

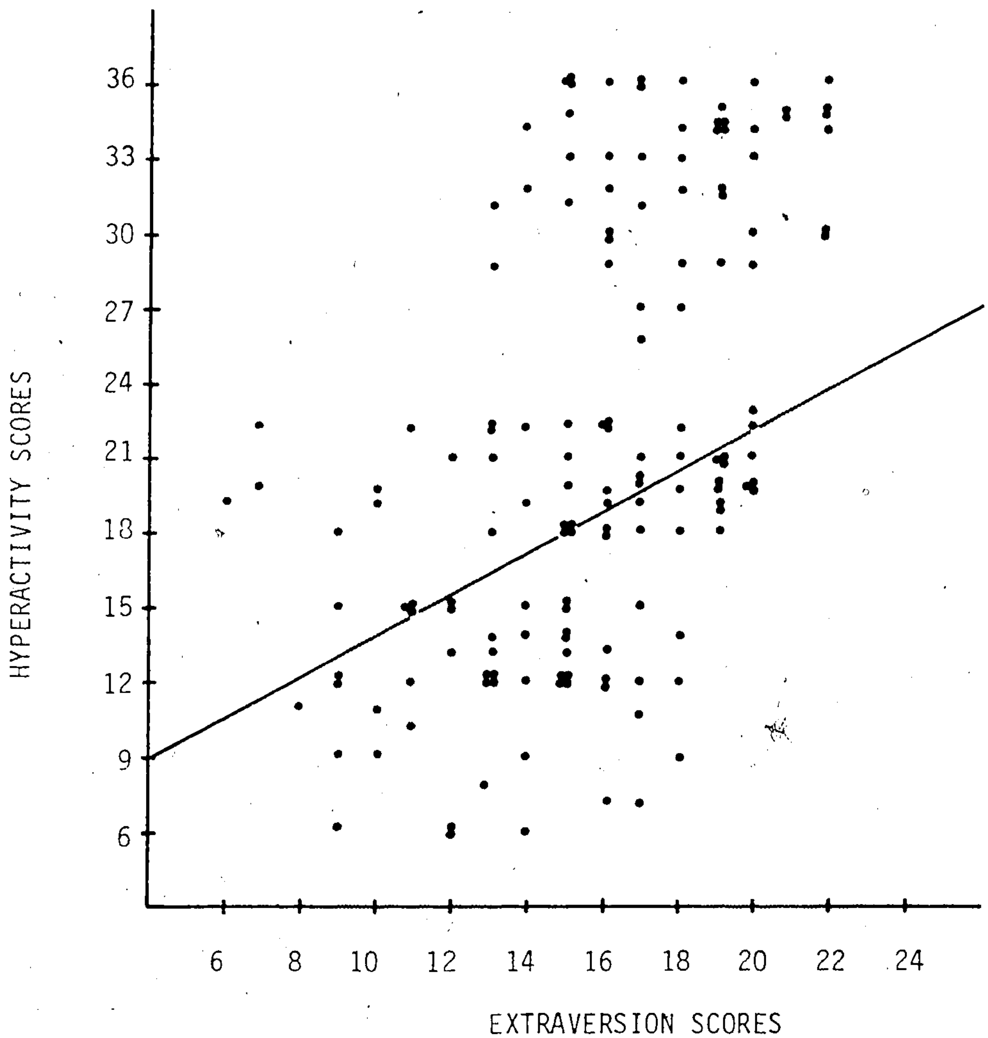

Figure 9. Linear Regression of Hyperactivity on Extraversion

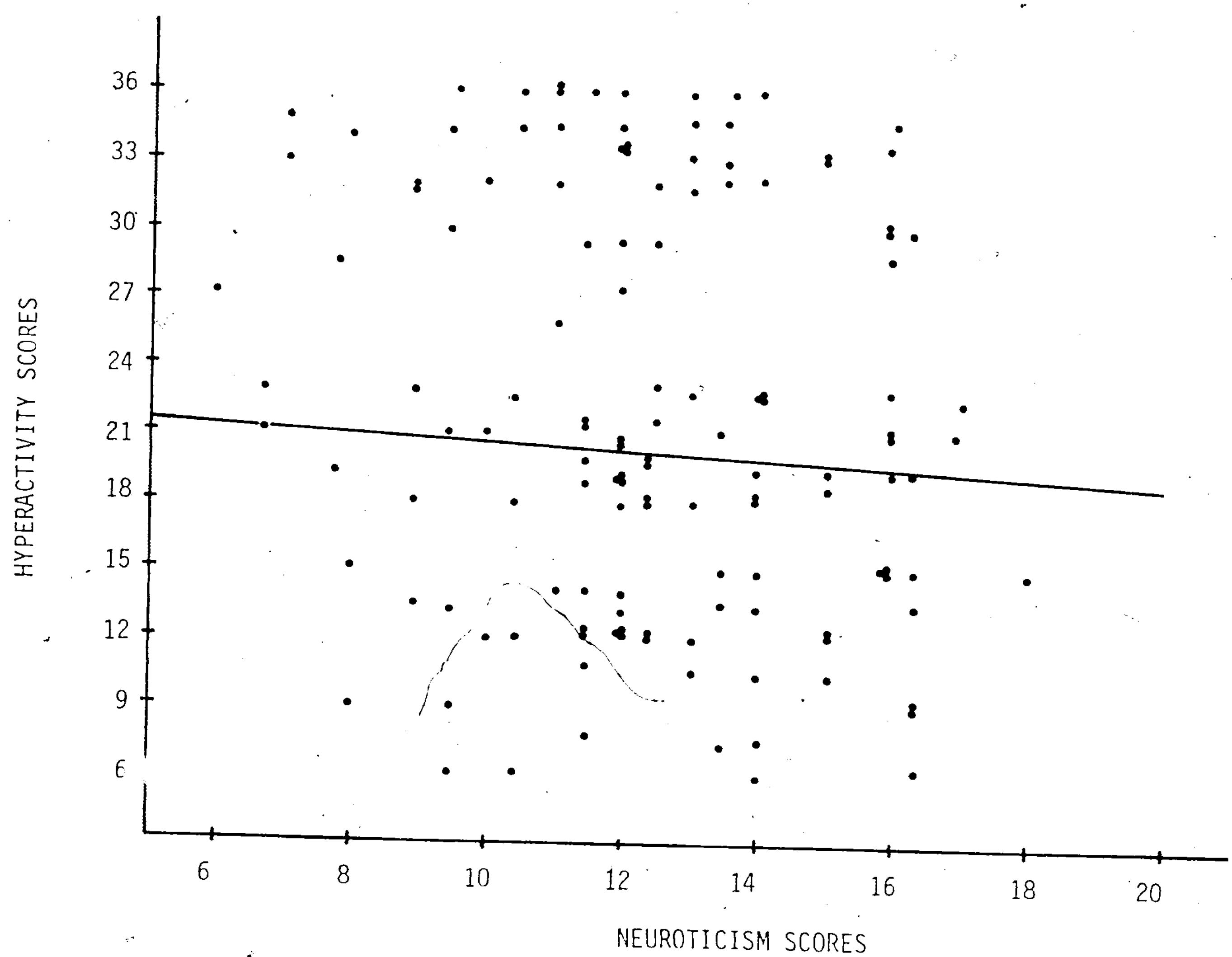

Figure 10. Linear Regression of Hyperactivity on Neuroticism

relatively linear and, compared with the graph of the relationship between HA and extraversion, there is more deviation of the scores relative to the regression line. This is consistent with findings of a low negative correlation between HA and N of -0.131. When regression lines were imposed on the scatter diagram for the relationship of HA to age and IQ the trends were similarly non-linear. Here the regression lines almost parallel the X-axis, in keeping with the low Pearson product-moment correlations obtained (Table 4). The analysis of the relative steepness of these lines follows.

The magnitude of the slopes, "b", of the regression lines calculated from the regression formula $Y = bX + a$ are summarized in Table 5. The probability values of the accompanying product-moment correlations are also included. The slope values "b" are for the relationships between HA and each of the variables of extraversion, neuroticism, lie scale, age and IQ, as expressed by the regression lines.

Table 5 shows that the greatest value for any slope, "b", is that between HA and extraversion of 0.862 which is also highly significant ($p < 0.001$). The only other slope which approaches significance is that between HA and N ($b = -0.174$; $p = 0.104$). The slopes between HA and the other variables are not significantly different from zero and are all non-significant, confirming their low product-moment correlations.

In summary, the preceeding data analysis confirms other findings that the only relationship which is consistently in line with the critical predictions of this study is that between HA and extraversion, both in terms of the extent ($r = 0.517$; $p < 0.001$) and nature ($b = 0.862$;

$p < 0.001$) of the relationships. The slope of the regression line for HA and N is negative ($b = -0.174$) and insignificant ($p = 0.104$) and is not in the predicted direction. Thus, the hypothesis that there is a positive relationship between HA and extraversion which is significant is upheld.

Table 5

Linear Regression Equations Showing "b" Values for Each of the Regression Lines of Hyperactivity Versus Age, IQ, Extraversion, Neuroticism, and Lie Scale

Variable	Left Margin	"b" Values	Significance of r
Age	5.73	+0.0195	0.4110
IQ	6.01	-0.0369	0.3750
Extraversion	2.29	+0.8623	0.0001
Neuroticism	6.52	-0.1746	0.1040
Lie Scale	5.80	+0.0350	0.4210

One-Way ANOVA

A Test of Hypothesis 1.3

The general purpose of this phase of the data analysis was to determine whether or not there were significant differences among the three hyperactive groups and the control group on the measures of extraversion, neuroticism and lie scale. Both age and IQ were also included. It was expected that the group with the highest means on the three measures would be the most hyperactive. In other words, it was expected that the HHA group would be significantly more extraverted and neurotic and have the highest lie scale score. Specifically, the purpose of this phase was a closer investigation of the previously observed relationships between HA and the personality inventory variables obtained from the product-moment correlation analysis. That analysis involved the total hyperactive sample (n = 150). This analysis sought to establish whether or not the same relationships held true for each of the hyperactive subgroups (n = 50) and for the control group as well. Data analysis in this section therefore, centered around five one-way ANOVAs. The dependent variables were extraversion, neuroticism, lie scale, age and IQ. The independent variable was groups of HA subjects and controls.

Perusal of Table 2 shows that the means and standard deviations of the entire sample (n = 150) of HA subjects on the variable of HA was 21.42. This compares with means of 11.7 20.02, and 32.44 for the low, middle, and high HA groups, respectively. The control group was not measured for HA. On the variable of extraversion, means also varied from 13.40 for the LHA group to 15.56 for the MHA and 17.92 for the HHA groups. Thus as HA increased there was a corresponding increase in extraversion (Figure 11).

When the HA group means are compared with the means of the control group on the extraversion variable, it is found that the HHA group mean of 17.94 was not much more than that of the control group, which is 17.04. It should be noted, however, that the control group mean was higher than both the low HA group (13.4) and middle HA group (15.56) on the same measure. With regards to neuroticism, the control group mean (14.92) was not much different from the low HA group

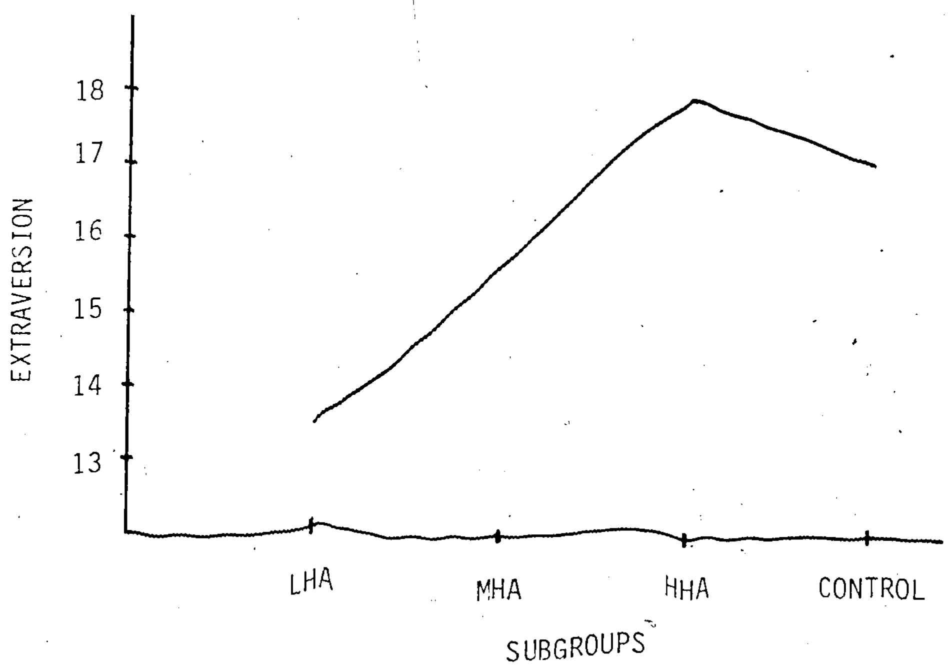

Figure 11. Mean Extraversion Scores of Three Hyperactive Groups and the Control Group

(14.78) or middle HA group (14.34), but was relatively much less than that of the HHA group (12.92). The significance of these mean differences will be analysed further using one-way ANOVA and Scheffé methods of data analysis.

A look at Table 6 which summarizes the results of the one-way ANOVAs for each of the four groups measured on each of the five variables reveals significant F's for extraversion, lie scale and IQ ($F[3/196] = 20.30, 4.95, 3.77$, respectively; $p<0.001$, $p<0.002$, $p<0.012$, respectively), but the F's for neuroticism and chronological age are insignificant ($p>0.05$).

The finding of a non-significant F was not unexpected for CA because of the application of control criteria. It was unexpected for neuroticism, however, the prediction being that the groups would vary significantly on neuroticism, with the high HA group being significantly neurotic. Consequently, another one-way ANOVA was performed without the control group (Table 7). Again, a non-significant F was obtained ($F[3/196] = 1.894$; $p<0.154$) confirming the previous finding of no statistically significant differences among HA groups on the variable of neuroticism. Similarly, when the control group was removed from the one-way ANOVA, the result was one of no significant differences among HA groups on the basis of IQ ($p>0.05$). It can be concluded on the basis of this analysis that this sample of HA subjects tended to have lower IQs and generally lied more than their normal control counterparts (see Table 2). The value of $p<0.05$ level of significance was used as the criterion for the Scheffé method of analyzing findings of significant F's.

Table 6

Summary of One-way ANOVA and Scheffe Test for Three HA Groups and the Control Group on the Personality Inventory Variables, Age, and IQ

Extraversion

ANOVA

Source	SS	MS	DF	F	P
Groups	0.58599609	195.33	3	20.34	0.000001
Error	0.18819258	9.60	196		

Probability Matrix for SCHEFFE Multiple Comparison of Means

	1	2	3	4
1. Low HA	1.0000	0.0081	0.0000	0.0000
2. Middle HA	0.0081	1.0000	0.0029	0.1307
3. High HA	0.0000	0.0029	1.0000	0.5701
4. Normal-Control	0.0000	0.1307	0.5701	1.0000

Neuroticism

ANOVA

Source	SS	MS	DF	F	P
Groups	0.11321094	37.74	3	1.71	0.1166284
Error	0.43255703	22.07	196		

Lie Scale

ANOVA

Source	SS	MS	DF	F	P
Groups	0.85134521	28.38	3	4.95	0.002466
Error	0.11228606	5.73	196		

Probability Matrix for SCHEFFE Multiple Comparison of Means

	1	2	3	4
1. Low HA	1.0000	0.2806	0.9416	0.0066
2. Middle HA	0.2806	1.0000	0.6185	0.4733
3. High HA	0.9416	0.6185	1.0000	0.3860
4. Normal-Control	0.0066	0.4733	0.0386	1.0000

Table 6 (continued)

Summary of One-way ANOVA and Scheffé Test for Three HA Groups and the Control Group on the Personality Inventory Variables, Age, and IQ

Age

ANOVA

Source	SS	MS	DF	F	P
Groups	0.3720	124.00	3	0.79	0.502330
Error	0.3087	157.51	196		

IQ

ANOVA

Source	SS	MS	DF	F	P
Groups	0.13300	443.33	3	3.77	0.012
Error	0.23074	117.72	196		

Probability Matrix for SCHEFFE Multiple Comparison of Means

	1	2	3	4
1. Low HA	1.0000	0.9695	1.0000	0.0426
2. Middle HA	0.9695	1.0000	0.9755	0.1310
3. High HA	1.0000	0.9755	1.0000	0.0467
4. Normal-Control	0.0426	0.1310	0.0467	1.0000

Table 7

Summary of One-Way ANOVA for Three HA Groups Only on Neuroticism

Source	SS	MS	DF	F	P
Groups	94.4933	47.2466	2	1.8947	0.15401
Error	3665.5000	24.9353	147		

Table 6 further reveals that when the significant F obtained was analyzed for statistically significant group differences on the measure of extraversion, statistically significant differences were found between the LHA and MHA groups ($p<0.008$), between the LHA and control groups ($p<0.001$), and between the MHA and HHA groups ($p < 0.003$). Figure 11 showed that as HA level increased there was a corresponding increase in the level of extraversion, with the lowest HA group having the lowest level of extraversion. This finding is consistent with the positive linear trend found in the correlation and regression analyses and with the salient hypothesis of this study of a positive significant linear relationship between HA and extraversion. The results are highly significant ($p<0.001$).

A significant difference was also found for lie scale score ($F[3/196] = 4.95$; $p<0.002$). When group differences are examined using the Scheffé method, it was found that there were significant differences between the control group and the HHA group ($p<0.038$) and between the control group and the LHA group ($p<0.006$). The results were shown in Table 6.

Inspection of Figure 12 shows that the group with the lowest mean lie scale score was the control group. The one with the highest lie scale score was the LHA group which also was the most neurotic. This result confirms the finding of a significant negative correlation ($r = -0.279$; $p<0.001$) between neuroticism and lie scale (see Table 4). However, the prediction that the HHA group would have a significantly higher lie scale score than the other HA groups has not been supported by this data analysis.

In summary, the results of these one-way ANOVAs confirmed the major finding of interest of a positive relationship between HA and extraversion. As group mean HA increased from low to high, there was a corresponding increase in extraversion. A significant F was found for extraversion and the Scheffé method also revealed that on this variable the individual HA groups differed significantly from each other as well (see Table 6). The relationship found between level of HA, as represented by the three groups, and neuroticism was not significant. Subsequent data analysis involved even smaller personality subgroups formed by splitting both extraversion and neuroticism at the median.

Two-Way ANOVA

A Test of Hypothesis 1.4

This phase of the data analysis sought to further investigate the relationships to hyperactivity of subgroups who were low or high in extraversion and neuroticism (Figure 13). A second objective was

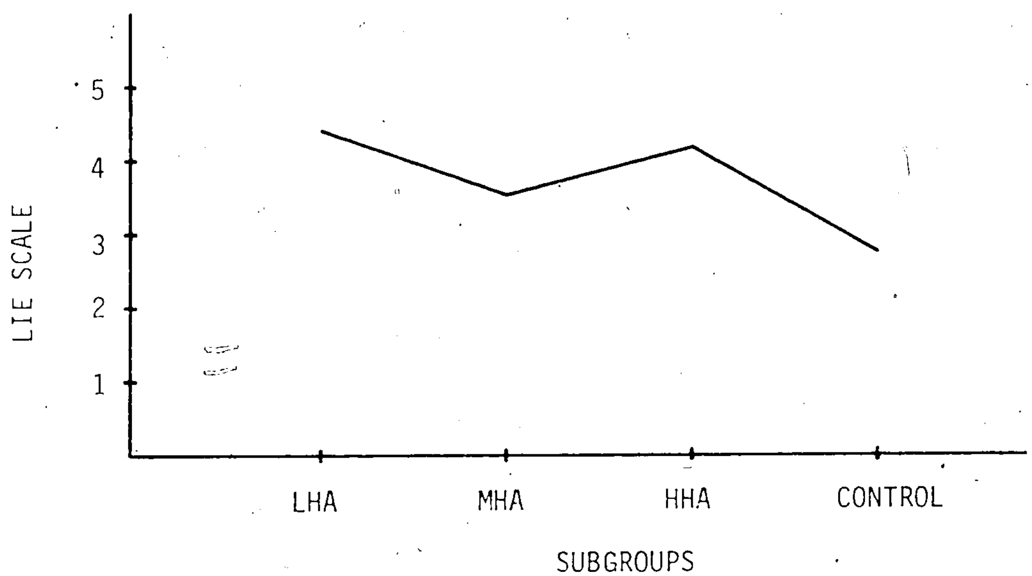

Figure 12. Mean Lie Scale Scores of Three HA Groups and the Control Group

to examine the effect of neuroticism on the hypothesized relationship between HA and E. The main hypothesis being tested in this section was, therefore, that the neurotic extravert (high neuroticism and high extraversion) would be the most hyperactive of all personality subgroups. A significant interaction between neuroticism and extraversion was also predicted.

In order to test these hypotheses a two-way analysis of variance method (ANOVA) was employed. The analysis was based on the total sample of hyperactive subjects (n = 150) split at the median of both neuroticism and extraversion, but not including scores at the median. The data thus gave four unequal personality subgroups which are categorized in Figure 13 and Table 8. Factor A (extraversion) had two levels (introversion and extroversion) and Factor B (neuroticism) had two levels (stable and neurotic). The criterion level of statistical significance used for this analysis was $p < 0.05$. The means of each of the four personality subgroups are contained in Table 8.

Table 8 indicated that, contrary to predictions, subjects who scored low on neuroticism (groups 1 and 3) have a total higher mean HA score of 22.84 than those who scored high on neuroticism (groups 2 and 4 -- mean HA score 20.71). Furthermore, subjects scoring high on extraversion (groups 3 and 4) had a total higher mean HA score of 26.07 than those subjects scoring low on E (groups 1 and 2 -- mean HA score 17.48). However, this was predicted. Low neuroticism and high extraversion scores were therefore associated with higher mean HA scores. The greatest mean discrepancy for the neuroticism scores (9.22) was between the stable groups 1 and 3. In summary, and on the basis of means analysis, no support was obtained for the prediction

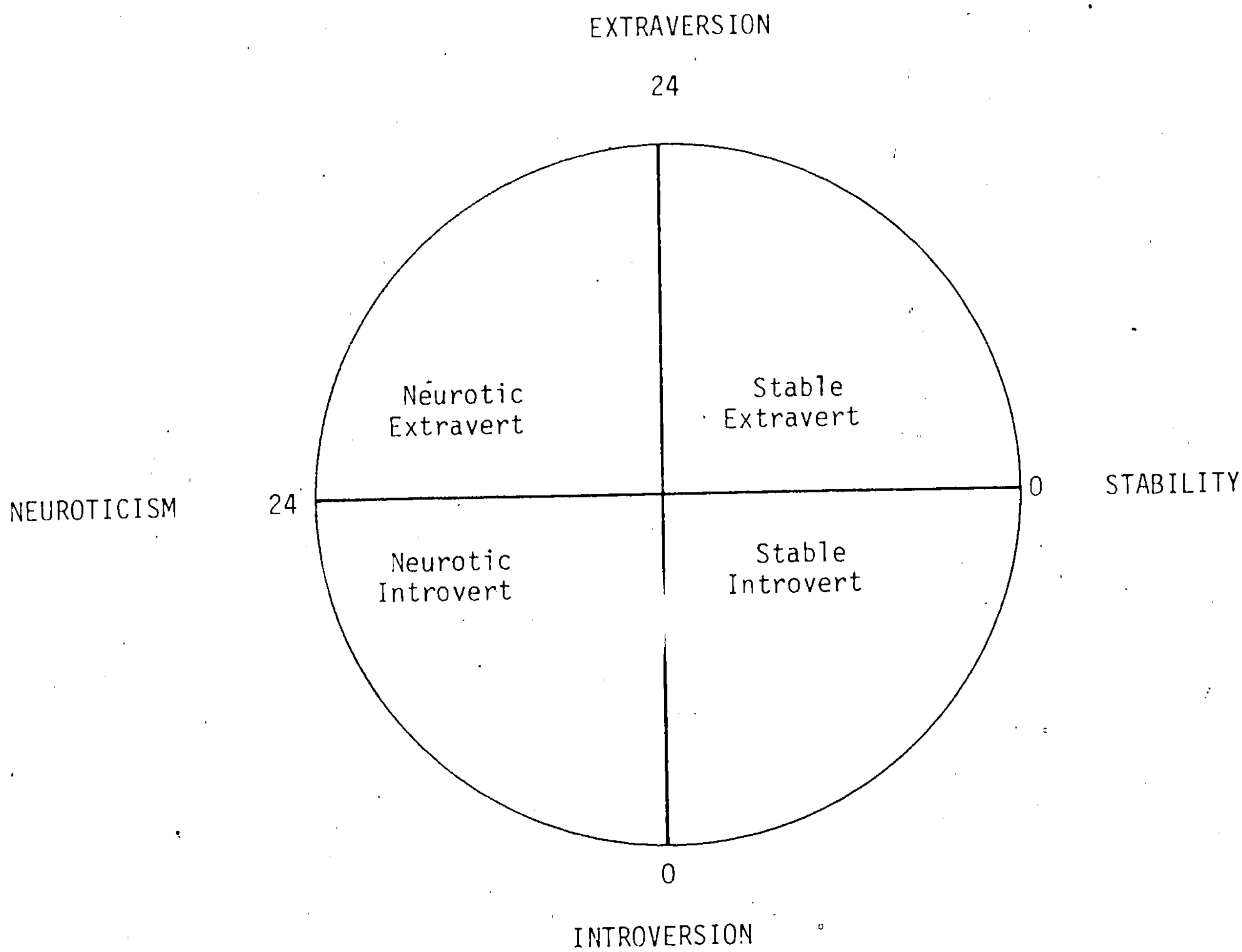

Figure 13. Personality Subgroups Based on Median Split

Table 8

Mean HA Scores on the Two Personality Scales (Extraversion and Neuroticism) for Four Personality Subgroups

	Low N - Low E (Stable Introvert) Group 1	High N - Low E (Neurotic Introvert) Group 2	Low N - High E (Stable Extravert) Group 3	High N - High E (Neurotic Extravert) Group 4
Hyperactivity				
Mean	18.23	16.73	27.45	24.69
N	30	37	33	26

that high N scores are associated with the highest HA scores.

Table 9, showing the results of the 2 x 2 means ANOVA conducted on the four personality subgroups, also reveal that the extraversion main effect was highly significant ($F[1/122] = 36.089$; $p < 0.001$). There were no significant main effects for neuroticism nor the interaction of extraversion and neuroticism, as predicted. Pairwise multiple comparisons using the Scheffé method revealed significant differences between group 1 (the stable introverted group) and group 3 (the stable extraverted group) ($p < 0.05$). Significant differences were also obtained between groups 1 and 4 (stable introvert, neurotic extravert), between groups 2 and 3 (neurotic introvert, stable extravert), and also between groups 2 and 4 (neurotic introvert, neurotic extravert) for $p < 0.05$. Mean differences between the other groups were not significant.

In terms of the personality subgroup categorization of this phase of the analysis, the results confirm the finding that the stable introvert is significantly less hyperactive than the stable extravert ($p < 0.05$) and less hyperactive than the neurotic extravert ($p < 0.05$) and that the neurotic introvert is significantly less hyperactive than the neurotic extravert ($p < 0.05$). Consequently, the hypothesis that the neurotic extravert would be the most hyperactive of all personality subgroups is not supported. On the contrary, it is the stable extraverted group which emerges as the most hyperactive of the four personality subgroups.

Table 9

Summary of Two-way ANOVA of Mean HA Scores
For Four Personality Subgroups

Source	SS	DF	MS	F-Ratio	P
A (Extraversion)	2286.793701	1	2286.793701	36.089294	0.00000
B (Neuroticism)	140.928467	1	140.928467	2.224078	0.13845
AB	12.268476	1	12.268476	0.193616	0.66070
Errors	7730.515625	122	63.364868		

Reaction Time Results

Results reported in this section are based on questions 2.3 and 2.4. Hypotheses relating to these questions are restated for the convenience of following the analyses of the data. In general, this phase of data analysis is concerned with the relationship of hyperactivity to the strength of the nervous system, a Soviet dimension of personality claimed to be "strikingly similar" to that of introversion-extraversion. Thus, data analysis was designed to investigate the relationships of HA to the strength of the nervous system using strength criteria as the basis for comparison of the groups.

Hypothesis 2.1. There are significant differences between degrees of hyperactivity (low, high) on a simple reaction time (RT) task to increasing auditory stimulus intensity, with the high hyperactive group having slower reaction times than the low hyperactive group.

Hypothesis 2.2. The greatest mean RT differences between the low and high hyperactive groups will be at the minimal intensities of the auditory stimulus, 10 db and 30 db (ANSI).

Hypothesis 2.3. Reaction time to the minimal intensities of the auditory stimulus (10 db, 30 db) will be slower for the high hyperactive group and faster for the low hyperactive group.

Hypothesis 2.4. There will be differences between the shapes of the curves relating reaction time (RT) to increasing auditory stimulus intensity. That is the curve for the high HA group will have a steeper and sharper [illegible] (slope) from the lowest to the highest auditory stimulus [illegible] when compared with the curve for the low HA group.

Reaction time data analysis to test the preceding hypotheses was based on the following procedures:

1. Analysis of mean RT scores (in milliseconds) for both HA groups.

2. Analysis of the shapes of the curves based on mean RT scores in milliseconds.

3. Transformed RT scores to Log_e and to t/t_{min}.

4. Graphical analysis based on the transformed RT scores.

5. Linear regression analysis to investigate the degree of gradient (slope).

6. Analysis of variance (ANOVA) methods for further analysis of the shapes of the curves. This analysis involved two major variables of interest, namely, Factor A (low and high HA groups) and Factor B (auditory stimulus intensity).

The Log_e transformation seemed necessary because in psychophysiological experiments such as the simple RT task used in this study, the relationship between the actual intensity of the stimulus presented and the perceived intensity, particularly at or near threshold, is not a linear one. Consequently, Log_e transformation applied to the absolute RT scores would tend to modify this discrepancy by bringing those variances closer to equality thereby reducing the disparity. The transformation also helps the data conform more closely to the assumptions of homogeneity of variance and additivity upon which further data analysis might be based.

Perusal of Table 10 shows that the extreme groups of subjects (n = 32) differed significantly from the larger hyperactive groups (n = 100) on the variables of hyperactivity ($p < 0.001$) and extraversion ($p < 0.001$). Differences on the basis of age, IQ, and neuroticism were not significant. The mean of 14.06 for extraversion was within the categorization used by Eysenck & Cookson (1969) for defining introversion (Low E, 0-15). The mean extraversion score of 17.75 (Table 10) is also consistent with the 17.85 and 17.22 used for extraverts by Entwhistle & Cunningham (1968). These statistics are all based on the JEPI. Essentially, therefore, the low hyperactive group (n = 16) falls into the category of introverts. The analyzed data could therefore be interpreted with respect to the variables of hyperactivity, introversion-extraversion, and strength of the nervous system, the relationship among these being the salient hypothesis of this study.

Perusal of Table 11 and Figure 14 shows that, as was predicted, the low and high hyperactive groups performed differently on the RT task with the high group having slower RTs than the low across

Table 10

Means and Standard Deviations of LHA and HHA Samples for Reaction Time Task

Variable	Group 1 (n = 16)		Group 2 (n = 16)	
	Mean	SD	Mean	SD
Hyperactivity	10.50	2.03	34.50	1.41
Age	128.31	14.45	125.62	12.57
IQ	91.68	10.14	94.00	12.75
Extraversion	14.06	3.11	17.75	2.56
Neuroticism	14.50	4.84	12.75	4.71
Lie Scale	3.62	2.15	4.68	2.75

Table 11

Mean Performance of LHA and HHA Subgroups on the RT Task (in milliseconds)

Subjects	Stimulus Intensity (dB = ANSI)				
	10	30	50	70	90
Low HA (n = 16)	2.59	2.01	1.97	1.79	1.64
High HA (n = 16)	3.89	2.96	2.76	2.51	2.36

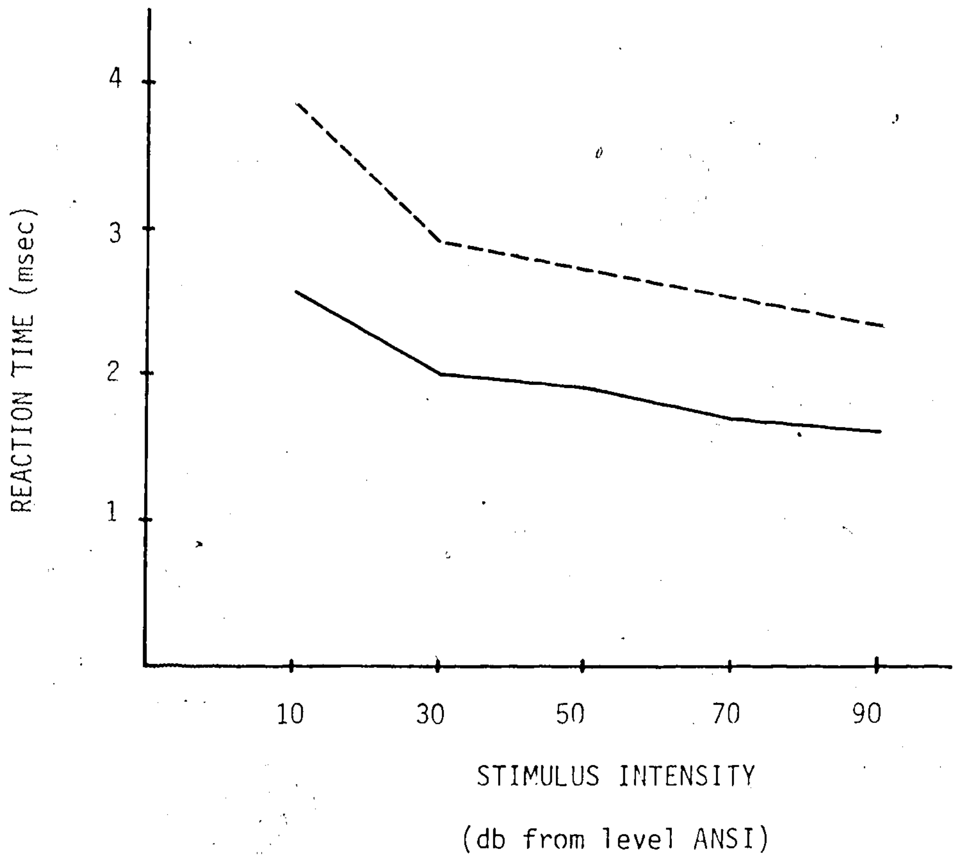

Figure 14. Mean RT as a Function of Stimulus Intensity (ANSI) for Low HA and High HA Groups

all stimulus intensities. It can also be ob ved that as stimulus intensity increased from minimal (10 db) to maximal (90 db) levels, there was a corresponding decrease in RT for both the low and high HA groups. Thus, subjects who were low in hyperactivity and low in extraversion demonstrated a clear tendency towards faster reaction time across the range of stimulus intensities.

Similarly, when RT data are transformed into mean Log_e, the relationship is again evident. That is, the high hyperactive group had slower RTs than the low hyperactive group across all stimulus intensities, and as stimulus intensity increased from low to high there was a corresponding decrease in RT. The mean Log_e RT for the low HA group across all intensities was 0.6631, compared to 1.029 for the high HA group.

Furthermore, when RT data in milliseconds are transformed into mean $t/t_{min.}$ ratios, the performance of the ow h ractive group was also relatively faster than that of the high group, [illegible].16 as compared to 5.25 (Table 12).

When the statistical significance of these mean Log_e differenc are further investigated using analysis of variance methods (Table 13), a highly significant main effect is revealed ($F[1/30] = 33.933$; $p<0.001$), indicating that there were group differences, as expected, on the variables of RT transformed into Log_e. This indication supports the previous findings of slower RTs for the high HA group compared with the low group.

In summary, on the basis of mean RT in milliseconds and mean Log_e transformed data, results support the hypothesis that there are

Table 12

Performance of LHA and HHA Subgroups on RT Task
Based on Log E and t/t min. Data

Subjects	Stimulus Intensity (db - ANSI)				
	10	30	50	70	90
LOG E					
Low Hyperactive	C.9241	0.6883	0.6591	0.5615	0.4827
High Hyperactive	1.3330	1.0660	0.9945	0.9061	0.8454
$t/t_{min.}$					
Low Hyperactive	1.611	1.241	1.215	1.102	1.000
High Hyperactive	1.705	1.277	1.188	1.087	1.000

Table 13

Summary of Two-way ANOVA With Repeated Measures for
LHA and HHA Subgroups (Log E Transformation)

Source	SS	DF	MS	F	P
Between Subjects	10.079	31			
"A" Main Effects	5.350	1	5.250	33.933	0.0000030
Subjects Within Groups	4.730	30	0.158		
Within Subjects	5.743	128			
"B" Main Effects	4.055	4	1.014	73.235	0.0000000
"A x B" Interaction	0.027	4	0.007	0.483	0.7485275
"B" x Subjects Within Groups	1.661	120	0.014		

significant differences between degrees of hyperactivity (low, high), with the high group having slower RTs across all levels of stimulus intensity than the low group. However, when the mean $t/t_{min.}$ ratios are subjected to further analysis using ANOVA methods, the mean differences previously observed were not significant.

With regard to Hypotheses 2.2 and 2.3, Table 11 and Figure 13 sho that the further the st lue departed from the maximum auditory stimulus of 90 db, the greater was the difference between the two groups in absolute mean value of RT. Whereas at 90 db the difference between the groups was only 72 milliseconds, at 10 db the difference was 95 milliseconds. These differences support Hypothesis 2.2 which predicted that the greatest mean RT difference between low and high HA groups would be at the minimal intensities of the auditory stimulus of 10 db and 30 db.

A similar relationship was obtained when the data were converted to Log_e ratios. Table 9 showed that the mean Log_e differences between the groups are greatest at the 10 db and 30 db stimulus intensity levels. The difference is 0.409 at the 10 db intensity level, and at the 90 db level it is 0.363.

ien the data were converted to $t/t_{min.}$ ratios, however, the order of difference was unexpectedly reversed beyond the 30 db level. Table 12 showed that the means for the high HA group are greater than those for the low HA group at the minimal intensity of 10 db, but not so at the higher intensities.

These findings support Hypothesis 2.3 which predicted that the reaction time to the minimal intensities of the auditory stimulus

(10 db, 30 db) would be faster in the case of the low hyperactive group and slower for the high hyperactive group. Further investigation of the relationship of strength criteria to levels of hyperactivity will be investigated using graphical analysis.

According to Nebylitsyn (1972), strength of the nervous system is reflected more in the shape of the function relating RT to increasing stimulus intensity than in absolute RT magnitude. He based his claim on the fact that the curves observed for the strong nervous system type were characterized by steeper gradients and sharper transitions from minimum to maximum stimulus intensities when compared with curves derived from subjects with a weak nervous system. These same criteria will be used in graphical analysis of raw and transformed RT data as a test of Hypothesis 2.4.

The curves for the low and high hyperactive groups are illustrated in Figures 14 and 15. These curves are based both on RT data in milliseconds and Log_e transformed RT data. For the high hyperactive group, curves are characterized by relatively steeper gradients. Also, the transitions of the high HA group from 10 db to 90 db are generally sharper, particularly between the 10 db and 30 db levels, when compared with the transitions of the low HA group. The same relationship holds when RT data were converted to $t/t_{min.}$ ratios (Figure 16). The magnitude of these curves is further analyzed using linear regression and analysis of variance methods.

The coefficient "b" of the linear regression equation $Y = a + bX$ for measuring the degree of slope of the curves was used to analyze the shapes of the curves. Only the interval between 10 db and 30 db was measured. In the above equation, "b" represents the gradient

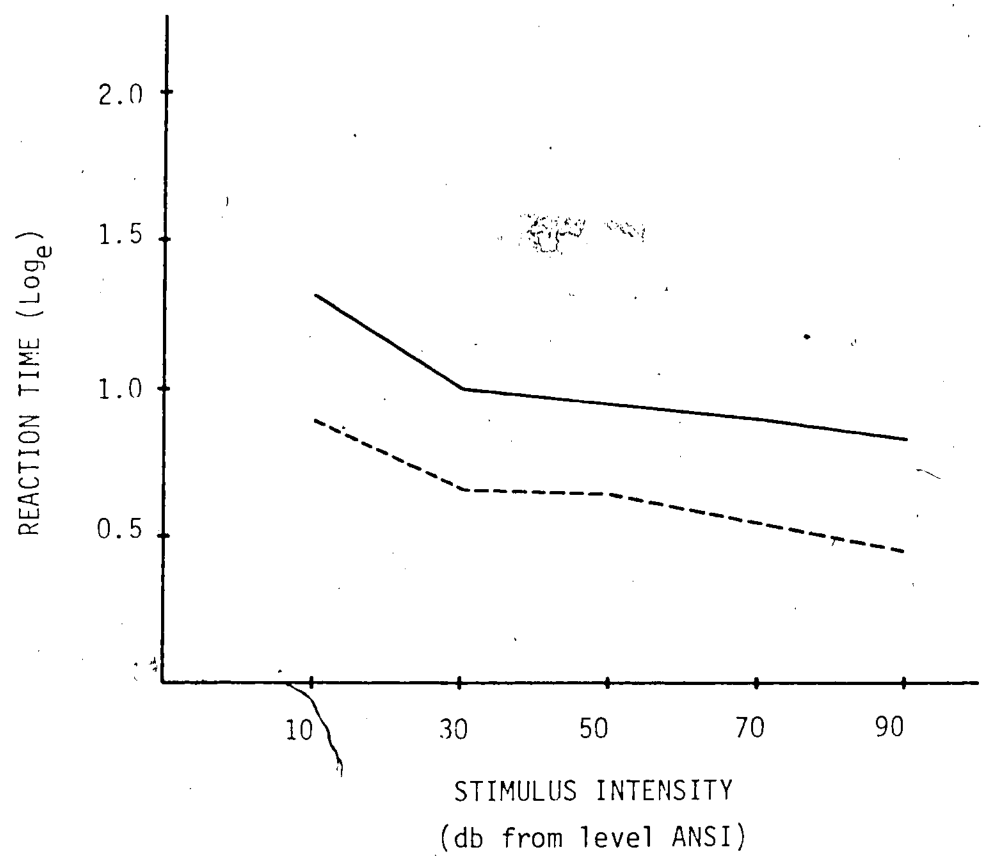

Figure 15. Mean RT (Log$_e$) Performance of LHA and HHA Subgroups as a Function of Intensity of Auditory Stimulus

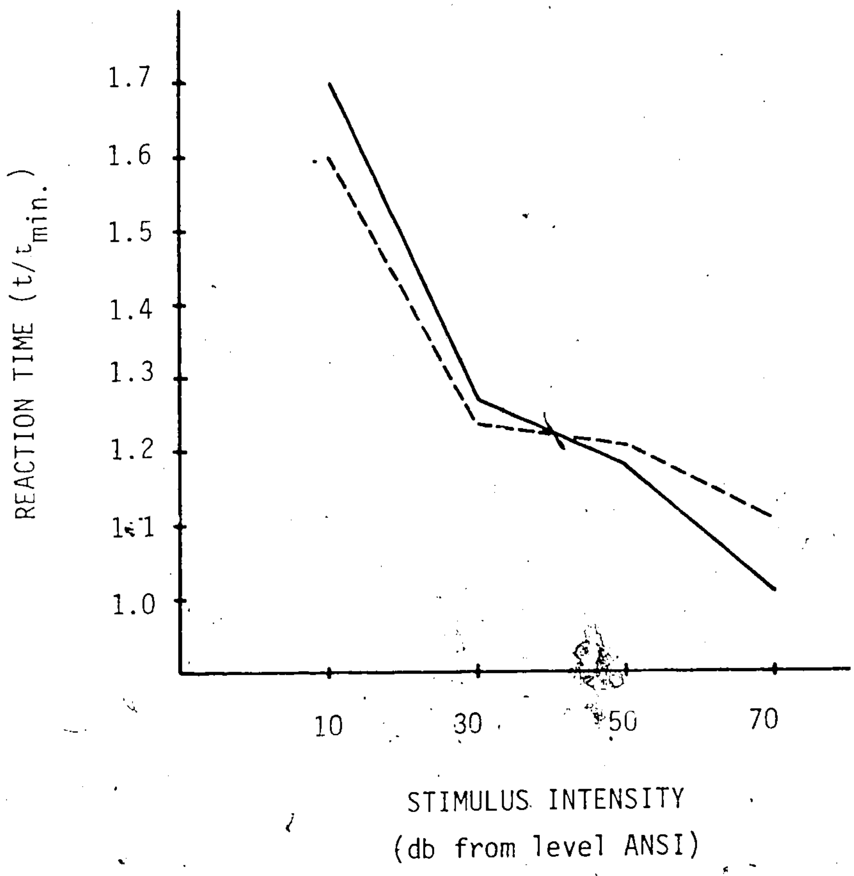

Figure 16. Mean RT ($t/t_{min.}$) Performance of LHA and HHA Subgroups as a Function of Intensity of Auditory Stimulus

or steepness of the slope while "a" indicates the point at which the regression lines cross the left margin. Examination of Table 14 and Figure 17 shows that the gradient of response, "b", is steeper for the high hyperactive group (b = -0.428) than for the low hyperactive group (b = -0.370). This negative regression slope is in accordance with research findings of Nebylitsyn (1972) and Venables & Tizard (1958) who reported a close relationship of the regression slope "b" to the level of performance at the weakest stimulus intensity.

Table 14

Linear Regression Equations Showing "a" and "b" Values for LHA and HHA Subgroups at 10 db and 30 db Levels

Variable		"b" Values	"a" Values
Low Hyperactive	RT	by.x = -0.370	ay.x = 1.981
High Hyperactive	RT	by.x = -0.428	ay.x = 2.133

On the whole, the preceding results have clearly demonstrated that the characteristics of the curves for the low and high hyperactive groups are similar to those reported by Nebylitsyn (1972) for the weak and also for the strong nervous system types. This relationship and those previously discussed have important general implications for the investigation of the relationship between hyperactivity and the strength of the nervous system. This is discussed in the following chapter.

Results of the two-way ANOVA provide further support for Hypothesis 2.4 which is concerned with the relationship of reaction

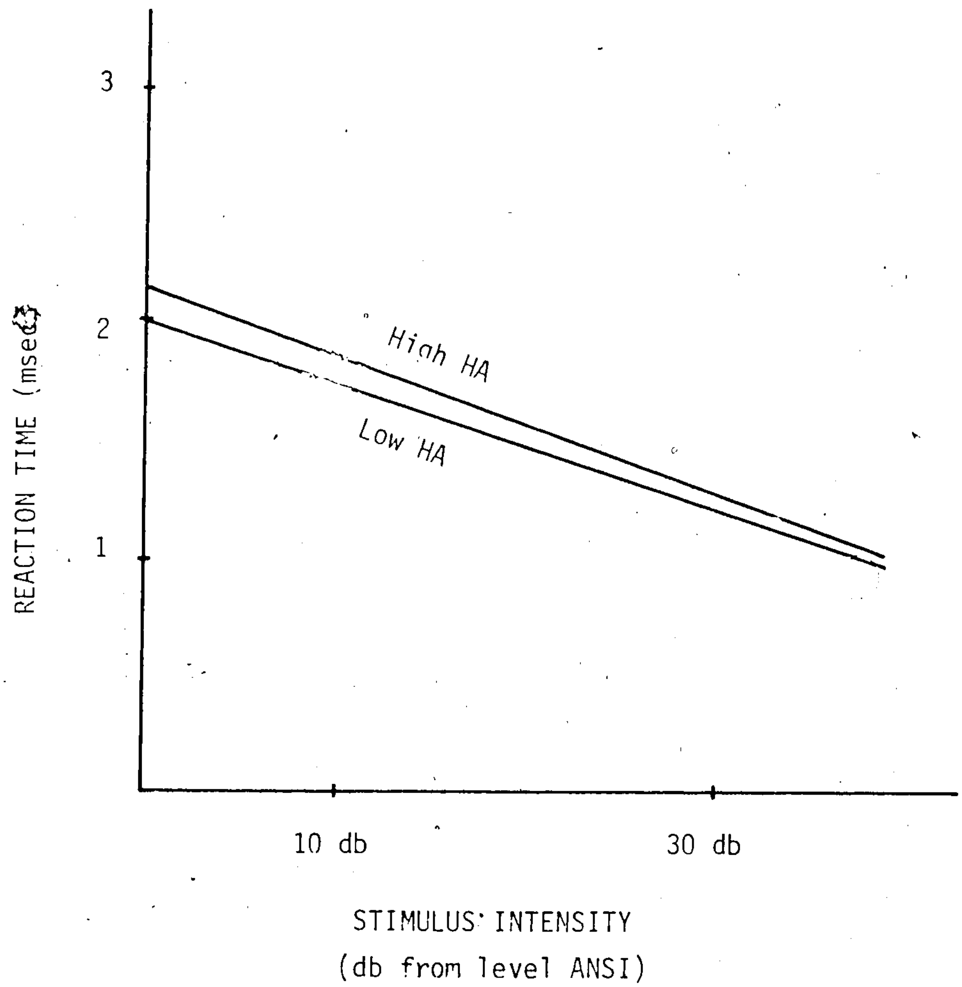

Figure 17. RT Performance of LHA and HHA Groups Based on Gradient of Slope "b" in the Equation Y' = b X + a for 10 db and 30 db Levels

time across all levels of intensity as an indication of the gradient or slope of the curves. The ANOVA performed on the Log_e transformed RT scores (Table 13) revealed a highly significant main effect due to stimulus intensity, Factor B ($F[4/128] = 73.235$; $p < 0.001$), indicating that there existed significant differences in RT as a function of changes in stimulus intensity from 10 db to 90 db. For the low HA group, mean Log_e scores varied from 0.9241 at the 10 db level to 0.4827 at the 90 db level, a difference of 0.4414. For the high HA group, mean Log_e scores varied from 1.333 at the 10 db level to 0.8454 at the 90 db level, a difference of 0.4876.

The analysis of variance performed on the $t/t_{min.}$ transformed scores (Table 15) also revealed that the main effect due to auditory stimulus intensity (Factor B) was statistically significant ($F[3/90] = 40.051$; $p < 0.001$). That is, there were significant differences in RT as a function of changes in stimulus intensity which varied for the LHA group from a high of 1.611 at the lowest intensity to 1.102 at the highest intensity. Similarly for the HHA group, RT means varied from a high of 1.705 at the 10 db level to 1.087 at the 70 db level. Both the main effect due to Factor A (HA groups) and the interaction of Factors A and B were non-significant. But these were not predicted (Table 15).

The performance of the low and high HA groups was plotted in Figure 9. This is based on $t/t_{min.}$ transformed scores. Perusal of this graph shows that in line with predictions, the high HA group was characterized by a relatively steeper gradient from minimal to maximal stimulus intensity, when compared with that for the low HA group. Although this difference is not statistically significant, the trend is in the hypothesized direction indicating that at the minimal intensities subjects with higher levels of HA respond t changes in auditory stimulation by relatively more rapid changes resulting in a curve of steeper gradient the magnitude of which was investigated by means of linear regression analysis. Results of this analysis were given in Table 14.

Table 15

Summary of Two-way ANOVA With Repeated Measures on RT of LHA and HHA Subgroups ($t/t_{min.}$ Transformation)

Source	SS	DF	MS	F	P
Between Subjects	2.757	31			
"A" Main Effects	0.016	1	0.016	0.1720	0.6815998
Subjects Within Groups	2.724	30	0.091		
Within Subjects	10.246	96			
"B" Main Effects	5.816	3	1.939	40.051	0.0000009
"AxB" Interaction	0.074	3	0.025	0.510	0.6764925
"B" x Subjects Within Groups	4.356	90	0.048		

Linear regression constants of the form Y = bX + a to cover the 10 db and 30 db stimulus intensity levels were calculated for each of the low HA and high HA groups. E ination of Table 14 showed that the slope of the gradient of response, "b", is steeper for the high HA group (b = -0.428) than for the low HA group (b = -0.370). This negative regression slope is in accord with the findings of other researchers (Venables & Tizard, 1954) which indicate a close relationship of the regression slope to level of performance at the weakest stimulus intensity level. However, it should be noted that while the trends are in the hypothesized direction, the results are not statistically significant.

In summary, the results generally support the predictions that the two groups of HA subjects differ significantly with respect to performance on the simple RT task, the high HA group having slower RTs than the low group. When the criteria of strength of the nervous system were applied to the high and low HA groups it was found that the high HA group satisfied the criteria for a strong nervous system whereas the low HA group satisfied the criteria for a weak nervous system. It should be noted that the high HA group was essentially extraverted and therefore similar to that of a strong nervous system type. Thus, the specific relationship between HA and the dimensions of introversion-extraversion and strength of the nervous system has been confirmed. Similarly, the more general hypothesis of this investigation, that HA is related to personality, has been confirmed. Findings for the high HA group can therefore be interpreted with respect to low cortical arousal levels, high sensory thresholds and lower sensitivity to sensory stimulation. The general implications of the theoretical, practical, and research relationships of HA to the two personality dimensions in particular and to personality in general are discussed in the following chapter.

CHAPTER VIII

DISCUSSION OF RESULTS

Introduction

The main purpose of this study was to investigate the relationship between hyperactivity and personality with particular reference to Eysenck's (1967) Theory of Personality and to the Theory of Strength of the Nervous System (Pavlov, 1955; Teplov, 1956; Nebylitsyn, 1966, 1957, 1959). The central hypothesis of the study was that hyperactivity is related to personality, and this was confirmed by results obtained through statistical analysis. The relationship between hyperactivity and personality was investigated through two related dimensions of personality. When the relationships between hyperactivity and variables of the JEPI were examined through different statistical procedures, a consistently positive and statistically significant relationship was found between hyperactivity and extraversion (the hypothesis of interest), but the hypothesized relationship between hyperactivity, neuroticism, and lie scale was non-significant.

When the relationship between hyperactivity and the strength of the nervous system dimension was investigated through the use of a simple reaction time task to increasing auditory stimulus intensity, it was found that hyperactivity was related to the strong nervous system as predicted. Generally, the high hyperactive group satisfied the criteria specified by Nebylitsyn for a strong nervous system. In summary, it was found that hyperactivity is related to the two personality dimensions as predicted.

It is within this framework of these two personality dimensions that the following discussion of the results is summarized and the implications for research, theory and practice discussed.

Extraversion - Introversion

The first stage of this study was concerned with the investigation of the relationship between hyperactivity, as defined by Davids' Rating Scale of Hyperactivity, and variables of the Jur r Eysenck Personality Inventory. Two hundred experimental subjec provided the data base for statistical analysis. The mai jestion to be answered was whether hyperactivity was positively and statistically related to extraversion, neuroticism, and lie scale. The critical relationship of interest was, however, the relationship between hyperactivity and extraversion, and the main statistical method used was correlation. Four hypotheses were formulated (1.1, 1.2, 1.3, 1.4).

Hypotheses 1.1 and 1.2 predicted a positive and significant relationship between hyperactivity and each of the inventory variables of extraversion, neuroticism, and lie scale. Pearson product-moment correlation, linear regression, and graphical analysis methods were used to test these hypotheses. The entire sample of 200 boys was involved. Hypothesis 1.3 posited that there were significant mean differences among the three hyperactive subgroups and the control group on measures of extraversion, neuroticism, and lie scale. This was tested through the use of one-way analysis of variance methods. Hypothesis 1.4 was concerned with the interaction of neuroticism and extraversion and its relationship with hyperactivity. The purpose of the analysis was to examine the extent to which smaller personality subgroups defined on extraversion and neuroticism were related to hyperactivity. It was predicted that the high hyperactive group would be significantly more extraverted, more neurotic, and have higher lie scale scores than the other two hyperactive groups or the control group. A two-way analysis of variance method was used to test this hypothesis. The main findings are discussed as follows:

Hypothesis 1.1. A statistically significant positive linear relationship was found between hyperactivity and extraversion, confirming the hypothesis. There are far reaching implications for this finding of a positive relationship between hyperactivity and Eysenck's theory of extraversion since this theory has been the subject of extensive research and some of the findings of this study may have relevance to hyperactivity theory, research and practice.

Hypothesis 1.2. The hypothesis of a positively linear relationship between hyperactivity and neuroticism and lie scale was not confirmed by the data. This ruled out neuroticism as a confounding variable in the investigation of the relationship between hyperactivity and extraversion. Thus the one relationship which is consistently in line with the critical predictions of this study is that between hyperactivity and extraversion. As was previously mentioned, the interrelationships found for the JEPI variables in this study are accordant with previous research findings and also with normative data from the JEPI manual. It might be possible to obtain an even higher correlation than that found in this study ($r = +0.517$) if the sample consisted of an older age group, since measurement of personality is generally more reliable beyond 10 years of age. The correlation coefficient found here may alsy reflect the restriction in the range of the extraversion variable reflected in the mean for extraversion of the total sample of

15.56. It may also reflect the difficulty which the Edmonton sample had with understanding certain items on the JEPI. Terms such as "gay", "lively", "happy-go-lucky", and "playing pranks", which could have increased the introversion score, do not seem to be frequently used by children in the Edmonton area.

<u>Hypothesis 1.3</u>. The hypothesis that significant mean differences existed among the three hyperactive groups and the control group on measures of extraversion, neuroticism, and lie scale, was confirmed for extraversion and lie scale but not for neuroticism. This adds further confirmation to the previous finding that neuroticism was not a confounding variable in the investigation of the relationship between hyperactivity and extraversion. The significant F found for extraversion indicated that there were group differences on this variable. When this indication was further analyzed u[illegible]he Scheffé method, it was found that extraversion increased with [illegible]ponding increase in hyperactivity, thus confirming the positive linear relationship previously found. With regards to the lie scale, it was found that the group with the lowest mean lie scale score was the control group whereas the group with the highest mean lie scale score was the low hyperactive group. It may be noted that when the hyperactive groups were compared with the control group on the measure of extraversion, the high hyperactive group was found to be more extraverted than the control group, but the difference was not significant.

<u>Hypothesis 1.4</u>. The hypothesis that the high hyperactive group would have significantly higher mean extraverted, neurotic, and lie scale scores than each of the other two hyperactive groups or the control group was confirmed for extraversion only. Thus the

prediction that the high hyperactive group would be the most neurotic and have significantly higher lie scale scores compared with the other groups, was not supported by the data anlaysis.

When smaller personality subgroups defined on extraversion and neuroticism were further investigated, the analysis of variance revealed that the stable introvert was significantly less hyperactive than the stable extravert. It was also found that the neurotic introvert was significantly less hyperactive than the neurotic extravert. Consequently, the prediction that the neurotic extravert would be the most hyperactive of all personality subgroups was not confirmed. On the contrary, it was the stable extraverted group which emerged as the most hyperactive of the four personality types.

Strength of the Nervous System

Hypotheses 2.1, 2.2, 2.3, and 2.4 were concerned with strength of the nervous system. Discussion of the results obtained is as follows:

Hypothesis 2.1. This hypothesis predicted that significant differences would exist between degrees of hyperactivity on a simple reaction time task to increasing auditory stimulus intensity, the high hyperactive group having slower reaction times than the low hyperactive group. This hypothesis was confirmed on the basis of raw reaction time scores in milliseconds and $\log_e$ transformed scores. It was found that the high hyperactive group had slower reaction times across all levels of stimulus intensity as compared with the low hyperactive group. These results are in general agreement with research findings which claim that the hyperactive child is slower and more variable when compared with normal children (Dykman et al., 1972; Firestone & Douglas, 1975; Porges et al., 1975 ; Grunewald-Zuberbier, 1975; Cohen, 1970; Cohen, Douglas & Morgenstern, 1971; Stevens, Sachdev & Millstein, 1968). However, these findings were based on Choice and Delayed Reaction Time tasks and not on the simple reaction time task to increasing auditory stimulation as used in this study. By way of interest it should be noted that Choice and Delayed Reaction Time has been used as a measure of attention span in research with hyperactive children. Barkley (1977) reviewed the literature on stimulant drugs and hyperactivity and reported that in virtually every stimulant drug study reaction time was significantly reduced by stimulant drugs (Barkley, Ullman & Brown, 1976; Cohen, Douglas & Morgenstern, 1971; Conners et al., 196[illegible]; [illegible]ers & R thschild, 1968; Sprague et al., 1970; Spring et al., 1973; Sroufe et al., 1973; Sykes, Douglas & Morgenstern, 1972; Zahn et al., 1975) or at least showed trends in that direction (Porges et al., 1975). These shifts in reaction time as a function of central nervous system stimulation are later interpreted by this writer with reference to shifts in the level of cortical arousal, the physiological basis of the introversion-extraversion theory, and the theory of strength of the nervous system as they relate to hyperactivity.

The [illegible]pose of hypotheses 2.2, 2.3 and 2.4 was to measure Pavlovian Strength of the Nervous System following the method used by Nebylitsyn (1972). Nebylitsyn specified certain indices of strength and these indices have been incorporated into the above hypotheses. He also suggested a simple reaction time method which can be used as an indirect estimate of strength of the nervous system provided that absolute reaction time scores were transformed to $t/t_{min.}$ ratios as the basis for analysis. However, for the purpose of comparison a second transformation, $\log_e$ was used as well. Results of the reaction time analysis will now be discussed with reference to three strength criteria as specified by Nebylitsyn.

(1) Reaction time should decrease as the intensity of the stimulus increases, and there should be differences in responses between the strong and weak nervous systems over the range of stimulus intensity. The well-known fact that reaction time to a stimulus decreases as the intensity of the stimulus increases (Woodworth & Schlosberg, 1954) is regarded by Nebylitsyn as the operation of the law of strength, the decrease in reaction time being interpreted as an increase in response magnitude. This was confirmed by the experiment in both transformations.

(2) Reaction time should be shorter for subjects with a weak nervous system due to their higher cortical arousal, and longer for subjects with a strong nervous system because of their lower cortical arousal. This was partly confirmed in that with the $\log_e$ transformation significant differences were shown to exist between the groups, the high hyperactive group having longer reaction times than the low hyperactive group. However, although similar differences between the groups were evident with the $t/t_{min.}$ transformation, these differences were not statistically significant. Thus, the nature of the transformation used was a factor in whether or not group differences found proved to be significant. This disparity may be due to the fact that when the $t/t_{min.}$ ratio transformation was applied to the data from children, the magnitude of the ratios for the highest to each of the other intensities for each group was not sufficiently significant

to be reflected in significant group differences. This reaction time methods has not previously been used with children and it is possible that the $\log_e$ transformation is more effective for children's reaction time data than the $t/t_{min.}$ transformation. The lack of statistical significance obtained when the $t/t_{min.}$ transformation was used may also be a reflection of the method used to define the groups, that is, the strength criteria applied. In this study the index of strength was introversion-extraversion. A few other studies have used this index and have obtained discouragingly deceptive and contradictory results (Mangan, 1967; Mangan & Farmer, 1967; Zharov & Yermolayeva-Tomina, 1972). They all failed to confirm the correspondence between introversion-extraversion and strength of the nervous system. It should also be noted that the reaction time method used here is only an indirect index of nervous system strength. According to Nebylitsyn (1972), the direct methods used as well validated and yield direct indices of the strength of the nervous system. These include the "induction" and "extinction with reinforcement" methods. The more feasible of the two methods is the EEG variant of extinction with reinforcement. These direct methods are much more sensitive than the reaction time method used here. Frigon (1976) used a direct method, the EEG variant of extinction with reinforcement, to test the linkage between extraversion-introversion and strength of the nervous system and confirmed the hypothesis that strength of the nervous system was related to the dimension of introversion-extraversion.

(3) According to Nebylitsyn, a critical index of strength is the shape of the curve relating reaction time to stimulus intensity. He claimed that the shape of the curve was crucial in differentiating

strong from weak nervous systems than differences in the magnitude of the latencies found, particularly when these curves were based on $t/t_{min.}$ ratios. Curves for individuals with a strong nervous system had steeper gradients and sharper transitions from minimal to maximal stimulus intensity. The magnitudes of the slopes could also be derived through linear regression and analysis of variance methods. The crucial segment of the curve in the analysis must be at the lowest stimulus intensities. It is at these intensities that differences in sensitivity would be the most obvious.

When these criteria are applied to this study, the relationships are partly confirmed. It was found that the curves for the high hyperactive group were generally steeper across all intensities than those for the low hyperactive group. At the minimal stimulus intensities, the discrepancy between the groups on the raw reaction time data and $\log_e$ transformed data were greatest, with the high hyperactive group having significantly slower reaction times than the low group. However, when these same relationships were compared with those of the $t/t_{min.}$ transformed data, the group differences were found to be in the same direction but were not statistically significant. The linear regression analysis and the analysis of variance methods confirmed the differences obtained. The hypotheses related to this discussion are summarized as follows:

<u>Hypothesis 2.1</u>. This hypothesis predicted that significant differences existed between degrees of hyperactivity on a simple reaction time task to increasing auditory stimulus intensity, with the hyperactive group having slower reaction times than the low hyperactive group. This hypothesis was confirmed for the $\log_e$ transformed

data.

Hypothesis 2.2. The prediction here was that the greatest mean reaction time differences between the low and high hyperactive groups would be at the minimal intensities of the auditory stimulus, that is, at 10 dB and 30 dB. This hypothesis was confirmed.

Hypothesis 2.3. The prediction here was that reaction time to the minimal intensities of the auditory stimulus would be slower for the high hyperactive group and faster for the low hyperactive group. This was partially confirmed. For the $\log_e$ transformation, differences between groups at the minimal stimulus intensities were significant and therefore provided confirmation of the hypothesis. For the $t/t_{min.}$ transformation, findings were not statistically significant.

Hypothesis 2.4. This hypothesis predicted differences between the shapes of the curves relating reaction time to increasing auditory stimulus intensity. The prediction was that the curve for the high hyperactive group would have a steeper and sharper gradient from the lowest to the highest auditory stimulus intensity when compared with the curve for the low hyperactive group. This hypothesis was partially confirmed. Graphically, the results meet Nebylitsyn's criteria. However, on the basis of $t/t_{min.}$ transformation, differences obtained were not significant.

Theoretical and Research Implications

The hypothesis that hyperactivity is related to personality was confirmed through two related theories of personality with a common hypothesized physiological substrate. The burden of this segment of the chapter is to examine and discuss the implications of this finding for theory, research and practice. These theories will throw a consid-

considerable amount of light on an understanding of the hyperactive child and offer a challenging opportunity for theorizing and research and practice on hyperactivity. The quantity of empirical research arising from Eysenck's theory of personality is voluminous, so that only the salient implications can be discussed here. As previously stated, the attempt to investigate the relationship between hyperactivity and personality and to systematically discuss the findings within a theory of personality has not been previously made. Consequently, any of the studies investigating extraversion-introversion or strength of the nervous system may be replicated with groups of hyperactive children. The potential for testing a number of hypotheses from Eysenck's theory with hyperactive subjects is one of the main research implications of this study. The implications are discussed under two subheadings: (1) physiological and psychological; (2) practical.

Physiological and Psychological Implications

One of the main results of this study has been the finding that the performance of the high hyperactive group on the RT task was slower across stimulus intensities, particularly at the lowest stimulus intensity, as predicted. This finding was interpreted with respect to Eysenck's theory of personality and the theory of strength of the nervous system. The critical interpretation based on these two theories is that hyperactivity may be related to chronically low cortical arousal levels and low sensitivity to sensory stimulation. Research evidence in support of this contention has already been cited (Satterfield & Dawson, 1971; Satterfield et al., 1972; Satterfield et al., 1974; Grunewald-Zuberbier et al., 1975; Williams, 1976). Since the popular hypothesis about the cortical levels and sensitivity to sensory stimulation of hyperactive children is one of high levels of cortical arousal and high sensitivity to sensory stimulation, the interpretation placed on the findings of this study are important for a better understanding of the hyperactive child. It is within this framework that some of the behavioral characteristics and the effect of stimulant medication on hyperactive children can be rationalized. Current management and practice procedures are generally based on the assumption that the hyperactive child is oversensitive to sensory stimulation, and that environmental conditions should be such as to modify sensory stimulation. The main implications of this study are therefore contrary to such assumptions and indicate that the hyperactive child may need more intense and more varied stimulation. This interpretation has considerable practical implications.

Stimulant drugs have been used quite successfully in the management of hyperactive children, but the reasons for their success have varied widely. Because of the assumption that hyperactive children were overstimulated, the effect of a stimulant drug in modifying behavioral activity has generally been regarded as paradoxical. Even within the context of the low cortical arousal hypothesis, the explanations of the effect of stimulant drugs on the hyperactive child have varied depending on the theoretical basis of the explanation. Williams (75), using Luria's theory, interpreted the low cortical arousal found for hyperactive children in his study as a lack of, and poor, central nervous system inhibition. Similarly, Satterfield's interpretation, based on his own hypothesis, was one of the insufficient central nervous system inhibition. Both Williams and Satterfield claimed that central nervous system arousal and central nervous system inhibition vary together and that the hyperactive child has a lack of central nervous system inhibition and a lower level of cortical arousal. However these studies were not directly concerned with personality differences. The main drug implication of this study is based on Eysenck's theory which claims that stimulant drugs tend to decrease cortical inhibition and increase cortical excitation and that personality differences are to be considered in predicting the effect of stimulant or depressant drugs. For the hyperactive child, the implication of these findings is that the effect of stimulant drugs is not paradoxical, it simply results in the raising of his chronically low cortical arousal level and the lowering of absolute sensory thresholds. The result of such an action is manifested behaviorally as inhibition of activity and a general efficiency in performance on many tasks. With regards to Eysenck's cortical inhibition theory which is based on Pavlov's research, the hyperactive child would, as a result of lower cortical arousal levels, be subject to greater cortical inhibition. Das (1973) also suggested that hyperactive children may be chronically cortically inhibited. Stimulant medication, therefore, reduces cortical inhibition, and so raises the arousal level. This interpretation seems consistent with neurological data on the function of the Ascending Reticular Activating System as it mediates sensory stimulation.

Another implication arising from the interpretation of the finding that hyperactive children may be characterized by chronically low arousal levels, is that it provides a framework with which one can interpret and rationalize some of the behavioral characteristics of the hyperactive child, particularly the relatively higher activity level. This could lead to a better understanding of the hyperactive child. Using Eysenck's theory again as the basis of this hypothesis, it may be possible to explain some hyperactive behaviors in terms of individual differences in the need for sensory stimulation. The high level of behavioral activity which is characteristic of hyperactive children may be indicative of their attempt to compensate for their chronically low states of cortical arousal. It may be that hyperactivity is secondary to a condition of low arousal and may represent the -aroused child's attempt to increase proprioceptive and exteroceptive sensory input. It may be a coping device therefore to increase abnormally low cortical arousal. Similar interpretations have been made for the extravert's behavioral characteristics. Various terms such as "stimulation seeking" and "stimulation hungry" have been ascribed to the extravert's behavior; this also may have relevance for the hyperactive syndrome. The behavioral syndrome of hyperactivity may be a response to low cortical arousal levels; individuals who are concerned with the management and education of the hyperactive child should be aware of this. Practical implications arising from such a possibility are discussed in the next section.

Although no direct measures were taken of sensory threshold differences between the high and low hyperactive groups, performance on the RT task has generally been interpreted as an indication of individual differences in sensory thresholds. Thus the high HA group who had slower RT across all stimulus intensities and particularly at the lowest stimulus intensity, is regarded as having a higher threshold and, consequently, is less sensitive to sensory stimulation.

Compared with normal children, hyperactive children would require more, rather than less, sensory stimulation for effective performance. If this assumption is correct, then the implications for practice would be to intensify the relevant stimuli while reducing random stimulation.

Practical Implications

The main practical implications of the results of this study arise from the finding that hyperactivity is related to personality and support the findings of Thomas, Chess & Birch (1968), and Chess (1960) who had conducted a longitudinal study on the relationship of hyperactivity to temperament, classifying the children according to temperamental types and suggesting teaching and management approaches that gave consideration to children's innate characteristics. However, what is different about the findings of the present study is that hyperactivity has been shown to be related to two personality dimensions with a common physiological underpinning, the implications of which have relevance to the management and education of the hyperactive child.

Personality as a variable must be considered in attempting to understand, manage and teach the hyperactive child at home and at school. This position supports Chess's findings which stressed that a child makes a positive adaptation to school and learns optimally when the demands made on him are consonant with his organismic capacities. Conversely, learning is impaired when the demands on the child are dissonant and become a source of stress. Knowledge of a child's personality should therefore guide parents and teachers in their interaction with the child. Personality research findings have already demonstrated the usefulness of adding personality and motivational measures to intelligence measures in research. These measures may well account for 75% of the variance in academic achievement. A better understanding of the hyperactive child with reference to personality may also provide a better framework for reacting to his behavior. Too often as a result of lack of this consideration is the hyperactive child categorized and treated as a conduct problem at home and at school.

One of the critical findings of this study concerns the interpretation of hyperactive children's performance on the reaction time task in terms of low cortical arousal, high sensory thresholds and hence, low sensitivity to sensory stimulation. Any attempt to improve the hyperactive child's efficient functioning in any environment must take these variables into consideration. Efficient management and education of such children should be involved in raising low cortical arousal levels, lowering high sensory thresholds and ensuring that sensory inputs are adequately presented. In terms of Eysenck's theory, it seems to involve introverting hyperactive children in order to improve the efficiency of their functioning. Environments and interventions may be either inhibitory or facilitatory depending on whether or not they punish hyperactive children by reducing their already chronically low arousal levels or reward them with interventions which raise their low cortical arousal levels.

Drug research points to general implications about the need for considering personality as a variable in that the average drug effect observed in a group of people will clearly be a function of individual characteristics within the group as well as the expected pharmacological action of the drug itself. One should therefore heed Claridge's (1970) warning that if a personality type dominated the group, the drug effect might be quite the opposite from that observed in a sample dominated by the opposite personality type. This need for consideration of the personality characteristics so well illustrated in drug research has relevance for cognitive, academic and other behavioral areas as well. In a specific way, the drug research relating to Eysenck's theory can be used to explain that the effect of stimulant drugs on hyperactivity is not paradoxical but rather the normal energizing of a cortically low aroused individual.

Low frequency, low intensity stimulus conditions involving long duration of work may be difficult for the hyperactive child because of his chronically low cortical arousal level. Similarly, monotonous and repetitive tasks involving minimal opportunities for movement may be punitive, since these may reduce the already low arousal level and lead to greater behavioral activity which may be incompatible with a given situation. Conversely, a knowledge of stimulus conditions that may raise cortical arousal levels would be invaluable for the management and teaching of the hyperactive child.

The stimulus properties discussed by Berlyne (1971) which have the effect of raising cortical arousal may have some relevance to the practical implications of this study. Berlyne described these properties as psychophysical and collative and these may have a place in managing and teaching the hyperactive child. For instance concern with psychophysical properties in practice means that hyperactive children may require more sounds of high and low pitch and intensity than intermediate ones. These may have a direct effect on the attentional deficits of hyperactive children. The concern about stimulus presentation is therefore paramount in teaching the hyperactive child and improving his attentional deficit. Various modalities may be utilized simultaneously in teaching the hyperactive child, thereby increasing the total level of sensory stimulation. The use of visual and auditory teaching materials give hyperactive children the opportunity to select the desired intensity and frequency levels that are most comfortable. Compared with normal children it has been found that hyperactive children tend to seek higher levels of intensity and frequency for optimal performances.

The collative properties discussed by Berlyne also have a place in programming for the hyperactive child, although they are not a direct implication of this study. Collative properties also tend to raise arousal levels and to demand attention, and they include such elements as novelty, surprisingness complexity, ambiguity and puzzlingness. There are research findings which show that hyperactive children and extraverts prefer complex stimuli.

In considering the environment for managing the hyperactive child classrooms with hyperactive children should reflect concern for some of the stimulus properties previously discussed. However, the entire classroom for the hyperactive child should not be stimulating. There should be opportunities for some hyperactive children with severe attentional deficits to work in quiet areas in the classroom, in order to permit the training of focus and span of attention. In other words, while individual differences in personality must be considered in planning classroom environments for hyperactive children, the specific deficits of these children must be catered for as well.

The practical implication arising out of the interpretation of the hyperactive child's behavior as one of stimulation seeking because of chronically low cortical arousal levels, points to the needs for individuals concerned with the managing and teaching of the hyperactive child to consider affording such children frequent opportunities to satisfy the stimulation seeking urge. For instance, in a classroom, satisfying such needs may involve having the hyperactive child distribute books or other materials, clean the chalkboard and run errands. Parents should be aware that long distance travelling in a limited space in a motor vehicle without opportunities for movement and action may be more difficult for the hyperactive child. Teachers should plan timetables allowing for shorter work periods, frequent changes, and frequent rest pauses. Timetables should be so arranged to permit subjects which demand long periods of sustained concentration and quiet to be followed by those which involve some physical activity and movement.

It has been well documented that reinforcement raises cortical arousal levels. It is not strange therefore that the use of Behavior Modification techniques with hyperactive children has been generally successful. In fact, behavior modification in conjunction with drug therapy is currently the management procedure of choice for hyperactive children. However, personality factors may set limits to the success of many of these behavior change programs and personality factors should not be ignored in the implementation of them. Reinforcement may be too strong or too weak for certain hyperactive children. In short, individual differences among hyperactive children need to be considered both in teaching them and managing their behavior.

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APPENDICES

APPENDIX 1

February 10, 1977

To the Parents / Guardians of ______________________________

Dear Parents (Guardians):

Your son is one of many boys selected to take part in a University of Alberta study on activity level and speed of reaction to a number of tones (sounds). Each boy in the study will first be asked to complete a questionnaire which will take about 20 minutes. This will be done at your son's school.

From those boys who have completed the questionnaire a random selection will be made consisting of a few boys who will be asked to do a simple reaction time task. This is a speed task and all that is required is that a boy press a button quickly every time he hears a tone on an earphone. A clock will record the amount of time taken to press the button. This task will take place in a soundproof room at the University of Alberta and will last for 30 minutes. This is all that is required.

I shall be happy to supply any further information which you may need concerning this study and can be contacted at 432-3693 (office) or 433-0075 (home) at any time.

Dr. Tom Blowers, Director of Research with the Edmonton Public School Board, has made the necessary arrangements and given permission for this study to take place subject to your consent to have your son participate. Since the findings of this study may help many children across Canada, it would be nice for your son to take part. Thanks.

Yours sincerely,

APPENDIX 2

CONSENT FORM

Name ____________________

School ____________________

☐ My son may participate in this study.

☐ I do not wish my son to participate in this study.

Name of Parent: ____________________

Date: ____________________

Please check [✓] one above and kindly return this form to your son's teacher.

APPENDIX 3

Davids' Rating Scale of Hyperkinesis

1. Hyperactivity - Involuntary and constant overactivity; advanced motor development (throwing things, walking, running, etc.); always on the move; rather run than walk; rarely sits.

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

2. Short attention span and poor powers of concentration - Concentration on a single activity is usually short, with frequent shifting from one activity to another; rarely sticks to a single task very long.

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

3. Variability - Behavior is unpredictable, with wide fluctuations in performance; "sometimes he (she) is good and sometimes bad."

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

4. Impulsiveness and Inability to Delay Gratification - Does things on the spur of the moment without thinking; seems unable to tolerate any delay in gratification of his (her) needs and demands; when wants anything, he (she) wants it immediately; does not look ahead or work toward future goals; thinks only of immediate present situation.

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

/continued

APPENDIX 3 (continued)

5. Irritability - Frustration tolerance is low; frequently in an ugly mood, often unprovoked; easily upset if everything does not work out just the way he (she) desires.

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

6. Explosiveness - Fits of anger are easily provoked; reactions are often almost volcanic in their intensity; shows explosive, temper-tantrum type of emotional outbursts.

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

7. Poor school work - Has difficulty participating successfully in school work; cannot concentrate on school work; has some specific learning difficulties or blocks (e.g., poor arithmetic, poor in reading, etc.); poor visual-motor coordination (e.g., awkward gestures, irregular handwriting, poor drawing, etc.).

Much less than most children	Less	Slightly Less	Slightly More	More	Much more than most children

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IN APPENDIX 4, LEAVES 214-216,

NOT MICROFILMED.

JUNIOR E.P.I., by Sybil B.G. Eysenck. Published by Educational and Industrial Testing Service, Box 7234, San Diego, California, U.S.A.

APPENDIX 5

Computer-generated Random Numbers

Block 1:

3	5	4	2	1
3	4	1	2	5
1	4	3	2	5
4	5	1	2	3
3	1	4	5	2

Block 2:

2	1	3	4	5
3	2	1	5	4
1	2	4	5	3
2	1	4	3	5
3	2	5	4	1

Block 3:

4	3	5	1	2
3	5	1	2	4
1	4	2	5	3
5	1	4	2	3
2	5	3	1	4

Block 4:

3	1	5	2	4
2	4	5	3	1
2	5	1	3	4
5	2	4	1	3
2	3	4	1	5

Block 5:

2	1	4	5	3
1	2	5	3	4
2	1	3	5	4
3	4	5	2	1
3	1	4	2	5

Key:

1 = 10 db 2 = 30 db 3 = 50 db

4 = 70 db 5 = 90 db

APPENDIX 6

NAME: ____________ SCHOOL: ______________ I.D.: __________

ACTIVITY LEVEL: _____ BLOCK: 1

	Intensity (dB)	Score
1	50	
2	90	
3	70	
4	30	
5	10	
6	50	
7	70	
8	10	
9	30	
10	90	
11	10	
12	70	
13	50	

	Intensity (dB)	Score
14	30	
15	90	
16	70	
17	90	
18	10	
19	30	
20	50	
21	50	
22	10	
23	70	
24	90	
25	30	

SUMMARY

	10	30	50	70	90
TOTAL					

TRIAL →

5 dB		
10 dB		
15 dB		
30 dB		
50 dB		

APPENDIX 7

APPENDIX 8