

To the Graduate Council:

I am submitting herewith a dissertation written by Timothy P. Winter entitled "Selective Attention of Hyperactive, Hyperactive-Learning Disabled, Learning Disabled, and Nondisabled Young Males: A Signal Detection Analysis." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the Doctor of Philosophy, with a major in Education.

Craig A. Wrisberg

C. A. Wrisberg, Major Professor

We have read this dissertation
and recommend its acceptance:

Stephen J. Handell

Patricia A. Beitel

Wendell L. Lennah

Edward T. Howley

Accepted for the Council:

LeW Minkel

The Graduate School

SELECTIVE ATTENTION OF HYPERACTIVE, HYPERACTIVE-LEARNING
DISABLED, LEARNING DISABLED, AND NONDISABLED YOUNG
MALES: A SIGNAL DETECTION ANALYSIS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Timothy P. Winter

March 1984

ACKNOWLEDGEMENTS

I would first like to thank Dr. Craig Wrisberg, my committee chairperson, who guided me during the course of this dissertation. I would also like to thank the other members of my committee for their assistance in my dissertation effort: Dr. Wendell Liemohn, for helping to develop my interest in special populations; Dr. Pat Beitel, for helping me arrive at a clear definition of my research and academic goals; Dr. Stephen Handel, for providing counsel regarding Signal Detection Theory; and Dr. Edward Howley, for his understanding and support throughout this project.

Thanks must also be extended to the children and principals of Knox and Anderson County, Tennessee Schools for their participation and interest in my study.

I am also grateful to my wife, Connie. She has provided constant support for my work and has tolerated the restrictions it has imposed upon our lifestyle. Without her encouragement, my dissertation and graduate work would have been much more difficult.

Finally, I thank my parents and family for the continued support they have provided throughout my college and graduate school years. Their expression of confidence in my work has meant a great deal to me.

ABSTRACT

The purpose of this study was to examine under two conditions of response pacing, the selective attention abilities of hyperactive (H), hyperactive-learning disabled (HLD), learning disabled (LD), and nondisabled (ND) groups using Signal Detection Analysis. A secondary objective was to determine whether differences in response latencies existed for the four groups. Sixty males, (5 each at ages 8, 9, & 10 years) from area schools served as subjects for the study. The visual stimulus, presented tachistoscopically, consisted of a group of red dots which formed the body of a triangle with additional dots along the periphery or embedded in the triangle functioning as cue(s). For the self-paced response condition the subject initiated each trial. Upon presentation of the slide, the subject depressed the appropriate telegraph key (designated "yes" if he thought cue(s) were presented or "no" if he thought no cue(s) were evidenced. Reaction time (RT) was measured from the moment the slide appeared until the subject lifted his finger to respond "yes" or "no." Response time was measured from the moment the slide appeared until the depression of either response key. For both pacing conditions, subjects received four blocks of twenty-eight trials with a one minute rest between blocks. In the forced-paced condition the subject rested his dominant hand between the two

response keys, and made a response upon stimulus presentation. The rate of presentation was one every 2.1 seconds; the duration of each stimulus was 0.1 second. The percentage of hits and false alarms, as well as d' (i.e., sensitivity) and B (i.e., response criterion) were calculated for all subjects for self-paced trials, forced-paced trials, and for the total of all trials. In addition, RT and movement time (MT) were recorded for the self-paced trials. The most noteworthy finding of the study was that the signal detection performance for the H and ND groups were not significantly different. The results indicated significant differences in the performance of HLD and ND groups on all measures. The findings suggest that the presence of learning disabilities adversely affects the selective attention ability of children and the combination of hyperactivity and learning disabilities magnifies the severity of selective attention deficits.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
1. Statement of Problem	3
2. Delimitations of the Study	5
3. Assumptions	5
4. Definition of Terms	6
II. REVIEW OF LITERATURE	12
1. Selective Attention Deficits	13
2. Classification	14
3. Memory	20
4. Reaction Time	24
5. Perceptual Preferences	28
6. Prior Learning	30
7. Sustained Versus Selective Attention	31
8. Summary	33
9. Signal Detection Theory	34
10. Summary	41
III. PROCEDURES	43
1. Selection of Subjects	43
2. Apparatus	45
3. Methods of Testing	47
IV. RESULTS	52
1. Analysis of Data	54
2. Results of Analysis	55
3. Discussion of Results	69

CHAPTER	PAGE
IV. RESULTS (cont.)	
4. Summary	82
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	87
1. Summary	87
2. Conclusions	90
3. Recommendations	91
LIST OF REFERENCES	94
APPENDIXES	106
A. CUE COORDINATES	107
B. SUBJECT DATA	109
C. SIGNAL DETECTION CALCULATIONS	111
D. COVER LETTER TO PARENT	113
E. PARENTAL PERMISSION FORM	115
F. INFORMED ASSENT	118
VITA	120

LIST OF TABLES

TABLES	PAGE
1. Descriptive Statistics For Hits During Total Trials	56
2. Descriptive Statistics For False Alarms During Total Trials	56
3. Descriptive Statistics For $\underline{d'}$ During Total Trials	57
4. Descriptive Statistics For $\underline{B}$ During Total Trials	57
5. Analysis Of Variance For Hits During Total Trials	58
6. Analysis Of Variance For False Alarms During Total Trials	58
7. Analysis Of Variance For $\underline{d'}$ During Total Trials	58
8. Analysis Of Variance For $\underline{B}$ During Total Trials	58
9. Descriptive Statistics For Hits During Self-Paced Trials	60
10. Descriptive Statistics For False Alarms During Self-Paced Trials	60
11. Descriptive Statistics For $\underline{d'}$ During Self-Paced Trials	60
12. Descriptive Statistics For $\underline{B}$ During Self-Paced Trials	60
13. Analysis Of Variance For Hits During Self-Paced Trials	61
14. Analysis Of Variance For False Alarms During Self-Paced Trials	61
15. Analysis Of Variance For $\underline{d'}$ During Self-Paced Trials	61

TABLES	PAGE
16. Analysis Of Variance For <u>B</u> During Self-Paced Trials	61
17. Descriptive Statistics For Reaction Time During Self-Paced Trials	62
18. Descriptive Statistics For Movement Time During Self-Paced Trials	62
19. Analysis Of Variance For Reaction Time During Self-Paced Trials	62
20. Analysis Of Variance For Movement Time During Self-Paced Trials	62
21. Analysis Of Variance For Group X Age Of Reaction Time	65
22. Analysis Of Variance For Group X Age Of Movement Time	65
23. Descriptive Statistics For Hits During Forced-Paced Trials	66
24. Descriptive Statistics For False Alarms During Forced-Paced Trials	66
25. Descriptive Statistics For <u>d'</u> During Forced-Paced Trials	66
26. Descriptive Statistics For <u>B</u> During Forced-Paced Trials	66
27. Analysis Of Variance For Hits During Forced-Paced Trials	67
28. Analysis Of Variance For False Alarms During Forced-Paced Trials	67
29. Analysis Of Variance For <u>d'</u> During Forced-Paced Trials	67
30. Analysis Of Varaince For <u>B</u> During Forced-Paced Trials	67

LIST OF FIGURES

FIGURE	PAGE
1. Probability Of Signal Detection	36
2. Picture Of Testing Equipment	46
3. Slide Pattern Of Standard Tree	48
4. Standard Tree Pattern With Additional Cues	48
5. Sensitivity (d') For Self-Paced Trials	71
6. Sensitivity (d') For Forced-Paced Trials	71
7. Percent Of Hits During Self-Paced Trials	72
8. Percent Of Hits During Forced-Paced Trials	72
9. Percent Of False Alarms During Self-Paced Trials	73
10. Percent Of False Alarms During Forced-Paced Trials	73
11. Criterion (B) During Self-Paced Trials	74
12. Criterion (B) During Forced-Paced Trials	74
13. Percent Of Hits During Total Trials	76
14. Percent Of False Alarms During Total Trials	76
15. Sensitivity (d') During Total Trials	77
16. Movement Time For Groups	80
17. Reaction Time For Groups	81

CHAPTER I

INTRODUCTION

There presently exist many theories which represent attempts to explain the filtering process by which people select and use cues from the immediate environment in order to produce a specific response (Broadbent, 1958; Deutsch & Deutsch, 1963; Keele, 1973; Norman, 1969; Welford, 1952). From these theories three general conclusions may be drawn. First, in the presence of many stimuli, the human as an information processor or system usually selects and attends to only one stimulus or cue. Second, individuals attend to those stimuli which have the most meaning to them in a specific situation. Third, distractions may occur due to the presence of unattended stimuli. It should be noted however, that theoretical rationale and empirical support for the latter conclusion are presently lacking (Magill, 1980).

Selective attention refers to the ability to attend to relevant environmental stimuli and ignore irrelevant stimuli (Tarver, Hallahan, Cohen & Kauffman, 1977). Kagan (1975) has hypothesized that children develop the ability to selectively attend with age and that improvement in the ability to selectively attend are a result of the development of increasingly differentiated perception.

A number of investigators (Dykman, Ackerman, & Oglesby 1980; McIntyre, Murray, & Blackwell 1981; Swanson 1981; Tarver, Hallahan, Cohen, & Kauffman, 1977; Vrana & Pihl, 1980) have demonstrated deficits in selective attention of learning disabled children. Attention deficits also have been evidenced in hyperactive or formerly hyperactive populations (Bremer & Stern, 1976; Dykman et al., 1980; Goldberg & Konstantareas, 1981; Fisher, 1977; Keogh, 1971; Radosh & Gittelman, 1981; Zambelli, Stamm, Maitinsky, & Loiselle, 1977). However, some studies involving both of these populations have suggested selective attention deficits to be characteristic of only learning disabled individuals (McIntyre et al., 1981; Ross, 1976). There appear to be several factors contributing to an inconsistency in these results. For example, across studies there exist discrepancies in the classification of the groups, primarily in the terminology and criteria used. In addition, there are subject-related and task-related considerations such as memory requirements, type of pacing, perceptual preferences, prior learning, and task duration (i.e., sustained versus simple selective attention) which differ across studies and may be responsible for discrepant patterns of results.

One paradigm which appears to offer a more precise analysis of selective attention is that proposed by signal detection theorists (e.g., Green & Swets, 1966). The two

basic parameters of this theory are sensory capacity (i.e., d') and the cut-off point or criterion for making a decision i.e., (B). The d' measure presumably allows the assessment of a subject's ability to make perceptual decisions. A large d' is indicative of very little uncertainty as to whether a signal occurred or not. The decision criterion or B is a subjectively set point used by the individual to make judgements as to whether a stimulus occurred or not. This point presumably biases an individual's perceptual decisions. Moreover, the placement of the criterion is assumed to have a direct effect on the types of errors an individual will make (Marteniuk, 1976). Recently this approach has been applied to the study of sustained attention in both learning disabled and hyperactive groups (Swanson, 1981; Goldberg & Konstantareas, 1981). Thus, the present study involved the application of this method of analysis to investigate the nature of selective attention capabilities of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled children.

1. STATEMENT OF PROBLEM

The primary purpose of the present study was to examine, under two conditions of response pacing, the selective attention abilities of hyperactive, hyperactive-learning disabled, learning disabled, and

nondisabled groups utilizing the method of signal detection analysis. In particular, an attempt was made to (a) compare the accuracy (d') of signal detection performance of hyperactive, hyperactive-learning disabled, and learning disabled groups with respect to each other and to matched nondisabled subjects, (b) compare the decision making criterion (B) of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled young children, and (c) compare the percent of hits and false alarms of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled young males. In addition, a secondary purpose of the present study was to examine the response latencies in decision making of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled groups.

The following research hypotheses with respect to signal detection analysis were tested:

1. There are no significant differences in the quantity d' (sensitivity) of hyperactive, hyperkinetic, learning disabled, and nondisabled children.

2. There are no significant differences in the location of the decision making criterion (i.e., B) of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled children.

3. There are no significant differences in the percentage of hits and false alarms of hyperactive, hyperkinetic, learning disabled, and nondisabled groups.

In addition to the three signal detection hypotheses the following research hypothesis was tested:

4. There are no significant differences in the rapidity of decision making as measured by response latencies (i.e., reaction and movement time) of hyperactive, hyperkinetic, learning disabled, and nondisabled groups.

2. DELIMITATIONS OF THE STUDY

The study was delimited to 8, 9, and 10 year old hyperactive, hyperkinetic, learning disabled, and nondisabled children living in Knox and Anderson Counties, in the state of Tennessee.

3. ASSUMPTIONS

1. It was assumed that all subjects who participated in the study were naive to the experimental task.

2. It was assumed that subjects attempted all tasks to the best of their ability.

3. It was assumed that prescribed medication has no effect on overall ability to selectively attend to appropriate phenomenon during performance. One subject in the hyperactive group was noted to be on medication, and his data was included because it approximated the mean values for that group.

4. With respect to the signal detection analysis, it was assumed that the signal and signal plus noise curves are normally distributed.

4. DEFINITION OF TERMS

Attention--A limited capacity to process information (Schmidt, 1982). For the purpose of this study attentional capabilities were tested using a task involving a brief exposure of a visual display consisting to a dot pattern in the form of a tree as the standard stimulus, and additionally, including extra dots as cues for the subject to detect.

Beta (B)--Response criterion or cut-off point, reflecting a subject bias in decision making (Marteniuk, 1976). It is calculated by dividing the ordinate of the normal curve for the percentage of hits by the ordinate value for false alarms percentage or probability forming a likelihood ratio.

Continuous Performance Test (CPT)--An experimenter-paced task in which the experimenter controls the moment of presentation and the duration of task stimuli (e.g., a series of letters) (Sykes, Douglas, Weiss, & Minde, 1971).

Index of Sensitivity (d')--One way of quantifying a

subject's ability to make perceptual decisions based on the assumption of equal variance of signal and signal plus noise Gaussian distributions (Green & Swets, 1966; Marteniuk, 1976). For the purpose of this study the index of sensitivity was calculated by dividing the total number of hits by the total number of trials cue(s) were presented, giving a hit probability. The false alarm probability is calculated by dividing the total number of false alarms by the total number of non-cue(s) trials presented. These two probabilities, hits and false alarms, are then matched on a table for d' values for a yes-no procedure (Swets, 1964).

Dichotic Listening Paradigm--An experimental condition in which the individual is presented a different message in each ear over headphones and is instructed to concentrate on one message and ignore the other.

Distractibility--An increase in the number of shifts of attention to different input sources (Kahneman, 1973). For the purpose of this study, distractibility was assumed to be related to the manner in which the standard tree pattern affected one's ability to detect cue(s) appearing within or along the periphery of the standard pattern.

False Alarm--In Signal Detection Theory, a type of error in which the subject reports that a signal occurred when in

fact none was presented (Green & Swets, 1966). The percentage of false alarms is calculated by dividing the number of trials in which the above type of error occurred by the total number of trials on which no signal was presented.

Forced Pacing--A treatment condition in which the time interval between each trial is controlled by the experimenter. For the purpose of this study, an intertrial interval of three seconds was used during forced-paced trials.

Hit--In Signal Detection Theory, a correct detection or an instance in which the subject correctly indicates that a signal or cue was presented (Green & Swets, 1966). The percentage of hits is calculated by dividing the total number of correct detections by the total number of trials in which signals actually occurred.

Hyperactivity--A term used "to describe the behavior of a child whose activity is probably not the result of some kind of neurophysiological or psychophysiological dysfunction" (Lubar & Deering, 1981, p.121). For the purpose of this study, hyperactivity was defined as those individuals who demonstrate an excessive amount of motor behavior or activity, but not aggressive behavior.

Hyperkinesis--"True" hyperkinesis is "a condition in which the primary problem is neurophysiological" often associated with some aspect of minimal brain dysfunction (Lubar & Deering, 1981, p.121). For the purpose of this study, hyperkinesis was defined as the behavior manifested by individuals who in addition to being learning disabled, express an excessive amount of motor activity, but not aggressive behaviors.

Learning Disability--An educational term identifying those individuals who demonstrate one or more "specific deficits in perceptual, integrative, relational, or expressive processes not attributable to sense organ defects which impair learning efficiency" (Bannatyne, 1971, p.15). For the purpose of this study, learning disability was defined as being present in those individuals (as determined by the school psychologist) who were of normal or above intelligence, but who demonstrate difficulties in learning.

Miss-Omission--In Signal Detection Theory, a type of error which occurs when the subject reports that no signal was presented when in reality, a signal was presented (Goldstein, 1980). The percentage of misses is calculated by dividing the total number of signals missed by the number of trials in which signals are presented.

Movement Time (MT)--The time from the initiation of a response to the completion of the movement (Schmidt, 1982). For this study, MT was measured from the moment the subject lifted his finger from the initiate switch until the moment he depressed either the "yes" or "no" telegraph keys.

Reaction Time (RT)--The time between the moment of presentation of an unanticipated stimulus and the moment of initiation of a response to the stimulus (Schmidt, 1975). For this study, RT was measured from the moment a slide appeared until the moment the subject lifted his finger from the initiate switch.

Selective Attention--The ability to attend to relevant environmental stimuli and ignore irrelevant stimuli (Tarver, Hallahan, Cohen, & Kauffman, 1977). For the purpose of this study, selective attention was assessed by evaluating the hits, false alarms, d' , and B (i.e., criterion) of subjects under forced and self-paced conditions.

Self-Pacing--A treatment condition in which the subject initiates each new trial by depressing a switch. For this study, self-pacing was defined by the subject initiating each new trial by depressing a switch when he was ready.

Serial Choice Reaction Time (SCRT)--A task involving a series of stimuli in which each subsequent stimulus in the series is presented as soon as the subject has responded to the previous stimulus.

Short-term Memory (STM)--A hypothetical memory store with a capacity of about seven elements, capable of holding moderately abstract information for up to 30 seconds; analogous to consciousness; a "workspace" for processing (Schmidt, 1982).

Speeded Classification--A procedure used to measure selective attention which requires the subject to sort a deck of cards marked with one to three dichotomous stimuli according to one critical attribute (e.g., circle) as quickly as possible into two piles (Copeland & Wisniewski, 1981).

CHAPTER II

REVIEW OF LITERATURE

In this review of literature the following topics are addressed: (a) selective attention deficits, (b) possible alternative explanations for performance deficits by hyperactive and learning disabled subjects in selective attention experiments and (c) signal detection theory. The first section presents evidence suggesting inconsistent results in studies examining selective attention for hyperactive and learning disabled groups. The second section includes a review of alternative explanations for performance differences by hyperactive and learning disabled subjects and is subdivided into six categories: (a) classification, (b) memory requirements, (c) reaction time requirements, (d) perceptual preferences, (e) prior learning, and (f) tasks involving sustained as well as selective attention. The review of literature concludes with a summary of the ways selective attention has been examined and with alternative explanations for the deficits observed in the selective attention performance of various special populations. One paradigm, signal detection theory, which appears to offer a more precise analysis of selective attention is highlighted.

1. SELECTIVE ATTENTION DEFICITS

Selective attention refers to the ability to attend to relevant environmental stimuli and ignore irrelevant stimuli (Tarver, Hallahan, Cohen, & Kaufman, 1977). Kagan (1975) has hypothesized that children develop the ability to selectively attend with age and that increases in selective attention are a result of the development of increasingly differentiated perception.

Dykman, Ackerman, and Oglesby (1980), McIntyre, Murray, and Blackwell (1981), Swanson (1981), Tarver et al. (1977), and Vrana and Pihl (1980) have demonstrated deficits in the selective attention of learning disabled children. Attention deficits also have been evidenced in hyperactive or formerly hyperactive populations (Bremer & Stern, 1976; Dykman et al., 1980; Goldberg & Konstantareas, 1981; Fisher, 1977; Hiscock, Kinsbourne, Caplan & Swanson, 1979; Keogh, 1971; Radosh & Gittelman, 1981; Rosenthal & Allen, 1978; Zambelli, Stamm, Maitinsky & Loiselle, 1977). However, studies involving both of these populations have suggested selective attention deficits to be a characteristic of only the latter group (i.e., learning disabled, McIntyre et al., 1981; and Ross, 1976). Due to variations in the design used in the various studies, the only consistent conclusion seems to be that hyperactive and learning disabled populations exhibit dysfunctioning in information processing.

The question exists, therefore, whether true selective attention deficits exist for hyperactive groups or whether apparent performance impairments are due to something else. Rosenthal and Allen (1978), in a synthesis of existing literature, have concluded that although support is given for the hypothesis that hyperactive individuals demonstrate low physiological arousal and attention deficits, the exact nature of the attention deficits is still unclear. In the next several sections of this review, possible alternative explanations for performance deficits by hyperactive and/or learning disabled subjects in selective attention experiments will be presented. These include: (a) classification inconsistencies, (b) memory requirements of the experimental task, (c) reaction time requirements of the experimental task, (d) differences in perceptual preference of subjects, (e) differences in the level of prior learning of subjects, and (f) tasks involving sustained as well as selective attention.

2. CLASSIFICATION

The following discussion is intended to offer some possible explanations for the inconsistencies in the finding of selective attention deficits in learning disabled, hyperactive, and hyperkinetic groups. First, there appears to be many inconsistencies in the terminology and

classification of these subject groups. For a large number of investigations examining selective attention either directly or collaterally in vigilance studies, the criterion for acceptance as "hyperactive" included such ambiguous statements as: (a) the major presenting complaint attested by parents and teachers (Campbell, Douglas, & Morgenstern, 1979; Goldberg & Konstantareas, 1981; Hiscock, Kinsbourne, Caplan, & Swanson, 1979; and Sykes, Douglas, Weiss, & Minde, 1971); (b) the diagnosis of at least one or any possible combination of psychiatrist, psychologist, pediatrician, or family physician (Goldberg & Konstantareas, 1981; Hiscock, Kinsbourne, Caplan, & Swanson, 1979; and Sykes, Douglas, Weiss, & Minde, 1971); (c) the absence of "hard" neurological signs such as paralysis (Campbell, Douglas, & Morgenstern, 1971; Hiscock, Kinsbourne, Caplan, & Swanson, 1979; and Sykes, Douglas, Weiss, & Minde, 1971); (d) the absence of gross intellectual impairment (Hiscock, Kinsbourne, Caplan, & Swanson, 1979); (e) the lack of any sensory impairment (Zambelli, Stamm, Maitinsky, & Loiselle, 1977); (f) the presence of hyperactivity since early childhood (Campbell, Douglas, & Morgenstern, 1971; Sykes, Douglas, Weiss, & Minde, 1971; and Sykes, Douglas, & Morgenstern, 1972); (g) sustained influence of the condition throughout the day (Campbell, Douglas, & Morgenstern, 1971; Sykes et al., 1972); and (h) the presence of "soft" neurological signs (Zambelli et al., 1977).

Most commonly, rating scales dominate the literature as the criterion for classification of hyperactive populations. Copeland and Wisniewski (1981), Dykman, Ackerman, and Oglesby (1980), Fisher (1977), and Radosh and Gittelman (1981) all used versions of Conner's (1969) Teacher Behavior Rating Scale (particularly the hyperactivity factor), in examining the attention of hyperactive groups. Another example, a list of eighteen hyperactive symptoms (Stewart, Pitts, Craig, & Dieruff, 1966), was used by Bremer and Stern (1976) to differentiate distractibility and attention deficits in hyperactive boys.

Conner's Teacher Rating Scale (Conners, 1969) is basically a Likert-type, four-point scale with thirty-nine items. This scale has more recently been shortened to ten items (Conners, 1973). Originally, this scale was developed to discriminate between gross differences in classroom behavior as a function of drug versus placebo treatment. This scale has been readily adopted by researchers to distinguish hyperactive from non-hyperactive children.

Sandoval (1981) has recently suggested several problems with existing scales. First, typically teachers are asked to rate a particular child "blind" concealing his/her status, hereby obtaining unbiased ratings. The problem is that under this condition a rater cannot help but become more sensitive to a particular child's behavior. Second, as described by Stewart and Haller (1975), most scales are

described by Stewart and Haller (1975), most scales are composed of leading questions covering symptoms that are usually stated in a negative manner. They suggest rating the whole class or subgroup with scales, including positively stated behaviors with items not necessarily descriptive of hyperactivity. Last, more concrete descriptors instead of the typical Likert-scale options (e.g., often, somewhat, or not at all) should be used. Sandoval (1981) concluded on the basis of his study that format changes may make raters more sensitive to individual differences and suggested that the School Behavior Survey (SBS) be considered as a model for future rating scales.

Another potential problem arising from studies conducted to examine attention deficits in various populations stems from a confusion between the terms "hyperactivity" and "hyperkinesis." Werry and Sprague (1970) define hyperactivity as an excessive amount of gross motor activity and/or an excessive amount of inappropriate activity. This type of hyperactivity may be a symptom of many psychopathic individuals or of those with behavior disorders. More commonly, hyperactivity is the chief complaint in the hyperkinetic syndrome. Rosenthal and Allen (1978) point out the other possible accompanying symptoms in this syndrome in addition to the hyperactivity characteristic. They include: normal intelligence, short attention span, low frustration tolerance, and impulsive behavior.

Upon review, many researchers confuse not only the terms hyperactivity and hyperkinesis by using them synonymously, but do not discriminate properly between the groups. This confusion may explain the varied results. Copeland and Wisniewski (1981) discovered that hyperactivity was related to poor performance than that of learning disabled children and nondisabled children on selected cognitive measures (i.e., Central-Incidental Learning task and Speeded Classification) including selective attention. The poorer performance was not associated with learning disabilities. In their study of vigilance which involved a selective attention task, Goldberg and Konstantareas (1981) found deficits for hyperactives. They noted that three of their ten hyperactive children demonstrated a specific learning disability. Zambelli et al. (1977) found selective attention deficits for hyperactive groups, but actually included the presence of soft neurological signs as one of their criteria for inclusion in their study. Bremer and Stern (1976) found no differences in selective attention performance for hyperactive and learning disabled groups if distractors were kept to a minimum. Last, Dykman, Ackerman, and Oglesby (1980) discovered the same results as the above study, but for both of these studies the terms hyperactivity and hyperkinesis were used synonymously upon examining potential attentional weaknesses.

Lubar and Deering (1981) have suggested a third

classification of hyperactivity, in this case, the true hyperkinetic. They define hyperkinesis as a condition in which the main problem is neurological in nature. In addition, Lubar and Deering (1981) emphasize the need to use the terms "hyperkinesis" and "specific learning disability" to describe some particular aspect of minimal brain dysfunction (i.e., MBD), and to use the term "hyperactivity" to describe the behavior of a particular child whose activity level is not the result of some kind of neurological or psychological dysfunctioning. Thus, they suggest that hyperactivity be defined simply as an excessive amount of gross activity and/or an excessive amount of inappropriate activity as described by Werry and Sprague (1970), but with the exclusion of aggressiveness. Aggressive behavior is suggested as a possible confounding variable in the hyperactivity factor with the Conners scale (1969) (Prinz, Connor, & Wilson, 1981).

Taking these studies into consideration, noting the discrepancies in language, requirements for inclusion, and the difficulties in rating scales noted by Sandoval (1981), these factors may offer an explanation for the varied results in selective attention performance of hyperactive-hyperkinetic groups.

3. MEMORY

A second possible explanation for discrepancies observed in the results of studies on selective attention may be the type of task used in the experiment. Probably one of the most commonly used measures of selective attention is Hagen's Central-Incidental Learning Task (Hagen, 1967). This task requires selective attention to one of several stimuli in a memory task. Basically the task involves the viewing of a series of cards with two types of pictures on each (e.g., a household item such as a lamp and an animal such as a camel). The subject's task is to recall the location (i.e., first, second or third. . . card presented) within the series of one of the types of pictures. Obviously the most effective strategy is to attend to the relevant picture and ignore the other. After demonstration of this type of recall (i.e., central), the child is asked to match the two pictures presented on each card (i.e., incidental recall). The effective recall of the central stimuli while ignoring irrelevant information is presumed to be the primary measure of selective attention. Typically a total recall score is calculated by subtracting the percentage of irrelevant information recalled from the percentage of relevant information recalled. Of particular relevance to the present study is the presence of a memory component in Hagen's task.

Although this type of task is purported to be a pure measure of attention, it is possible that differences in subjects' memory ability may be a confounding performance variable. Copeland and Wisniewski (1981) as well as Torgeson (1977) point out that the use of efficient strategies has been shown to be lacking in the performance of many learning disabled subjects, particularly on tasks of reading skill. Despite this fact Hagen's task continues to be used to demonstrate selective attention deficits in the performance of learning disabled children (Hallahan, Kauffman, & Ball, 1973; Tarver, Hallahan, Cohen, & Kauffman, 1977; and Hallahan, Tarver, Kauffman, & Graybeal, 1978), although Swanson (1979) found no deficit using this technique. Tarver, Hallahan, Cohen, and Kauffman (1977) found qualitatively similar learning strategies (i.e., selective attention and verbal rehearsal) for hyperactive and adult groups. The hyperactive subjects' serial recall curves demonstrated a primacy and recency effect (i.e., more recall of first and last items than in the middle). Learning disabled children tended to recall more items from the middle. The researchers suggested that because the hyperactive subjects' performances were similar to that of adults, the deficits may be more in line with a possible developmental lag and not necessarily true deficits. Carroll (1972; 1973) found that the Visual Memory Scale (VMS), a test used to measure short-term visual recognition

memory in young children, differentiated the performance of neurologically impaired retarded children from nonneurologically impaired retardates in that the performance of the neurologically impaired was significantly inferior. Learning disabilities, hyperactivity (Werry & Sprague, 1970), and more recently, hyperkinesis (Lubar & Deering, 1981; Zambelli et al., 1977) have been associated with neurological impairment. Therefore, it might well be argued that selective attention tasks with memory demands are not tapping "pure" selective attention deficits. In other words, those measures of selective attention which include a strong memory component are probably reflecting the memory deficits of neurologically impaired as well as attention deficits.

Copeland and Wisniewski (1981) used several measures of selective attention, including Hagen's task, and discovered selective attention deficits for LD groups, although with hyperactive-like children, no deficits were evidenced. Because the hyperactive-like children demonstrated an excess of motoric behavior but no evidence of neurological impairment while the learning disabled group would be expected to show neurological abnormalities, the results were consistent with what can be expected for selective attention measures with a memory component.

In addition to Hagen's Task (1967) several other measures have been used which appear to contain a memory

factor. One of the more familiar measures is the Matching Familiar Figures Test (Kagan, Rosman, Day, & Phillips, 1964). This measure purports to measure reflection-impulsivity, or cognitive tempo, in a selective attention context. The task involves the presentation of fourteen sets of pictures of familiar objects and animals. The subject is shown a standard stimulus (e.g., a cow) and six familiar ones (e.g., a horse, ox, dog, cow, etc.) and is required to choose the one among the six alternatives which is equal to the standard stimulus (i.e., the cow). Both response latency and the number of errors (i.e., incorrect matches) are recorded. Using the Matching Familiar Figures Test, Campbell (1969) and Campbell, Douglas, and Morgenstern (1971) demonstrated inefficient cognitive styles for hyperactive children, particularly an indication of impulsivity as demonstrated by shorter latencies and a greater number of errors for the selective attention task.

Vrana and Pihl (1980) used a modification of the Reflection-Impulsivity task to examine selective attention deficits in learning disabled children. The task involved a 3-second visual presentation of a card with pictures of circles and squares on it. The card was then turned over and the examiner asked, "How many circles did you see?" After the fifth card the child was asked, "How many squares did you see?" After the sixth card the child was asked, "How many circles did you see?" Then the child was asked,

"How many squares did you see?" Last, the child was asked, "How many rows did you see?" In this study central recall was calculated from all questions related to circles while incidental recall information was derived from all questions related to squares and to rows. They found lower central recall for learning disabled children than for nondisabled children but only when central and incidental stimuli were presented together.

In summary, it appears that the studies reviewed in this section have used tasks with a memory component which likely contributed to the poor performance of learning disabled and in some cases hyperactive children. Therefore, it is difficult to draw clear-cut conclusions about the selective attention deficits of these populations from the results of these experiments.

4. REACTION TIME

Another potential confound in the interpretation of selective attention in studies investigating the performance of hyperactive, hyperkinetic, and learning disabled subjects is the possibility of differences in reaction time of these subjects and that of nondisabled subjects.

The speeded classification task is one method of assessing selective attention which requires minimal memory skill (Garner & Felfoldy, 1970; Strutt, Anderson, & Well,

1975). This task typically requires subjects to sort decks of cards with one to three dichotomous stimuli (e.g., circle or square) on them, on the basis of a particular attribute (e.g., form). However, subjects are usually timed as they sort. Copeland and Wisniewski (1981) used this type of task in comparing the selective attention of LD and hyperactive children. They found that hyperactive children took a longer time sorting and made more errors. Younger LD children also had a difficult time and demonstrated the above characteristics. The authors acknowledged that their subjects may have been deficient in fine motor ability as well as selective attention. A more interesting note from this study stems from the fact that the performance of the hyperactive children on the speeded classification task was not consistent with that found for subjects on the Hagen task. Besides the possibility of motor problems, Douglas (1972) has found that for tasks which are of short duration and/or self-paced, hyperactive and normal subjects' performances are equivalent. However, in tasks which are force-paced (i.e., experimenter-paced), performance of the two groups is different. These differences are expressed by a greater number of errors and slower reaction times for the hyperactive groups.

Many other researchers have used tasks which are speeded in nature; a common example is the visual search task. McIntyre, Murray, and Blackwell (1981) projected a

series of letters on a screen and required subjects to hold down a foot pedal until a particular letter was found. When this was done the subject released the pedal and then identified the location of the letter on a grid. McIntyre et al. (1981) found that the response latencies of learning disabled and learning disabled/hyperactive boys were longer than those of their matched controls. However, the latencies for strictly hyperactive boys were not significantly different from those of their controls. Therefore, longer latencies may be a characteristic of the learning disabled groups only, not both (i.e., learning disabled and hyperactive) as was typically thought (Campbell, Douglas, & Morgenstern, 1971).

Sykes, Douglas, Weiss, and Minde (1972) used a Continuous Performance Test (i.e., CPT) in which the experimenter controlled the moment of presentation of each of a series of letters or geometric shapes and the duration of stimulus presentation. Hyperactive children made fewer correct responses (i.e., subject's accuracy in detecting significant stimuli, no. correct responses/total no. significant stimuli presented) than their controls, although the two groups did not differ in overall number of errors (i.e., no. of responses to non-significant stimuli). In reference to the interstimulus interval (i.e., either 1.0 or 1.5 seconds), hyperactive children made more responses to non-significant stimuli than their controls only at the slow

(1.5 sec. interstimulus interval) pace. Sykes, Douglas, and Morgenstern (1972) used a CPT involving both visual and auditory presentations and obtained results which were consistent with the above study. Subjects in this study were also given a Serial Reaction Time task and a Choice Reaction Time task. Choice reaction times were not significantly different for both groups. Therefore, reaction time differences noted in other studies with hyperactive and nondisabled groups may be the result of the nature of the task (i.e., experimenter paced). Swanson (1981) examined selective attention by using a vigilance task and discovered that learning disabled children made fewer correct detections of auditory stimuli over time while their performance on the visual task did not deteriorate. The nondisabled subject's sustained attention was actually better on the shorter visual task with decrements noted only for the longer auditory interval. Taken together the results of these studies suggest that several temporal factors may influence the performance of hyperactive and learning disabled subjects on selective attention tasks. These dimensions include the type of pacing of the task (self or forced) as well as the length of the interstimulus interval.

5. PERCEPTUAL PREFERENCES

Several researchers have attempted to clarify the effect that various distractors may have on selective attention performance (Bremer & Stern, 1976; Radosh & Gittelman, 1981). It is generally accepted that a major factor affecting the performance of hyperactive children on many tasks is distractibility. However, it might be argued that the methods used to investigate this issue have been problematic. For example, Bremer and Stern (1976) used a task requiring subjects to read short stories during which distracting stimuli such as a ringing telephone with flashing lights or a sinusoidal oscilloscope display accompanied by a 75-db sound were presented. Radosh and Gittelman (1981) required their subjects to perform arithmetic problems on a paper which was bordered by two inches of distractors of high appeal such as magazine pictures of toys, animals, etc. A low appeal condition involved borders containing meaningless abstractions (e.g., lines). It may be argued that by putting the subjects, especially hyperactive children, under such unrealistic conditions (i.e., high appeal, thus very distracting) may be of little value to those in the classroom. Ideally, such situations would not occur in the classroom. Low appeal conditions were suggested by Strauss and Lehtinen (1947)

years ago. Thus, there remains a need to identify the source of attention difficulties under more applied conditions.

Campbell et al. (1971) examined cognitive style differences between hyperactive and nondisabled groups using the Children's Embedded Figures Test (Karp & Konstadt, 1963) as a measure of field dependence-independence. This test measures the subject's ability to separate an item from the field in which it is embedded. The field independent subject is able to isolate a figure from a confusing embedding context (Douglas, 1972). They found that hyperactives were more often field dependent. Thus, it might be speculated that the hyperactive child would demonstrate difficulty isolating a figure from the background, a definite requisite in many of the selective attention tasks already discussed. One other point to mention in relationship to the issue of cognitive style is that the hyperactive child is often characterized as impulsive. Campbell et al. (1971) noted in a task which required rapid response rates, that the hyperactive child is slower, suggesting poor ability to concentrate or to abstract the required information (i.e., field dependent). Thus, it appears that perceptual style may be a factor contributing to the poor performance of hyperactive children on measures of selective attention. It might therefore be argued that selective attention deficits reported in some

studies are the result of perceptual dysfunctioning and not primarily due to inefficient problem solving strategies as suggested previously (Copeland & Wisniewski, 1981; Torgeson, 1977).

6. PRIOR LEARNING

Another factor to consider when attempting to integrate selective attention findings is that of prior learning. Studies by Neisser (1963), Hiscock, Kinsbourne, Caplan, and Swanson (1979), Radosh and Gittelman (1981), and Bremer and Stern (1976), involving the use of such standard measures of selective attention as the Matching Familiar Figures Test or the Hagen Central-Incidental Recall task, presuppose prior knowledge of reading, the alphabet, geometric shapes, arithmetic, or identification of animals and/or household items. Prior learning of any or all of these may be subject to cultural, social, and/or economic bias. Neisser (1963) has demonstrated variations in decision-times required for the processing of different letters as well as different length lists. Much research is still being pursued using visual search paradigms involving letters. Goldberg and Konstantareas (1981) developed one of the few interesting and meaningful vigilance/attention tasks for children. The task required the child to observe a screen while pressing a button on his/her left which would make a happy clown show

his face. Sometimes the clown's nose would "run away" so their task was to let the clown know when his red nose was lit by pressing a button on his/her right side after the initiation of the trial. Further research examining selective attention of children needs to consider the true demands of the task to determine whether the task is free of possible educational bias.

7. SUSTAINED VERSUS SELECTIVE ATTENTION

Recently a hypothesis directly differentiating learning disabled from hyperactive children has been presented (Ackerman, Elardo, & Dykman, 1976). The "central organizing hypothesis" states that hyperactive children demonstrate sustained attention deficits while learning disabled children exhibit selective attention deficits. These researchers suggest that the exact location of dysfunctioning for each of these groups is in the frontal and temporal lobes of the brain. Contrary to the results of several other studies (McIntyre et al., 1981; Ross, 1976), Ackerman et al. (1976) found that the performance of hyperactive and learning disabled subjects did differ from that of nondisabled groups but not from that of each other on a visual search task. The two disabled groups (i.e., learning disabled & hyperactive) also demonstrated lower baseline scores than the nondisabled on other measures

(e.g., Digit Span subtest; the Junior Personality Inventory). One curious offshoot of this study was the finding that the performance of hyperactives was not significantly affected by monetary rewards. Also, through a preliminary analysis of heart rate two seconds prior to stimulus onset for the criterion runs, deceleration components which reflect a characteristic of attention set, were not evident in hyperactive subjects, although they were present for the nondisabled. This fact seems to suggest the possibility of physiological or electroencephalographic differences as well as just a lack of attentional preparation.

McIntyre, Murray, and Blackwell (1981) tested Ross's (1976) suggestion that deficits in selective attention are a characteristic of learning disabled, but not of hyperactive children. They matched 12 learning disabled, 12 learning disabled-hyperactive, and 12 hyperactive children with nondisabled subjects based on age, IQ, and socioeconomic status. Their visual search task was derived from Neisser's (1963) task which involved searching for target letter(s) within an array of noise letters with time and errors as the dependent variables. The results revealed no differences between the logarithmically transformed latencies of hyperactives and those of their controls, although the learning disabled and learning disabled-hyperactive groups did differ significantly. These results seemed to support

Ross' hypothesis that selective attention deficits are characteristic of learning disabled only while hyperactive groups demonstrate sustained attention deficits.

The findings discussed in this section suggest that deficits in selective attention noted by many researchers for hyperactive groups, may in actuality be the result of performance variables such as fatigue due to the length of time involved in the experimental period, and thus may reflect deficits in sustained, and not selective attention. In addition, the varied results across studies might be predicted by the differences in time of performance bouts used by different researchers.

8. SUMMARY

Based upon the literature reviewed thus far, it is clear that selective attention has been examined by the use of a variety of experimental tasks or techniques including (a) continuous performance, (b) dichotic listening, (c) central-incident recall, and (d) speeded classification. Several factors which might contribute to performance differences on these tasks include (a) memory requirements, (b) reaction time (pacing), (c) perceptual preferences, (d) prior learning, and (e) the confound of sustained and selective attention. All of the studies reviewed seem to support the notion that selective attention deficits exist

for learning disabled children, although the picture isn't as clear concerning attention deficits for hyperactives. When the apparent lack of continuity in the classification and identification of learning disabled, hyperactive, and hyperkinetic conditions is considered, it becomes obvious that further testing to clarify the attentional similarities and differences of learning disabled and hyperactive subjects is needed.

9. SIGNAL DETECTION THEORY

One paradigm which appears to offer a more precise analysis of selective attention deficits with learning disabled and hyperactive populations is that offered by signal detection theory. Fitts and Posner (1968, p.44-46) have presented a brief explanation of the theory of signal detection which will be summarized in the following paragraph.

The basic premise of signal detection theory is that every variation in physical energy at a sense organ gives rise to some change within the organism. Any new stimulus then occurs against a background of stimulation already present. The probability of detecting the new stimulus depends upon its intensity relative to the background. Neither the background (i.e., noise or N) nor the signal (i.e., S) is constant in its effect. Both can be

represented as distributions (Figure 1). These curves represent the frequency of assumed internal activity of varying magnitudes for the occurrence of the background information alone or for the background information plus the signal. The quantity d' is a measure of the distance between the normalized means of the two distributions. The higher the value of d' the more likely the subject is predicted to be able to detect the presence of the signal. The theory assumes that humans decide the question, (i.e., whether or not a signal occurred), by adopting a criterion (B). Any internal activity of a magnitude greater than that of the criterion will result in the report of a signal. Conversely, activity of lower magnitude than the criterion value will result in the report of no signal. Two types of errors are possible: either a signal may be missed altogether (i.e., miss), or a signal may be reported when in actuality none was presented (i.e., false alarm). By shifting the criterion value, a subject may vary the proportion of these two types of errors.

Therefore, an individual is presumed to make a decision as to whether or not a signal is present by discriminating between neural activity created by noise alone and that containing noise plus incoming information (Marteniuk, 1976). This point is significant because it emphasizes the fact that decisions people make are affected by internal states of the individual. Other factors such as motivation

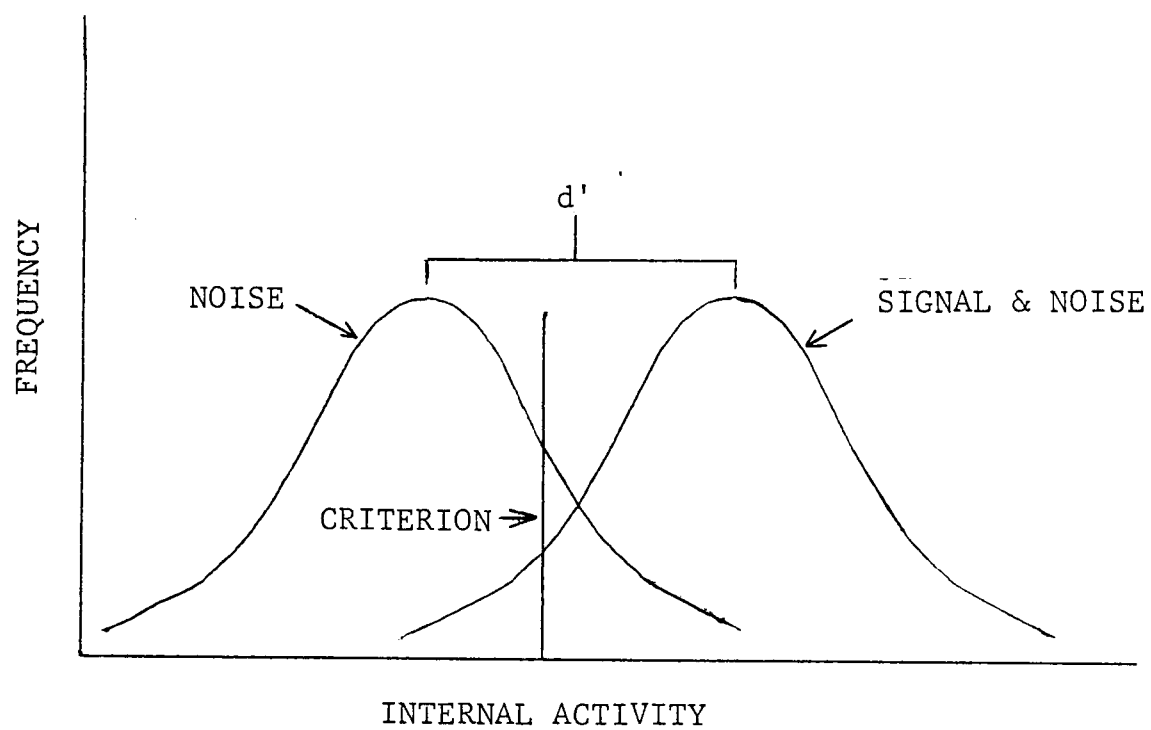


FIGURE 1
PROBABILITY OF SIGNAL DETECTION

and prior learning may also bias decisions by altering the location of the criterion. Marteniuk (1976) suggests two examples of situations in which signal detection theory may contribute to the study of perceptual-motor skills. First he suggests that by analyzing the signal detection ability of superior performers it may be possible to determine how they are able to make rapid decisions. Either their sensory systems are acute, causing them to sense additional information that the average individual is incapable of detecting, or because of prior experience, they use strategies indicative of greater confidence, resulting in a different placement of their cut-offs or criterion.

Given this discussion it appears possible to examine the signal detection performance of both hyperactive and learning disabled groups. Since hyperactives have been characterized by a predisposition to make rapid decisions, it is possible that their sensitivity (i.e., d') is not the same as that of nondisabled individuals. This would be evidenced by lower d' values and a higher percentage of false alarms for the hyperactive group than that of the nondisabled. It is possible that hyperactive individuals differ from nondisabled individuals with respect to the confidence with which they set their criterion. A more strict criterion would result in less false alarms but also more misses. A lenient criterion would result in a greater percentage of hits as well as an increase in false alarms.

Marteniuk (1976) has suggested that signal detection theory may be used to examine the influence of stress on one's judgements. He proposes that the mere presentation of stimuli may cause increases in arousal. Because excitement is classified as a form of stress which may cause arousal to increase beyond an optimal level (Welford, 1968; 1973), it might be predicted that stimulus presentation will cause an individual to shift his cut-off point to the left (see Figure 1) thereby resulting in more false alarms but more hits also. Given an association between underarousal and hyperactivity, it might be predicted that the signal detection performance of hyperactive individuals would reflect many errors of omission (i.e., misses). If an individual is overly aroused (e.g., higher level of neural noise), this would affect the variance of the signal plus noise curve independent of B and performance would be expected to be characterized by more false alarms.

Swanson (1981) tested the hypothesis that learning disabled children manifest a sustained attention deficit. This was done by means of a TSD analysis in a visual and auditory continuous performance task (CPT). On the visual CPT, subjects observed a single letter on the screen for 0.5 seconds with a rest interval of 1.5 seconds between trials. Subjects responded by a thumb movement on a punch button, only when the letter "X" was preceded by letter "A." The

auditory CPT used the same format with letters recorded on tape. The results showed that learning disabled children made significantly fewer correct detections, more false alarms, and were less sensitive to critical stimuli than were nondisabled. However, the performance of the two groups did not differ with respect to the location of their response criterion (B); B decreased significantly over time for both groups while d' remained unchanged.

Goldberg and Konstantareas (1981) used only a visual modality in a TSD paradigm. This task differed primarily from that of Swanson (1981) in that it was self-paced. Subjects observed a plexiglass screen and pressed a button when they detected the drawing of a clown's face and did not press if just the clown's nose was presented. Two deficiencies in performance were evidenced. First, hyperactive children detected fewer signals (i.e., the complete face) than nondisabled subjects. Second, hyperactive children demonstrated a higher incidence of false alarm rates; they also demonstrated slower observing response rates.

It might be argued that a signal detection analysis has several advantages over the traditional approaches to measuring selective attention. First, the pacing of the activity can be either self or force-paced (i.e., experimenter-determined). A self-paced approach appears more in line with what a child would expect in a real life

situation, that is, he/she can spend as much time on an activity as needed. Second, reporting a signal indicative of their attending might be expected to function as a reinforcer for observing. Third, a signal detection approach enables the researcher to more closely examine attentional strategies. Poor selective attention can be discriminated between the subject who does not detect the cue(s) as expressed by errors of omission, versus the subject who responds randomly as expressed by false alarms. Through simultaneous analysis of the percent of correct detections and the percent of false alarms, the researcher can estimate the effect that distractors are having on the performance of the subject. Moreover, the quantity d' , a measure of sensitivity, and that of B , a measure of the location of the decision-making criterion, should provide further explanation for the proportion of hits and false alarms. Fourth, this paradigm allows the researcher flexibility in relationship to the type of stimulus array (visual or auditory) that will be given to the subject. In other words, through careful creation or selection of stimuli one can avoid possible confounds found in standard stimulus cards or slides. Fifth, signal detection analysis allows for the addition of other measures (e.g., response latencies) without affecting primary task performance. Sixth, this paradigm typically requires the subject to make a simple yes/no response immediately following the

presentation of the stimulus. This procedure does not impose any difficult cognitive or memory demands on the subject. Seventh, the subject usually responds by making a simple movement such as pressing a button or pushing a key. Therefore, the motor action does not require the specific fine manual dexterity found in many tasks (e.g., card sorting). Last, the duration of the experiment can be adapted to the specific needs of the researchers. In other words, an experiment vigilant or involving selective attention for a considerable period of time is not required.

10. SUMMARY

On the basis of the literature cited, it appears that the psychophysical method of signal detection may be effectively applied to the measurement of attention in human subjects, including that of hyperactive and learning disabled individuals. A signal detection approach to analyzing selective attention would be predicted to: (a) rely less on a strong memory component evidenced in tasks used in other studies, (b) allow the experimenter to manipulate the pacing of the task, thereby altering reaction time requirements, and (c) allow for the presentation of simple stimuli in a short period of time, thus reducing cultural or prior knowledge biases of subjects, and without testing the short attention span noted in hyperactive

populations. It was the purpose of this study to utilize a signal detection approach in an attempt to more clearly delineate the mechanisms of selective attention in learning disabled, hyperactive, hyperactive-learning disabled, and nondisabled children.

CHAPTER III

PROCEDURES

The procedure used in this study involved the following four areas: (a) selection of subjects, (b) selection of performance apparatus, (c) methods of testing, and (d) data collection.

1. SELECTION OF SUBJECTS

The subject population was limited to sixty young children, fifteen of whom were hyperactive (i.e., H), fifteen learning disabled (i.e., LD), fifteen both hyperactive and learning disabled (i.e., HLD), and fifteen nondisabled. The subjects within each of these groups were distributed evenly among eight, nine and ten year old ages. The diagnosis of hyperactivity was based upon a minimum of two of the following criteria: (a) teacher's and principal's reports, (b) a score of at least one standard deviation above the mean on the Conner's scale of hyperactivity, (1969), (c) medical and developmental histories from the school psychologist, and (d) behavioral observations made by the school psychologist. "Learning disabilities" although strictly an educational term, was used to identify those individuals who demonstrated one or

more "specific deficits in perceptual, integrative, relational or expressive processes not attributable to sense organ defects which impair learning efficiency" (Bannatyne, 1971, p.16). A criterion of at least one year below the normal grade equivalent in achievement on the Otis-Lennon Mental Ability Test (Otis & Lennon, 1967) administered by the school's teachers with assistance from the school psychologist that academic year, was used to determine inclusion in the LD group. This diagnosis of learning disabled was confirmed by a school psychologist. The HLD group was selected according to both of the criteria for hyperactivity and learning disability mentioned above. The remaining fifteen nondisabled control subjects were matched with the H, LD, and HLD subjects on the basis of age. The IQ of all subjects was within the range of 72-105.

All subjects were drawn from Anderson and Knox County, Tennessee schools. They were enrolled in elementary schools in grades 3-5 (i.e., ages 8-10). All subjects were naive to the purpose of the investigation since part of the intention of the project was to determine the types of strategies used by individuals in the performance of the experimental task. All subjects were volunteers and were not paid for their participation. A parent or guardian for each subject was asked to sign an informed assent statement upon their decision to allow their child's participation in the study. The assent form was retained by the researcher.

2. APPARATUS

An eight bank timer (Lafayette Instruments, Model No. 52020) in conjunction with a slide projector (Kodak Carousal 850H), modified with a Lafayette Instruments Lens (Model No. 63050) which was adapted to function as a tachistoscope (i.e., an apparatus used for the brief exposure of visual stimuli) was utilized in the present study. For the forced-paced condition the subject rested his right hand on the table between two telegraph keys separated by a distance of 12 inches (Figure 2). Attached to the keys were cards with the words "yes" or "no" on them, designating which key to depress in response to the presence or absence of a stimulus if stimulus cue(s) appeared ("yes") or not ("no"). For the self-paced condition, a digital timing apparatus (Reaction/Movement Timer, Lafayette Instruments Model No. 63017) and an initiate button was included in addition to the above equipment. Subjects placed their right hand on an initiate button located directly between the two response keys which, upon depression, initiated each trial after a one second delay, and upon its release, stopped the reaction time display which had started accumulating time from the moment the slide appeared on the screen. Time continued to accumulate on the response time display until the subject depressed one of the telegraph keys which subsequently

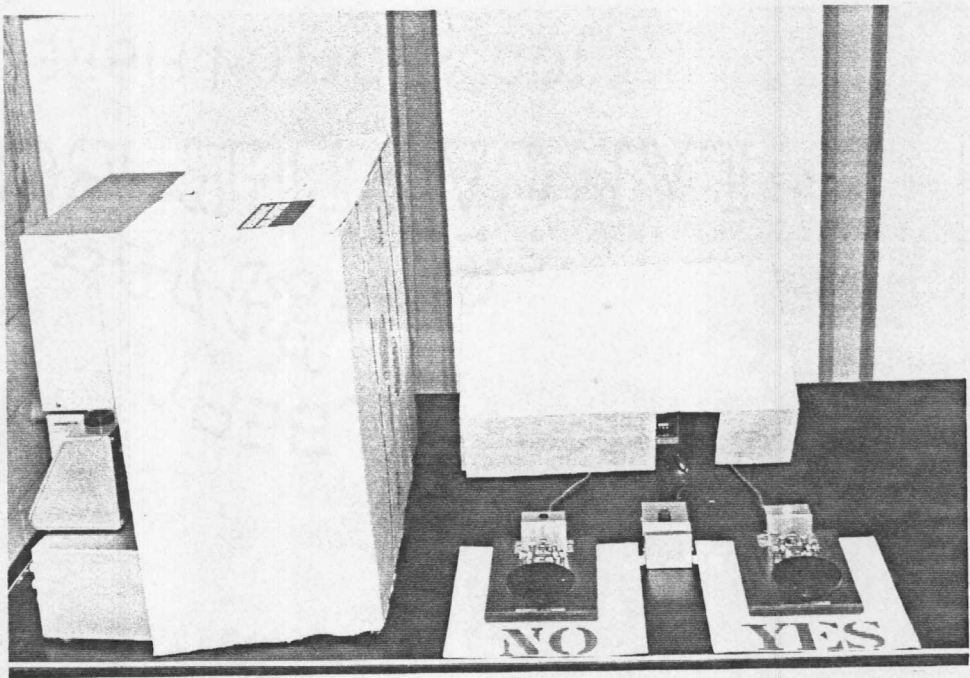


FIGURE 2
PICTURE OF TESTING EQUIPMENT

opened an electronic switch attached to the timing apparatus and stopped the display. The reaction time functioned as a measure of decision time while the subtraction of the reaction time from the response time provided a measure of movement time.

3. METHODS OF TESTING

The subject was brought into the testing area. He was told the experimenter's name and that the experimenter was doing a project for school in which he needed help. The subject was told that there was a Christmas tree on the screen that would light up for a short amount of time. The standard tree pattern (Figure 3) consisted of a group of red dots $\frac{1}{2}$ inch in diameter separated center to center by a distance of $2 \frac{1}{2}$ inches forming the outline and body of an equilateral triangle. This pattern (which was approximately 9 inches in height) was projected onto a screen with the subject seated 84 inches away. The subject was first shown the standard tree pattern for as much time as needed until he thought he could remember the tree pattern. Then the standard tree pattern with all additional cue lights (dots) was presented. This display remained on until the subject had time to review all possible locations of additional cue(s). The cue(s) or additional lights appeared anywhere along the periphery (Figure 4) or within the body

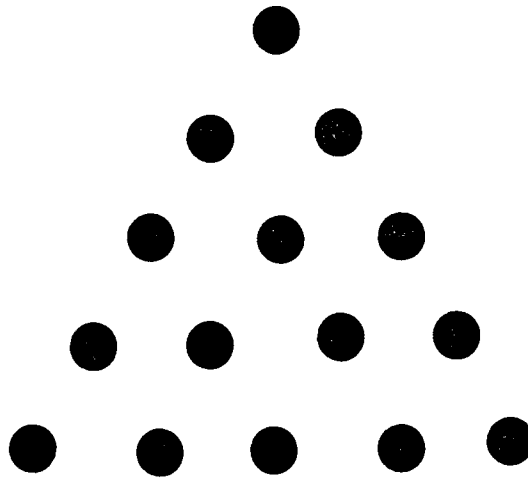


FIGURE 3

SLIDE PATTERN OF STANDARD TREE

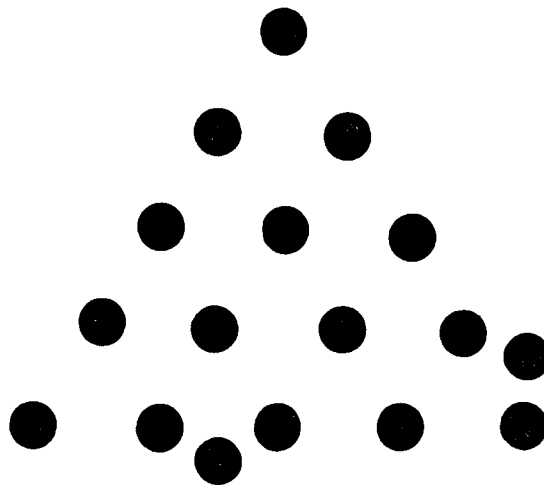


FIGURE 4

STANDARD TREE PATTERN WITH
ADDITIONAL CUES

of the standard tree pattern. For the location of cue(s) see Appendix A. The subject was told to watch carefully and tell the experimenter whether any additional lights (cues) appeared with the standard tree. The display was presented until the subject responded verbally "yes" or "no." Five trials were given in which the subject had to report whether the standard tree or the standard plus additional cues was presented, and this constituted the screening test. The accuracy of subject's responses was used to determine whether subjects appeared to understand the concept "selectively attending." Subjects who did not appear to understand this concept could not be assumed to understand the instructions for either the "force-paced" or the "self-paced" selective attention task. If the individual responded incorrectly on any of the five trials, the researcher thanked him for helping him and was then excused. Only one subject was excused in this experiment.

Subjects who responded correctly to the five screening items were asked to let the experimenter show them another activity and then decide if they wanted to help him by playing the game some more. If the subject agreed, he was told that the same tree pattern would be used except that now the lights would flash for only a short length of time. The subject was told that he simply had to push the "yes" key on the right if he thought any cue(s) appeared with the standard tree pattern and to push the "no" key on the left

if no additional cue(s) appeared with the standard tree pattern. The purpose of the forced-paced selective attention condition was to determine the degree to which subjects were able to attend to the occurrence of cues in a standard tree pattern with a response time limitation. For the forced-paced selective attention condition the subject was told to respond as fast as possible because the next new tree pattern would occur very soon (i.e., 2.1 seconds) and that there was not time to rest or respond after each pattern was flashed (i.e., 0.1 seconds). Each trial included a 1 second foreperiod, presentation of the visual array (i.e., tree pattern) for 0.1 second and a 1.1 seconds decision response interval. The subject was asked if he would like to see the experimenter perform the task once. If his response was "yes", one sample trial was presented. Subjects received a total of 112 trials, 28 in each block with each block involving a fixed decrease in the number of additional cue(s) they were required to selectively attend (i.e., 4, 3, 2, 1 additional cue(s) respectfully). On 25 percent of the trials the additional cues were embedded in the context of the tree pattern and on 25 percent of the trials, they occurred along the periphery of the standard pattern. A one minute break occurred between each block of trials. The subject's responses ("yes" or "no") were recorded by the experimenter.

Under the self-paced condition, a similar procedure was

followed except that subjects initiated each trial by depressing a button and held it down until he made a decision "yes" or "no" and depressed the appropriate key. Again, a demonstration was provided if the subject requested it. The subject's responses included (a) the decision ("yes" or "no"), (b) reaction time, and (c) total response time. All data were recorded on an audiotape.

CHAPTER IV

RESULTS

A within subjects, cross-over design was used with each subject receiving both inter-trial delay conditions (i.e., self- and forced-paced) and cue variation conditions (i.e., 4, 3, 2, or 1 cue(s) for blocks 1, 2, 3, and 4, respectively). The testing order was counterbalanced within the four groups of hyperactive, learning disabled, hyperactive-learning disabled, and nondisabled control subjects. Each subject was tested on two days within a four day period.

The dependent measures included: (a) percentage of hits, (b) percentage of false alarms, (c) d' , (d) B , (e) reaction time, and (f) movement time (See Appendix B for a description of Signal Detection calculations). The latter two measures were recorded only for the self-paced condition. For a more complete discussion of the calculation procedures for d' and B , see Coombs, Dawes, and Tversky (1970), especially Chapter 6, or Green and Swets (1966).

The independent variables included: (a) groups (i.e., hyperactive, learning disabled, hyperactive-learning disabled, and nondisabled), (b) pacing conditions (i.e., forced and self-paced), and (c) age (i.e., 8-10 years).

The quantity d' allowed assessment of the extent of the effect of a distractor (i.e., tree pattern) on selective attention to the presence of additional cue(s). The score d' reflects a subject's sensitivity to the presence of additional cues. Examination of the location of the decision making criterion (B) provided information about the proportion of missed signals, hits, and false alarms. The location of B was the measure used to determine the strictness or leniency of a subject's decision making or bias. Finally, an inspection of response latencies (i.e., reaction time and movement time) under self-paced conditions was conducted to determine whether different error rates between groups were the result of perceptual deficits which would be portrayed by no differences in reaction time and movement time among groups or due to rapid decision making. If inaccuracies in detections were due to rapid decision making, then the imposition of the forced-paced conditions (i.e., those in which all subjects are forced to make rapid decisions), should result in the performance of the groups being compatible.

The data were collected and analyzed to determine whether differences existed between groups (hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled young males) on each of the dependent measures. Another purpose was to determine whether pacing conditions influenced performance on the four Signal Detection Theory

Measures by testing for differences between forced and self-paced values.

This chapter includes the: (a) methods of data analysis, (b) results of analyses, and (c) discussion of the results.

1. ANALYSIS OF DATA

A summary of the results gathered in this experiment can be found in Appendix C. Separate one factor (groups) analyses of variance (ANOVA) were conducted for each of the six dependent measures for total trials and for each of the two pacing conditions (i.e., self- and forced-paced). Subjects were nested within groups. A two-way ANOVA (groups X age) was also conducted to examine the extent of interaction effect of these two variables on signal detection performance and on reaction time and movement time of the self-paced trials. A Newman-Keuls post hoc test (Ferguson, 1981) was used to locate the source of significant ($p < 0.05$) differences. Finally a t test for independent samples (Ferguson, 1981) was used to determine if the two pacing conditions correlated or resulted in different performance for each of the six dependent measures.

2. RESULTS OF ANALYSIS

Although d' and false alarms values tended to correlate with the percentage of hits, hereby providing similar information, the results for each dependent measure will be discussed.

Total Trials

Descriptive statistics for the four Signal Detection Theory measures (i.e., hits, false alarms, d' , and B) for groups are presented in Tables 1, 2, 3, and 4, respectively. The one-way ANOVA summary tables for each of the four measures are presented in Table 5, 6, 7, and 8, respectively. The results for the total trials analysis revealed a significant group effects with respect to: hits, $F(3,56)=3.52$, $p<0.021$; false alarms, $F(3,56)=4.36$, $p<0.008$; and d' , $F(3,56)=3.52$, $p<0.021$.

For all four measures the nondisabled group demonstrated the highest (or in the case of false alarms, the lowest) mean values followed by the hyperactive, learning disabled, and hyperactive-learning disabled groups. The Newman-Keuls post hoc test revealed a significantly higher percentage of hits for the nondisabled than for the hyperactive-learning disabled group. For false alarms, the nondisabled and hyperactive groups had a significantly lower percentage of false alarms than both the

TABLE 1

DESCRIPTIVE STATISTICS FOR HITS
DURING TOTAL TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	92.5	4.7
Learning Disabled	82.5	13.6
Hyperactive	85.8	11.4
Hyperactive-LD	78.0	17.2

TABLE 2

DESCRIPTIVE STATISTICS FOR FALSE ALARMS
DURING TOTAL TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	13.0	10.8
Learning Disabled	19.6	11.3
Hyperactive	13.9	13.8
Hyperactive-LD	30.9	22.3

TABLE 3

DESCRIPTIVE STATISTICS FOR $\underline{d'}$
DURING TOTAL TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	2.54	.79
Learning Disabled	1.98	.63
Hyperactive	2.47	1.01
Hyperactive-LD	1.57	1.21

TABLE 4

DESCRIPTIVE STATISTICS FOR $\underline{B}$
DURING TOTAL TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	1.29	1.11
Learning Disabled	1.00	.43
Hyperactive	1.40	.75
Hyperactive-LD	.84	.36

TABLE 5

ANALYSIS OF VARIANCE FOR HITS
DURING TOTAL TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	16697585	5565861.7	3.52	0.021
S (Groups)	56	88436774	1579228.1	-	-
Total	59	105134359	-	-	-

TABLE 6

ANALYSIS OF VARIANCE FOR FALSE ALARMS
DURING TOTAL TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	30430876.5	10143625	4.36	0.008
S (Groups)	56	130366446.4	2327972	-	-
Total	59	160797322.9	-	-	-

TABLE 7

ANALYSIS OF VARIANCE FOR d'
DURING TOTAL TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	92615.9	30871.9	3.52	0.021
S (Groups)	56	491236.3	8772	-	-
Total	59	583852.2	-	-	-

TABLE 8

ANALYSIS OF VARIANCE FOR B
DURING TOTAL TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	2661280	887093	1.68	0.18
S (Groups)	56	29584146	528288	-	-
Total	59	32245426	-	-	-

hyperactive-learning disabled and the learning disabled groups. Also, the hyperactive-learning disabled demonstrated a significantly higher percentage of false alarms than the learning disabled. For d' , the nondisabled and hyperactive groups demonstrated greater sensitivity than did the hyperactive-learning disabled group.

Self-Paced Trials

Descriptive statistics for the four Signal Detection Measures for groups are presented in Tables 9, 10, 11, and 12. The one-way ANOVA summary tables for the four measures are presented in Table 13, 14, 15, and 16, respectively. The results for the self-paced trials, revealed significant group effects for hits, $F(3,56)=2.86$, $p<0.045$ and for false alarms, $F(3,56)=3.2$, $p<0.03$. In addition, significant group differences were found for both RT, $F(3,56)=3.27$, $p<0.028$ and MT, $F(3,56)=4.27$, $p<0.009$ (See Tables 17, 18, 19, and 20).

Inspection of the mean values reveals the same trend found in the performance for total trials. The nondisabled group demonstrated the highest (lowest for false alarms) performance on all measures, and were followed by the hyperactive, learning disabled, and hyperactive-learning disabled groups, respectively. The results of the Newman-Keuls post hoc test revealed that the nondisabled and hyperactive groups had a significantly greater percent of

TABLE 9

DESCRIPTIVE STATISTICS FOR HITS
DURING SELF-PACED TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	92.7	4.6
Learning Disabled	81.2	14.8
Hyperactive	84.5	14.0
Hyperactive-LD	78.0	20.2

TABLE 10

DESCRIPTIVE STATISTICS FOR FALSE ALARMS
DURING SELF-PACED TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	13.5	9.9
Learning Disabled	17.0	12.6
Hyperactive	15.5	21.2
Hyperactive-LD	32.3	26.0

TABLE 11

DESCRIPTIVE STATISTICS FOR d' DURING
SELF-PACED TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	2.56	.77
Learning Disabled	2.07	.82
Hyperactive	2.52	1.33
Hyperactive-LD	1.59	1.24

TABLE 12

DESCRIPTIVE STATISTICS FOR B DURING
SELF-PACED TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	1.53	1.59
Learning Disabled	1.30	.80
Hyperactive	2.00	2.46
Hyperactive-LD	.97	.45

TABLE 13

ANALYSIS OF VARIANCE FOR HITS
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	18115312	6038437.3	2.86	0.045
S (Groups)	56	118416738	2114584.5	-	-
Total	59	136532050	-	-	-

TABLE 14

ANALYSIS OF VARIANCE FOR FALSE ALARMS
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	33155593.7	11051864	3.2	0.03
S (Groups)	56	193350929.6	3452695	-	-
Total	59	226506523.3	-	-	-

TABLE 15

ANALYSIS OF VARIANCE FOR d'
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	93615.5	31205.2	2.73	0.05
S (Groups)	56	639428.1	11418.4	-	-
Total	59	733043.7	-	-	-

TABLE 16

ANALYSIS OF VARIANCE FOR B
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	9211645.8	3070548.6	1.30	0.28
S (Groups)	56	131998025.5	2357107.5	-	-
Total	59	141209671.3	-	-	-

TABLE 17

DESCRIPTIVE STATISTICS FOR REACTION TIME
DURING SELF-PACED TRIALS

GROUPS	$\bar{x}$ msec	SD
Nondisabled	448	140
Learning Disabled	577	138
Hyperactive	464	109
Hyperactive-LD	548	148

TABLE 18

DESCRIPTIVE STATISTICS FOR MOVEMENT TIME
DURING SELF-PACED TRIALS

GROUPS	$\bar{x}$ msec	SD
Nondisabled	494	104
Learning Disabled	697	191
Hyperactive	575	213
Hyperactive-LD	527	137

TABLE 19

ANALYSIS OF VARIANCE FOR REACTION TIME
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	178320.5	59440.2	3.27	0.028
S (Groups)	56	1018277.2	18183.5	-	-
Total	59	1196597.7	-	-	-

TABLE 20

ANALYSIS OF VARIANCE FOR MOVEMENT TIME
DURING SELF-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	356679.3	118893.1	4.27	0.009
S (Groups)	56	1559806.7	27853.7	-	-
Total	59	1916485.9	-	-	-

hits than did the hyperactive-learning disabled group. In addition, the nondisabled group demonstrated a higher percentage of hits than either the learning disabled or the hyperactive groups. For false alarms, hyperactive-learning disabled subjects demonstrated a significantly higher percent than all the other groups, which did not differ significantly from each other.

Although a significant difference was obtained for reaction time, the Newman-Keuls procedures failed to reveal any significant pairwise differences. The trend in mean reaction times varied slightly from that evidenced in the previous analysis. The nondisabled group had the fastest reaction time followed by that of the hyperactive, hyperactive-learning disabled, and learning disabled groups.

As in the case of the reaction time analysis, a significant difference was obtained for movement time. The movement time of the nondisabled group was fastest, followed by that of the hyperactive-learning disabled, hyperactive, and learning disabled groups, respectively. On the basis of the Newman-Keuls post hoc test, the nondisabled and the hyperactive-learning disabled groups demonstrated significantly faster movement time than the learning disabled group.

A 4 (groups) X 3 (age) ANOVA revealed a significant main effect of groups and a significant groups X age interaction for both RT, $F(6,48)=2.33$, $p<0.047$ and MT,

$F(6,48)=2.53$, $p<0.033$ (See Tables 21 and 22). The 10-year-old nondisabled group demonstrated the fastest reaction time followed closely by the 10-year-old learning disabled group. The 9-year-old hyperactive-learning disabled group had the slowest reaction time. The difference between the fastest and slowest times was significant. For movement time the 10-year-old nondisabled group again had the fastest time. Based upon the Newman-Keuls test, this group's performance was significantly different from that of the group with the slowest movement time (10-year-old, learning disabled). The second (10-year-old, hyperactive group) and third (10-year-old, hyperactive-learning disabled group) fastest movement time groups were also significantly different from the slowest group (10-year-old, learning disabled).

Forced-Paced Trials

Descriptive statistics for the Signal Detection measures for groups are presented in Tables 23, 24, 25, and 26. The one-way ANOVA summary tables for the four measures are presented in Tables 27, 28, 29, and 30, respectively. The results for the forced-paced trials revealed significant effects for hits, $F(3,56)=3.68$, $p<0.017$; false alarms, $F(3,56)=4.34$, $p<0.008$; and for d' , $F(3,56)=4.88$, $p<0.0045$.

For the percentage of hits, the nondisabled group

TABLE 21

ANALYSIS OF VARIANCE FOR GROUP X AGE
OF REACTION TIME

SOURCE	df	SS	MS	F	p
Groups	3	178320.45	59440.15	3.71	0.018
Age	2	25963.6	12981.8	0.81	0.451
Age X Groups	6	223587.6	37264.6	2.33	0.047
S (Age X Groups)	48	768726.0	16015.13	-	-
Total	59	1196597.65	-	-	-

TABLE 22

ANALYSIS OF VARIANCE FOR GROUP X AGE
OF MOVEMENT TIME

SOURCE	df	SS	MS	F	p
Groups	3	356679.3	118893.1	5.23	0.003
Age	2	123927.4	61963.7	2.73	0.076
Age X Groups	6	344617.63	57436.3	2.53	0.033
S (Age X Groups)	48	1091261.6	22734.6	-	-
Total	59	1916485.9	-	-	-

TABLE 23

DESCRIPTIVE STATISTICS FOR HITS
DURING FORCE-PACED TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	92.1	6.7
Learning Disabled	86.5	8.1
Hyperactive	87.1	9.6
Hyperactive-LD	78.1	18.6

TABLE 24

DESCRIPTIVE STATISTICS FOR FALSE ALARMS
DURING FORCE-PACED TRIALS

GROUPS	$\bar{x}$ %	SD
Nondisabled	14.1	12.2
Learning Disabled	22.2	12.7
Hyperactive	12.4	11.2
Hyperactive-LD	29.5	20.7

TABLE 25

DESCRIPTIVE STATISTICS FOR d'
DURING FORCE-PACED TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	2.80	.83
Learning Disabled	2.01	.50
Hyperactive	2.54	.86
Hyperactive-LD	1.65	1.27

TABLE 26

DESCRIPTIVE STATISTICS FOR B DURING
FORCE-PACED TRIALS

GROUPS	$\bar{x}$	SD
Nondisabled	.97	1.22
Learning Disabled	1.36	2.25
Hyperactive	1.36	.77
Hyperactive-LD	.89	.36

TABLE 27

ANALYSIS OF VARIANCE FOR HITS
DURING FORCE-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	15142143.5	5047381	3.68	0.017
S (Groups)	56	76783669.2	13711369	-	-
Total	59	91925812.7	-	-	-

TABLE 28

ANALYSIS OF VARIANCE FOR FALSE ALARMS
DURING FORCE-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	28179805.1	9393268	4.34	0.008
S (Groups)	56	121193656.3	2164172	-	-
Total	59	149373461.4	-	-	-

TABLE 29

ANALYSIS OF VARIANCE FOR d'
DURING FORCE-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	120832	40277.5	4.88	0.005
S (Groups)	56	462567.9	8260	-	-
Total	59	583400	-	-	-

TABLE 30

ANALYSIS OF VARIANCE FOR B DURING
FORCED-PACED TRIALS

SOURCE	df	SS	MS	F	p
Groups	3	2835434.6	945144.9	0.52	0.67
S (Groups)	56	101667040.4	1815482.8	-	-
Total	59	104502475	-	-	-

demonstrated the highest value of correct detections and were followed in performance by the hyperactive, learning disabled, and hyperactive-learning disabled groups. The nondisabled group detected a significantly greater percent of cue(s) than the hyperactive-learning disabled. Interestingly, the hyperactive group had the lowest percent of false alarms. They were followed by the nondisabled, learning disabled and the hyperactive-learning disabled groups. The poor performance by the hyperactive-learning disabled was found to be significantly different from that of all the other groups. In addition, the performance of the learning disabled group was also significantly different from that of the hyperactive and the nondisabled groups. For d' , the nondisabled group demonstrated the greatest sensitivity. The performance of this group was followed in descending accuracy by that of the hyperactive, learning disabled and hyperactive-learning disabled groups. Based upon the Newman-Keuls test, both the nondisabled and hyperactive groups were significantly more sensitive than the hyperactive-learning disabled group.

Pacing Conditions

Separate t tests for differences in hits, false alarms, d' , and B for self- versus force-paced conditions revealed no significant effects. Although not statistically significant, a greater percentage of hits and a higher

sensitivity (d') was evidenced under the forced-paced condition. A less strict criterion (B) and a lower percentage of false alarms occurred under the forced-paced condition.

3. DISCUSSION OF RESULTS

Pacing Conditions

This study provided no support for the suggestion that forced-pacing would result in a significant decrease in performance on the four measures derived from signal detection analysis. Such a lack of support is based on the absence of any significant differences between pacing conditions on any of the four measures. This appears in direct opposition to Douglas' (1972) proposal that the performance of hyperactive children is equivalent to that of nondisabled subjects under self-paced conditions but inferior to that of nondisabled subjects under forced-paced conditions. There appears to be at least two possible explanations for the lack of support for Douglas' hypothesis in the present study. First, in this study the testing period was relatively brief in nature (20 minutes); this may have reduced the possibility that the short attention span characteristic of most hyperactive children influenced performance. Second, this study clearly differentiated

between hyperactive children and hyperactive children who also had learning disabilities.

Several trends in the present findings appear noteworthy. First, with one exception (i.e., the learning disabled group) although not significant, all groups demonstrated greater sensitivity (d') under the forced-paced condition than under the self-paced condition (see Figures 5 and 6). Second, one would normally have expected that by imposing a time restraint on subjects, their performance would be impaired (i.e., decreases in the percent of hits, increases in the percent of false alarms, and lowered d' values). However, this was found to be true for the percent of hits only for the nondisabled group (see Figure 7 and 8). In relation to false alarms, performance decreased (i.e., higher occurrence of false alarms) under forced-paced conditions for nondisabled and learning disabled groups but increased for the two hyperactive groups (see Figure 9 and 10). Lastly, all groups (with the exception of the learning disabled group) established a stricter criterion (B) under the self-paced condition than under the forced-paced condition (see Figure 11 and 12). This result was not unexpected due to the fact that under the self-paced condition subjects had an unlimited amount of time to make their decisions. Therefore, immediate judgements would not have to be made and the subject would have more time to reflect on his final decision.

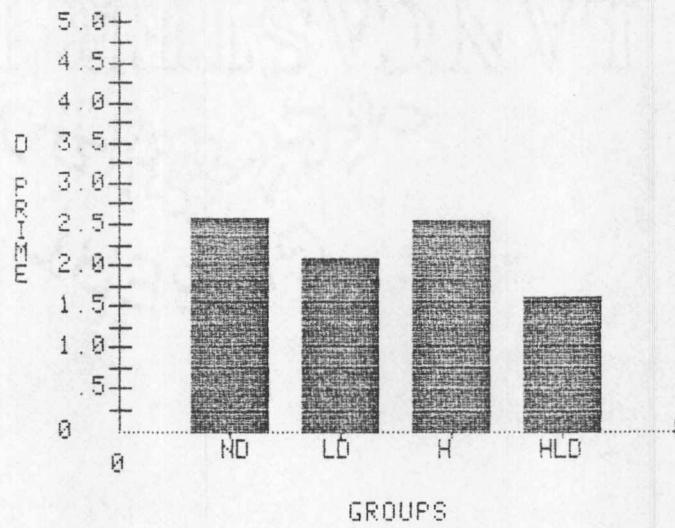


FIGURE 5

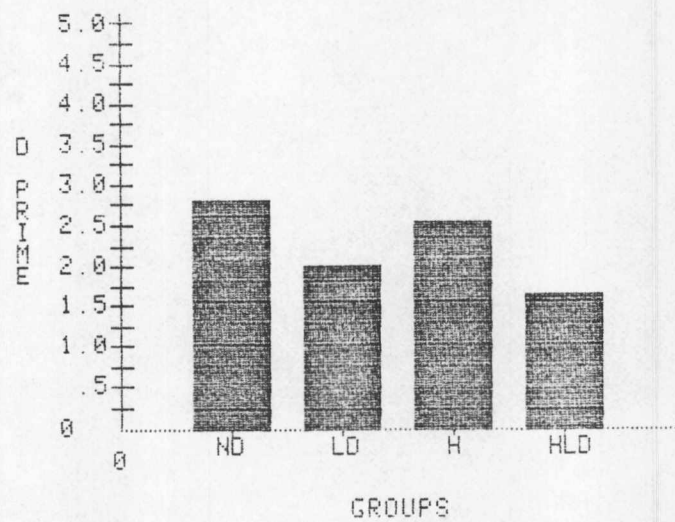
SENSITIVITY (d') FOR SELF-PACED TRIALS

FIGURE 6

SENSITIVITY (d') FOR FORCED-PACED TRIALS

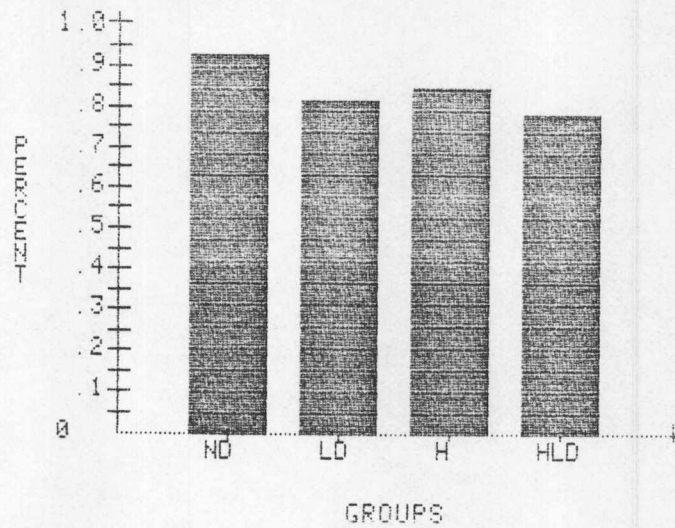


FIGURE 7

PERCENT OF HITS FOR SELF-PACED TRIALS

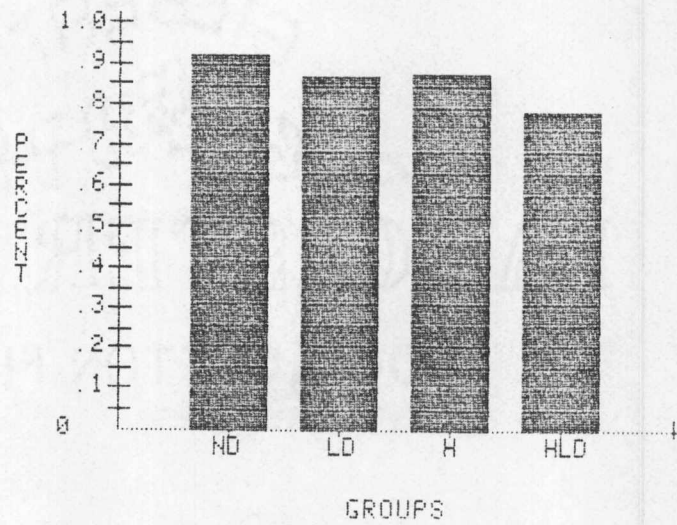


FIGURE 8

PERCENT OF HITS DURING FORCED-PACED TRIALS

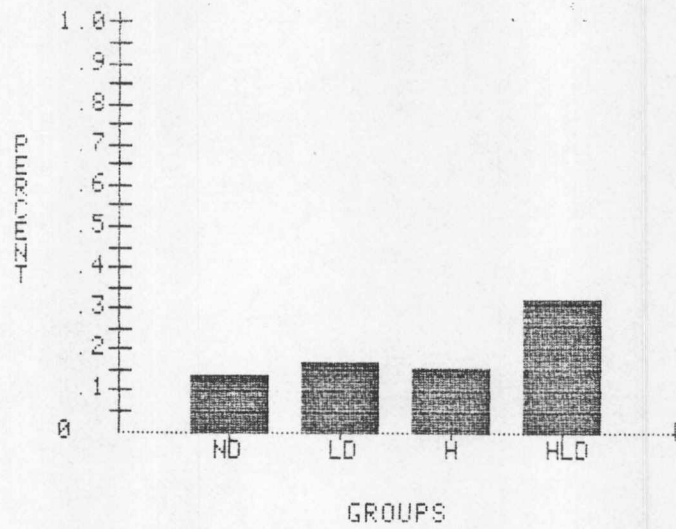


FIGURE 9

PERCENT OF FALSE ALARMS DURING
SELF-PACED TRIALS

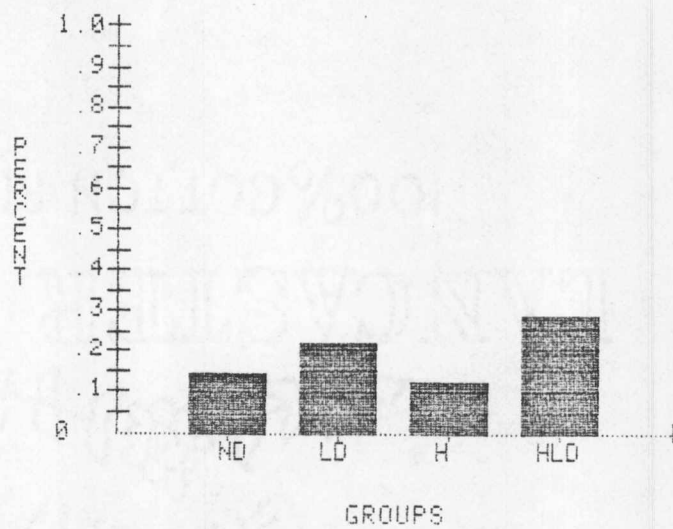


FIGURE 10

PERCENT OF FALSE ALARMS DURING
FORCED-PACED TRIALS

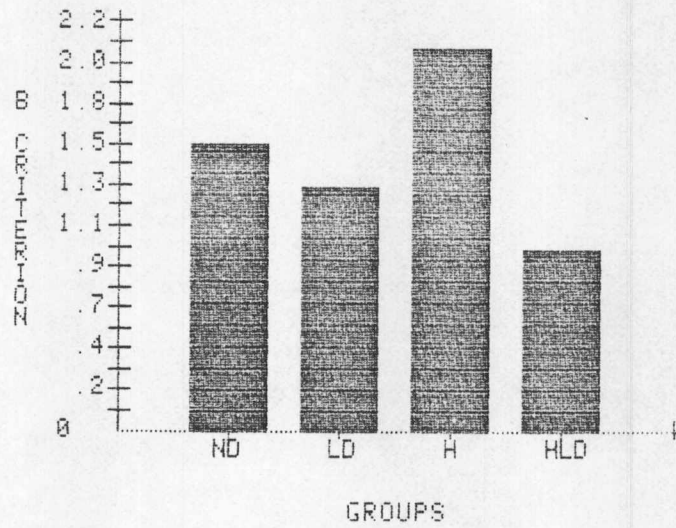


FIGURE 11

CRITERION (B) DURING SELF-PACED TRIALS

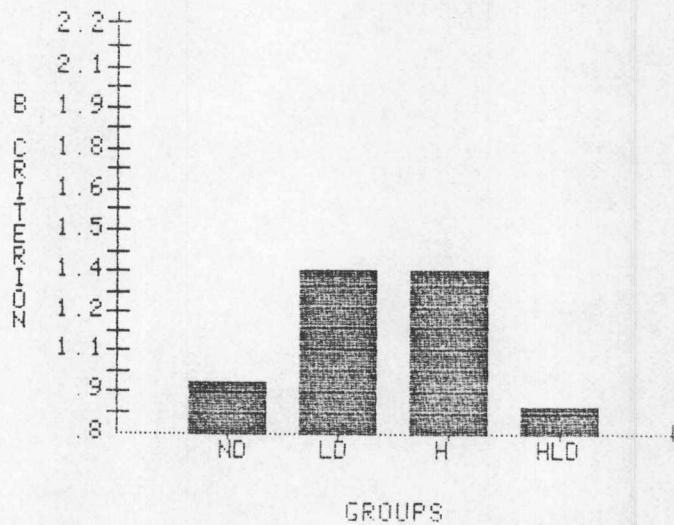


FIGURE 12

CRITERION (B) DURING FORCED-PACED TRIALS

Groups

Hyperactive-Learning Disabled Group. Excluding the measures of movement time and reaction time, this group consistently demonstrated the poorest performance. On the basis of total trials their performance on all measures was always significantly inferior to that of the nondisabled subjects (see Figure 13,14 and 15). For false alarms their performance was inferior (higher percentage of false alarms) to that of all the other groups. For d' , their performance indicated a level of sensitivity lower than that of the nondisabled, and the hyperactive groups (see Figure 6). While their correct detections (hits) were similar in quantity to that of the hyperactive and the learning disabled groups, they tended to have fewer than either group (see Figure 13).

Under self-paced conditions, the false alarms of the hyperactive learning disabled group were significantly higher than those of the other three groups (see Figure 10). For hits, their performance differed (i.e., lower percentage) from that of the nondisabled and the hyperactive groups (see Figure 7). Although the d' and the B measures of this group under self-paced conditions appeared to be lower than those of the other groups, no significant differences between the groups were obtained.

Under forced-paced conditions this group again

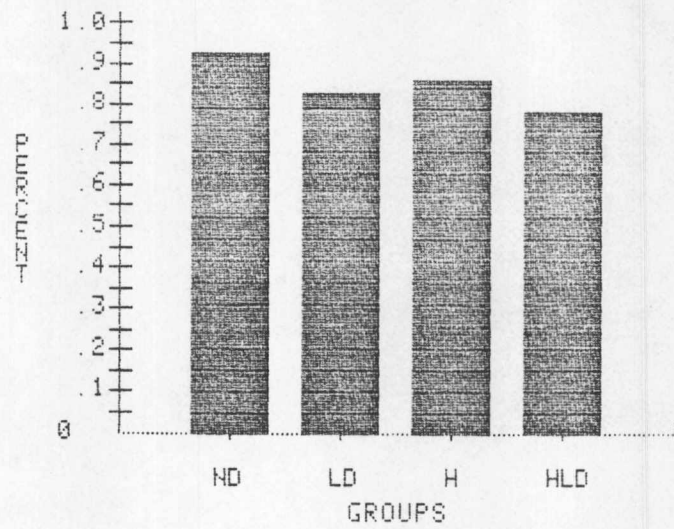


FIGURE 13

PERCENT OF HITS DURING TOTAL TRIALS

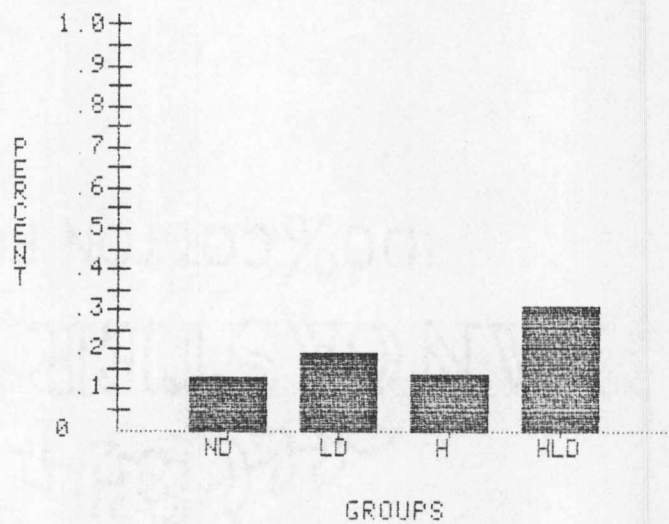


FIGURE 14

PERCENT OF FALSE ALARMS DURING
TOTAL TRIALS

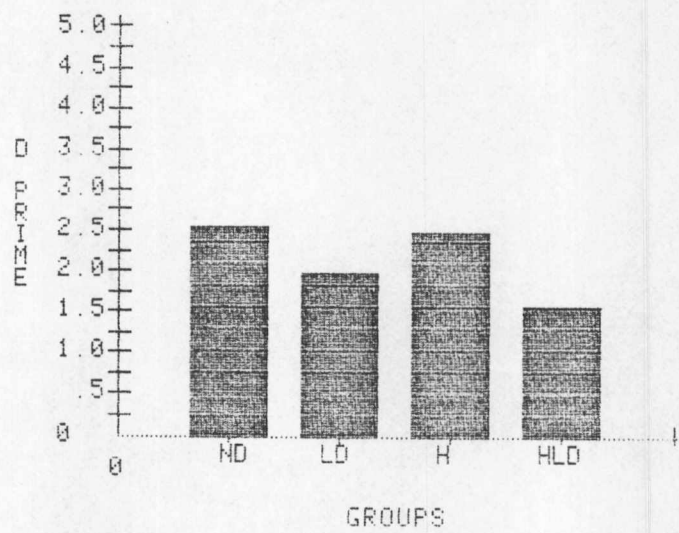


FIGURE 15

SENSITIVITY (d') DURING TOTAL TRIALS

portrayed the poorest performance. For hits, their performance differed significantly (i.e., lower percentage) only from that of the nondisabled group while for d' , their performance was significantly less sensitive than that of both the nondisabled and the hyperactive groups. Lastly, their percentage of false alarms was significantly higher than that of the other three groups (see Figure 10).

Learning Disabled Group. Excluding the measure B , the mean performance of this group appeared to be next to the poorest on all the signal detection measures. However, on the basis of the Newman-Keuls post hoc tests their performance differed significantly only from that of (a) the nondisabled group for hits under forced-paced conditions (i.e., a lower percentage), (b) the nondisabled and hyperactive-learning disabled groups for movement time (see Figure 16), and (c) the nondisabled and the hyperactive groups for false alarms (i.e., a lower percentage on both total trials and forced-paced trials).

Hyperactive Group. Of major importance was the fact that for only two of the nine signal detection measures (i.e., d' for total trials and hits for self-paced trials) did this group's performance differ from that of nondisabled subjects. In fact, for several measures (such as B for self-paced, forced-paced and total trials, and false alarms

for forced-paced trials) their performance was equal to and at times better than that of nondisabled subjects (e.g., Figure 10). For several measures (i.e., d' for total trials and false alarms for total trials and for forced-paced trials) their performance was significantly better than that of the learning disabled group. For six of the nine signal detection measures their performance was significantly better than that of the hyperactive-learning disabled group. The only measure that revealed relatively poor performance for this group was movement time (see Figure 16). For this measure their performance was close to that of the learning disabled group which had a movement time which was significantly slower than that of the other three groups.

Reaction Time

Although a significant groups effect was found for reaction time under the self-paced condition, no significant pairwise comparisons were obtained using the Newman-Keuls procedure. The learning disabled group followed by the hyperactive-learning disabled group demonstrated the slowest mean values (see Figure 17). Post hoc inspection of the significant age X groups interaction for reaction time revealed significantly slower times only for the last two groups when compared with that of the fastest group (i.e., 10-year-old, nondisabled group). The three

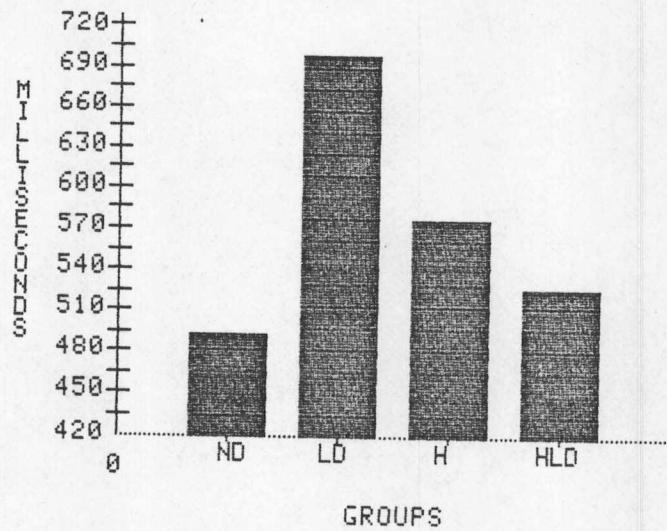


FIGURE 16

MOVEMENT TIME FOR GROUPS

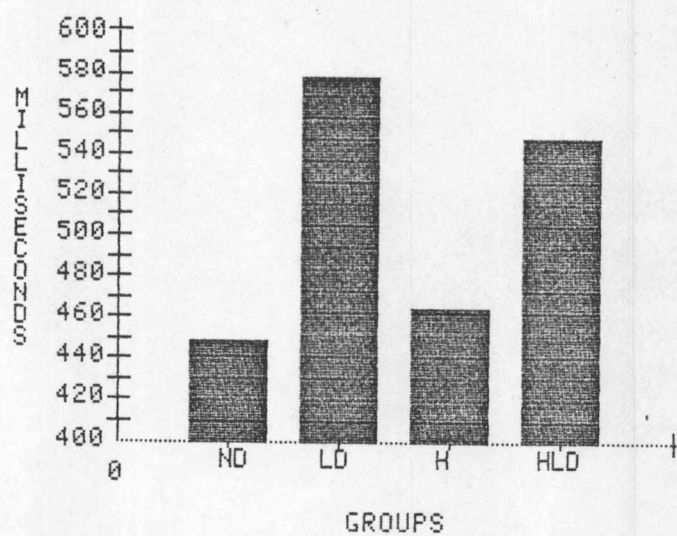


FIGURE 17
REACTION TIME FOR GROUPS

fastest movement times were obtained by subjects 10 years of age but each from three different groups (i.e., nondisabled, hyperactive, and hyperactive-learning disabled).

4. SUMMARY

The results of this study seem to indicate that selective attention deficits are a characteristic of learning disabled and hyperactive-learning disabled (i.e., hyperkinetic) subjects. This result is in agreement with those of previous studies (Dykman, Ackerman, & Oglesby, 1980; Traver et al., 1977; Vrana & Pihl, 1980). More importantly the results of this study are in support of Ross' (1976) hypothesis that selective attention deficits are characteristic of individuals with learning disabilities and not of those who manifest hyperactivity. Thus, it might be argued that the attention deficits that have been reported for hyperactive or formerly hyperactive groups in previous studies (Bremer & Stern, 1976; Dykman, et al., 1980; Goldberg & Konstantareas, 1981; Fisher, 1977; Keogh, 1971; Radosh & Gittelman, 1981; and Zambelli, Stamm, Maitinsky, & Loiselle, 1977) were due to inappropriate identification or classification of subjects as hyperactive rather than as hyperkinetic, or vice versa. Extreme differences in the performance of hyperactive-learning disabled and hyperactive groups were found for almost all measures.

Many of these differences were significant, with most mean values for the two groups appearing at the opposite ends of the continuum.

Inconclusive evidence was found with respect to response tendencies. Douglas (1972) noted that for tasks which are of short duration and/or self-paced, the performance of hyperactive and nondisabled subjects are usually equivalent. However, in tasks which are forced-paced, performance of the groups usually differs. Douglas (1972) has proposed that these differences are typically expressed in terms of a higher number of errors and/or slower reaction times for the hyperactive group. In the present study no differences in signal detection performance were found for these two groups for either self-paced or forced-paced conditions. However, a difference in the movement time performance of the two groups was evident on self-paced trials. For this measure both the nondisabled and hyperactive-learning disabled groups demonstrated faster MTs than did the hyperactive group. McIntyre et al. (1981) found that the response latencies of learning disabled and hyperactive-learning disabled subjects were longer than those of nondisabled subjects. In the present study, when RT and MT were combined a similar trend to that reported by McIntyre, et al. (1981) was found. Therefore, it might be argued that longer latencies are characteristic of learning disabled groups, including those that are also hyperactive.

One other point to consider in discussion of RT/MT is response tempo. One characteristic commonly associated with hyperactive children is impulsivity (Kagan, Rosman, Day, Albert, & Phillips, 1964; Keogh, 1971). This speeding-up of decision making usually results in the subject making more errors. However, based upon response times of the hyperactive group investigated in the present study, there appears to be no particular support for an impulsivity interpretation.

In agreement with Sykes et al. (1972), the present findings for false alarms (i.e., responses to non-significant stimuli), revealed no differences in performance between hyperactive and nondisabled groups. Although Sykes et al. (1972) found this fact to be true for only trials with a fast interstimulus interval (i.e., similar to the present study's forced-paced condition), apparently the responses of hyperactive can not be labelled as impulsive. Impulsive responding would result in a large number of false alarms if there were errors.

The hyperactive child has also been characterized as being field dependent (Campbell, 1969; Douglas, 1972). The field-dependent subject would be expected to demonstrate difficulty in isolating a figure or cue(s) from a confusing, high information context. Therefore, one would expect many misses or a low percentage of hits in the signal detection performance of a field dependent subject. Based upon the

signal detection and the reaction time and movement time performance of the hyperactive group used in the present study, it might be speculated that they were not overly field dependent (i.e., they did not experience difficulty in isolating the cue(s) from the background pattern of a tree).

The results of this study did appear to be consistent with those of Swanson (1981) who also used a signal detection analysis, although his study required sustained attention over a considerable length of time (i.e., stimuli presentation time 28 minutes). Based upon the d' values obtained in the present study, learning disabled and hyperactive-learning disabled subjects appeared to be less sensitive to critical stimuli than were nondisabled or hyperactive subjects. In both the Swanson (1981) study and the present investigation, no group differences were found with respect to the location of subject's response criterion (B). Significant differences in B tend to be found only in studies which deliberately alter signal/noise ratios, or offer varying payoff matrices (e.g., Guralnick, 1972).

The results of this study seem to support the notion that signal detection analysis is a viable method for examining selective attention performance in special populations. In addition to the typical probabilities or percentage of stimuli identified or missed offered by other measures of selective attention, signal detection analysis

provided two additional measures, d' and B , which provide a more detailed explanation of selective attention performance (Sheehan & Drury, 1971; Swets, 1977).

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

1. SUMMARY

It was the primary intent of this study to examine under two conditions of response pacing, the selective attention abilities of hyperactive, hyperactive-learning disabled, learning disabled, and nondisabled groups utilizing the method of Signal Detection Analysis. A secondary objective was to determine whether differences existed in response latencies (as reflected in reaction and movement times during self-paced trials) for the four groups.

Sixty young males, ages 8, 9, and 10 years, from Knox and Anderson County, Tennessee Schools served as subjects for the study. Each group had five subjects from each of the three age categories. The special children were identified conjunctively by Principals, Resource Teachers, and School Psychologists.

A tachistoscope and reaction/movement timer were the primary apparatus used in the study. The standard visual stimulus consisted of a group of red dots which formed the outline and body of a triangle. Additional red dots

situated along the periphery or embedded in the context of the standard pattern functioned as the cue(s). Two conditions of response pacing were utilized. For the self-paced condition the subject initiated each trial by depressing an initiate switch and holding it down until a slide was presented briefly (i.e., for 0.1 second). Upon presentation the subject released the switch and depressed the appropriate telegraph key, (designated "yes" if he thought additional cue(s) were presented or "no" if he thought that no additional cue(s) were presented) as quickly as possible. Reaction time was measured from the moment the slide appeared until the moment the subject lifted his finger from the initiate switch. Response time was measured from the moment the slide appeared until the moment of depression of either of the response keys. Subjects were instructed to depress the initiate switch and keep it depressed until they made a decision regarding which key to depress; then they attempted to move their hand to the respective key "as fast as possible." Subjects received four blocks (decreasing in the number of additional cue(s); 4, 3, 2, and 1) of twenty-eight trials with a one minute rest between each block. In the forced-paced condition the subject rested his dominant hand between the two response keys and made the appropriate response upon presentation of the stimulus by the experimenter. The rate of presentation of stimuli in this condition was one every 2.1 seconds.

The stimulus was displayed for 0.1 second.

The percentage of hits and false alarms, as well as d' and B were calculated for all subjects for self-paced trials, forced-paced trials and for the combined total of all trials. In addition, reaction and movement times were recorded for self-paced trials. A one-way analysis of variance (groups) was conducted for each of the dependent measures under each of the pacing conditions and for total trials. In addition, a two-way ANOVA (groups X age) for signal detection measures was conducted for each of the pacing conditions and for total trials. This same analysis was conducted for reaction time and movement time means under the self-paced condition. Separate t tests were conducted on each of the signal detection measures to compare performance under the two pacing conditions. Newman-Keuls post hoc tests were used to locate the source of significant differences ($p < 0.05$).

The most noteworthy finding of the study was that the signal detection performance for the hyperactive and the nondisabled groups (regardless of dependent measure or pacing condition analyzed) was not significantly different. In addition, the results indicated significant differences in the performance of hyperactive-learning disabled and nondisabled groups for all measures. It is suggested that the discrepancies noted in the results of earlier studies examining the selective attention performance of hyperactive

and learning disabled groups, may have been due to inappropriate classification of subjects. When such problems are controlled for, it appears that the selective attention performance of hyperactive children parallels that of nondisabled subjects. The present findings suggest that the presence of learning disabilities adversely affects the ability to selectively attend. (This notion received support from the finding of poor selective attention performance by both the learning disabled and the hyperactive-learning disabled groups.) Moreover, from the present results it appears that the combination of hyperactivity and learning disabilities magnifies the severity of selective attention deficits to a greater degree than the existence of either condition alone.

2. CONCLUSIONS

It is acknowledged that alternative explanations of the strategies subjects may have used to make their decisions for this task are possible. However, due to the fact that signal detection was the task used in this study, the following conclusions are offered, based on the assumption that all subjects were selectively attending in some fashion to stimuli during task performance. Based on the results obtained in this study the following conclusions appear warranted:

1. There exist no differences in the selective attention performance of hyperactive and nondisabled children.

2. The presence of learning disabilities is reflected in poor selective attention performance.

3. The combination of hyperactivity with learning disabilities adversely affects selective attention performance.

4. Extreme care must be taken when identifying children as hyperactive. The selective attention performance of individuals experiencing learning disabilities in addition to hyperactivity may be expected to be inferior to that of hyperactive-only subjects.

3. RECOMMENDATIONS

1. There is a need for additional research which examines the response rates of special groups under different pacing conditions. Of particular importance will be experiments which systematically vary both inter-trial intervals and stimulus presentation duration.

2. There is a need for research investigating the presence of distraction and its effect on reaction time and detection rates by varying the background display size and target size. This type of investigation should allow more accurate determination of factors in the visual display

which are affecting the performance of learning disabled and hyperactive-learning disabled subjects.

3. There is a need for research which examines the effect of various spatial distributions of stimuli on reaction time and selective attention for nondisabled and special groups. This type of research may serve to determine whether the "spreading of attention" noted by Post and Leibowitz (1981) with nondisabled subjects is a quality expressed by special groups. If not, this might contribute to an explanation of the poor performance of learning disabled and hyperactive-learning disabled subjects on various detection measures.

4. There is a need for additional research which tests Kahneman and Henik's (1976) hypothesis that the addition of items of a relevant nature to the background of a display causes increased interference or distraction. Investigation of this nature may further elaborate the mechanisms of selective attention difficulties in learning disabled and hyperactive-learning disabled subjects.

5. Additional research is needed which examines the response trends of special groups. Recently, processes such as matching (i.e., a comparison of successive signals to determine the extent of physical identity; Rabbit, Cumming, & Vyas, 1976) or some other generalized rules have been evidenced to bias observation in visual search paradigms. Additional examination of such trends might contribute to an

explanation for the poor performance of special groups on selective attention measures.

6. There is a need for additional research which tests the effect of practice on the efficiency and perceptual processing of special groups.

LIST OF REFERENCES

LIST OF REFERENCES

- Ackerman, P.T., Elardo, P.T., & Dykman, R.A. A psychosocial study of hyperactive and learning disabled boys. Journal of Abnormal Child Psychology, 1979.
- Bakwin, H. Bakwin, R.M. Clinical management of behavior disorders in children. Philadelphia: W.B. Saunders, 1966.
- Bannatyne, A. Language, reading and learning disabilities. Springfield, Ill.: Charles C. Thomas, 1971.
- Bax, M. Who is hyperactive? Developmental Medicine and Child Neurology, 1978, 20, 277-278.
- Braud, L.W. The effects of frontal EMG biofeedback and progressive relaxation upon hyperactivity and its behavioral concomitants. Biofeedback and Self-Regulation, 1978, 3(1), 69-89.
- Bremer, D.A., & Stern, J.A. Attention and distractibility during reading in hyperactive boys. Journal of Abnormal Child Psychology, 1976, 4(4), 381-387.
- Broadbent, D.E. Perception and communication. Oxford: Pergamon Press, 1958.
- Buktenica, N.A. Auditory discrimination: A new assessment procedure. Exceptional Children, 1971, 237-240.
- Burks, H. The hyperactive child. Exceptional Children, 1960, 27, 18-26.
- Campbell, S. Cognitive styles in normal and hyperactive children. Unpublished doctoral dissertation, McGill University, 1969.
- Campbell S.B. & Douglas, V.I. Cognitive styles and responses to the threat of frustration. Canadian Journal of Behavioral Science, 1972, 4, 30-42.
- Campbell, S.B., Douglas, V.I., & Morgenstern, G. Cognitive styles in hyperactive children and the effect of methylphenidate. Journal of Child Psychology, Psychiatry, 1971, 12, 55-67.
- Cantwell, D.P. The hyperactive child: Diagnosis, management, current research. New York: Spectrum, 1975.

- Carrol, J.L. Assessment of short-term visual memory and its educational implication. Perceptual Motor Skills, 1973, 37, 383-388.
- Carrol, J.L. A visual memory scale (VMS) designed to measure short-term visual recognition memory in 5 and 6 year old children. Psychology in the Schools, 1972, 9, 152-158.
- Clements, S.D. Minimal brain dysfunction in children. In S. Sapioc & A. Nitzburg (Eds.), Children with learning problems. New York: Brunner/Mazel, 1973.
- Clements, S.D. Minimal brain dysfunction in children. Identification and terminology. Public Health Service Publication No. 1415, 1966.
- Cohen, N.J. & Douglas, V.I. Characteristics of the orienting response in hyperactive and normal children. Psychophysiology, 1972, 9, 238-245.
- Cohen, N.J., Weiss, G., & Minde, K. Cognitive styles in adolescents previously diagnosed as hyperactive. Journal of Child Psychology and Psychiatry and Allied Disciplines, 1972, 13, 203-209.
- Conners, C.K. A teacher rating scale for use in drug studies with children. American Journal of Psychiatry, 1969, 126, 804-888.
- Conners, C.K. rating scales for use in drug studies with children. Psychopharmacology Bulletin, 1973, 15, 24-84.
- Coombs, C.H., Dawes, R.M., & Tversky, A. Mathematical psychology, an elementary introduction. Englewood Cliffs, N.J.: Prentice-Hall, 1970.
- Copeland, A.P., & Wisniewski, N.M. Learning disability and hyperactivity: deficits in selective attention. Journal of Experimental Child Psychology, 1981, 32, 88-101.
- Deutsch, J.A. & Deutsch, D. Attention: Some theoretical considerations. Psychological Review, 1963, 70, 80-90.
- Douglas, V.I. Sustained attention and impulse control: Implications for handicapped children. In J.A. Swets & L.L. Elliot (Eds.), Psychology and the Handicapped Child, Washington, D.C., U.S. Office of Education, 1973.

Douglas, V.I. Stop, look and listen: The problem of sustained attention and impulse control in hyperactive and normal children. Canadian Journal of Behavioral Science, 1972, 4, 259-281.

Dykman, R.A., Ackerman, P.T., & Oglesby, D.M. Correlates of problem solving in hyperactive, learning disabled, and control boys. Journal of Learning Disabilities, 1980, 13(6), 23-32.

Dykman, R.A., Walls, R.C., Suzuki, T., Ackerman, P.J., & Peters, J.E. Children with learning disabilities: Conditioning, differentiation, and the effect of distraction. American Journal of Orthopsychiatry, 1970, 40, 744-782.

Feingold, B. Hyperkinesis and learning disabilities linked to the ingestion of artificial colors and flavors. Journal of Learning Disabilities, 1976, 9, 551-559.

Ferguson, G.A. Statistical analysis in psychology and education (5th ed.). New York: McGraw-Hill, 1981.

Firestone, P. & Douglas, V. The effects of reward and punishment on reaction times and autonomic activity in hyperactive and normal children. Journal of Abnormal Child Psychology, 1975, 3, 210-215.

Fisher, M.A. Dimensional interaction in hyperactive children: classification of computer-displayed stimuli. Bulletin of the Psychonomic Society, 1977, 10(6), 443-446.

Fitts, P.M. & Posner, M.I. Human performance. Belmont, California: Brooks/Cole, 1967.

Fulton, C.D. & Hubbard, A.W. Effect of puberty on reaction and movement times. Research Quarterly, 1972, 46(3), 335-344.

Garner, W.R., & Felfoldy, G.L. Integrality of stimulus dimension in various types of information processing. Cognitive Psychology, 1970, 1, 225-241.

Gibson, E.J. Principles of Perceptual Learning and Development. New York: Appleton-Century-Crofts, 1969.

Goldberg, J.O., & Konstantareas, M.M. Vigilance in hyperactive and normal children on self-paced operant task. Journal of Child Psychology, Psychiatry, 1981, 22, 55-63.

Goldstein, E.B. Sensation and perception. Belmont, CA.: Wadsworth, 1980.

Graham, F.K., & Kendall, B.S. Memory-for-designs test: Revised general manual. Perceptual and Motor Skills, 1960, 11, 147-188.

Green, D.M., & Swets, J.A. Signal detection theory and psychophysics. Huntington, New York: Kreiger, 1966.

Grunewald-Zuberbier, E., Grunewald, G., & Rasche, A. Hyperactive behavior and EEG arousal reactions in children. Electroencephalography and Clinical Neurophysiology, 1975, 38, 149-159.

Guralnick, M.J. Observing responses and decision processes in vigilance. Journal of Experimental Psychology, 1972, 93(2), 239-244.

Hagen, J.W. The effect of distraction on selective attention. Child Development, 1967, 38, 685-694.

Hagen, J.W., & Huntsman, N.J. Selective attention in mental retardate. Developmental Psychology, 1971, 5(1), 151-160.

Haith, M.M. Developmental changes in visual information processing and short-term visual memory. Human Development, 1971, 14, 249-261.

Hallahan, D.P., Gajar, A.H., Cohen, S.B., & Tarver, S.G. Selective attention and locus of control in learning disabled and normal children. Journal of Learning Disabilities, 1978, 11(4), 47-52.

Hallahan, D.P., Kauffman, J.M., & Ball, D.W. Selective attention and cognitive tempo of low achieving and high achieving sixth grade males. Perceptual and Motor Skills, 1973, 36, 579-583.

Hallahan, D.P., Kauffman, J.M., & Ball, D.W. Effects of stimulus attenuation on selective attention performance of children. The Journal of Genetic Psychology, 1974, 125, 71-77.

Hallahan, D.P., Tarver, S.G., Kauffman, J.M., & Graybeal, N.L. A comparison of the effects of reinforcement and response cost on the selective attention of learning disabled children. Journal of Learning Disabilities, 1978, 11(7), 39-47.

Hiscock, M., Kinsbourne, M., Caplan, B., & Swanson, J.L. Auditory attention in hyperactive children: effects of stimulant medication on dichotic listening performance. Journal of Abnormal Psychology, 1979, 88(1), 27-32.

Kagan, J. Reflection-impulsivity and reading ability in primary grade children. Child Development, 1965, 36, 609-628.

Kagan, J., Rosman, B.L., Day, D., Albert, J., & Phillips, W. Information processing in the child: Significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78 (1, Whole No. 578).

Kahneman, D. Attention and effort. Englewood Cliffs, N.J.: Prentice-Hall, 1973.

Kahneman, D. & Henik, A. Effects of visual grouping on immediate recall and selective attention. In S. Dornic (Ed.), Attention and performance VI. International Symposium on Attention and Performance (6th), Stockholm, Sweden, 1975.

Karp, S.A. & Konstadt, N.L. Manual for the Children's Embedded Figures Test. New York: Cognitive Tests, 1963.

Keele, S.W. Attention and human performance. Pacific Palisades, CA: Goodyear, 1973.

Kerr, R. Psychomotor learning. New York: Saunders, 1982.

Keogh, B.A. Hyperactivity and learning disorders: A review and speculation. Exceptional Children, 1971, October, 101-109.

Kinsbourne, M. Artificial food colors impair the learning performance of hyperactive children: Laboratory evaluations of in-patients. Paper presented at the Learning Disabled Child: A Multidisciplinary Challenge, Boston University School of Medicine, January 1979.

Kupietz, S. Bialer, I., & Winsberg, B.G. A behavior rating scale for assessing improvement in behaviorally deviant children: a preliminary investigation. American Journal of Psychiatry, 1972, 128(11), 116-120.

LaBerge, D., Peterson, R.J., & Norden, M.J. Exploring the limits of cueing. In S. Dornic (Ed.), Attention and performance VI. International Symposium on Attention and Performance (6th), Stockholm, Sweden, 1975.

Omizo, M.M. & Michael, W.B. Biofeedback-induced relaxation training and impulsivity, attention to task and locus of control among hyperactive boys. Journal of Learning Disabilities, 1982, 15(7), 414-416.

Otis, A.S. & Lennon, R.T. Otis-Lennon Mental Ability Test. New York: Harcourt, Brace & World, Inc., 1967.

Porges, S.W., Walker, G.F., Korb, R.J., & Sprague, R.L. The influences of methylphenidate on heart rate and behavioral measures of attention in hyperactive children. Child Development, 1975, 46, 727-733.

Post, R.B. & Leibowitz, H.W. The effect of refractive error on central and peripheral motion sensitivity at various exposure durations. Perception and Psychophysics, 1981, 29(2), 91-94.

Pribram, K.H. Memory and the organization of attention. In D.B. Lindsley and A.A. Lumsdaine (Eds.), Brain function and learning. Berkeley, CA.: University of California Press, 1967.

Prinz, R.J., Connor, P.A., & Wilson, C.C. Hyperactive and aggressive behaviors in childhood: Intertwined dimensions. Journal of Abnormal Child Psychology, 1981, 9(2), 191-202.

Rabbit, P.M.A., Cumming, G., & Vyas, S. An analysis of visual search: Entropy and sequential effects. In S. Dornic (Ed.), Attention and performance VI. International Symposium on Attention and Performance (6th), Stockholm, Sweden, 1975.

Radosh, A., & Gittelman, R. The effect of appealing distractors on performance of hyperactive children. Journal of Abnormal Child Psychology, 1981, 9(2), 179-189.

Rogers, M.E., Lilienfeld, A.M., & Pasamanick, B. Prenatal and paranatal factors in the development of childhood behavior disorders. Acta Psychiatrica Scandinavica, 1955, 1, 1-157.

Rosenthal, R.H., & Allen, T.W. An examination of attention, arousal, and learning dysfunctions of hyperkinetic children. Psychological Bulletin, 1978, 85(4), 689-715.

Ross, A.O. Learning disability: The unrealized potential. New York: McGraw-Hill, 1977.

Ross, A.O. Psychological aspects of learning disabilities and reading disorders. New York: McGraw-Hill, 1976.

- Rugel, R.P. & Rosenthal, R. Skin conductance, reaction time and observational ratings in learning disabled children. Journal of Abnormal Child Psychology, 1974, 2, 183-192.
- Sandberg, S., Rutter, M., & Taylor, E. Hyperkinetic disorder in psychiatric clinic attenders. Developmental Medicine and Neurology, 1978, 20, 279-299.
- Sandoval, J. Hyperactive children: 12 ways to help them in the classroom. Academic Therapy, 1982, 18(1), 107-113.
- Sandoval, J. Format effects in two teacher rating scales of hyperactivity. Journal of Abnormal Child Psychology, 1981, 9(2), 203-218.
- Sandoval, J. Lambert, N.M., & Sassone, D.M. The identification and labelling of hyperactivity in children: An interactive model. In C.K. Whalen & B. Henker (Eds.), Hyperactive children: The social ecology of identification and treatment. New York: Academic Press, 1980.
- Schmidt, R.A. A schema theory of discrete motor skill learning. Psychological Review, 1975, 225-260.
- Schmidt, R.A. Motor control and learning, a behavioral emphasis. Champaign, Illinois: Human Kinetics, 1982.
- Schulman, J.L. & Reisman, J.M. An objective measure of hyperactivity. American Journal of Mental Deficiency, 1959, 64, 455-456.
- Schworm, R.W., & Abelseth, J.L. Teaching the individual with severe learning problems: Strategies which point to success. Education and Training of the Mentally Retarded, 1978, 13(2), 146-153.
- Sheehan, J.J. & Drury, C.G. The analysis of industrial inspection. Applied Ergonomics, 1971, 2(2), 74-78.
- Shiffrin, R.M., & Schneider, W. Toward a unitary model for selective attention, memory scanning, and visual search. In S. Dornic (Ed.), Attention and performance VI. International Symposium on Attention and Performance (6th), Stockholm, Sweden, 1975.
- Sprague, R.L., & Sleator, E.K. Effects of psychopharmacologic agents on learning disorders. Pediatric Clinics of North America, 1973, 20, 719-735.

Sprague, R.L., Barnes, K.R., & Werry, J.S. Methylphenidate and thioridazine: Learning, reaction time, activity, and classroom behavior in disturbed children. American Journal of Orthopsychiatry, 1970, 40(4), 615-628.

Sprague, R.L. & Toppe, L.K. Relationship between activity level and delay of reinforcement in the retarded. Journal of Experimental Child Psychology, 1966, 3, 390-397.

Spring, C. Greenberg, L. Scott, J., & Hopwood, J. Reaction time and the effect of Ritalin on children with learning problems. Perceptual and Motor Skills, 1973, 36, 75-82.

Steven, D.A., Stover, C.E., Backus, J.T. The hyperkinetic child: Effect of incentives on the speed of rapid tapping. Journal of Consulting and Clinical Psychology, 1970, 34, 56-59.

Stewart, M.A. & Haller, I.P. Letters to the editor: Hyperactive children. Journal of the American Medical Association, 1975, 231, 134-135.

Stewart, M.A., Pitts, R.N., Craig, A.G., & Dieruf, W. The hyperactive child syndrome. American Journal of Orthopsychiatry, 1966, 36, 861-867.

Strutt, G.F., Anderson, D.R., & Well, A.D. A developmental study of the effects of irrelevant information on speeded classification. Journal of Experimental Child Psychology, 1975, 20, 127-135.

Sulzbacher, S.I. Psychotropic medication with children: An evaluation of procedural biases in results of reported studies. Pediatrics, 1973, 51, 513-517.

Swanson, L. Vigilance deficit in learning disabled children: A signal detection analysis. Journal of Child Psychology, Psychiatry, 1981, 22(4), 393-399.

Swanson, L. Comparison of normal and learning disabled children on short-term memory recall and selective attention. Journal of Genetic Psychology, 1979, 135, 155-156.

Swets, J.A. (Ed.). Signal Detection and recognition by human observers: Contemporary reading. New York: John Wiley & Sons, 1964.

Swets, J.A. Signal detection theory applied to vigilance. In: R.R. Mackie (Ed.) Vigilance theory, operational performance and physiological correlates. New York: Plenum Press, 1977.

- Sykes, D.H., Douglas, V.I., & Morgenstern, G. The effect of methylphenidate (Ritalin) on sustained attention in hyperactive children. Psychopharmacologia, 1972, 25, 262-274.
- Sykes, D.H., Douglas, V.I., Weiss, G., & Minde, K.K. Attention in hyperactive children and the effect of methylphenidate (Ritalin). Journal Child Psychology, Psychiatry, 1971, 12, 123-139.
- Tarver, S.G., Hallahan, D.P., Cohen, S.B., & Kauffman, J.M. The development of visual selective attention and verbal rehearsal in learning disabled boys. Journal of Learning Disabilities, 1977, 10(8), 491-500.
- Torgeson, J.K. The role of nonspecific factors in the task performance of learning disabled children: A theoretical assessment. Journal of Learning Disabilities, 1977, 10(1), 35-40.
- Vrana, F. & Pihl, R.O. Selective attention deficit in learning disabled children: A cognitive interpretation. Journal of Learning Disabilities, 1980, 13(7), 387-391.
- Warm, J.S. Psychological processes in sustained attention. In R.R. Mackie (Ed.), Vigilance, theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.
- Welford, A.T. The psychological refractory period and the timing of high speed performance-a review and a theory. British Journal of Psychology, 1952, 43, 2-19.
- Werry, J.S., & Sprague, R.L. Hyperactivity. In C.G. Costello (Ed.), Symptoms of psychopathology. New York: Wiley, 1970.
- Werry, J.S., Sprague, R.L., & Cohen, M.N. Conner's teacher rating scale for use in drug studies with children: An empirical study. Journal of Abnormal Child Psychology, 1975, 3, 217-229.
- Zahn, T.P., Abate, F., Little, B., & Wencher, P.H. Minimal brain dysfunction, stimulant drugs, and autonomic nervous system activity. Archives of General Psychiatry, 1975, 32, 381-387.
- Zambelli, A.J., Stamm, J.S. Maitinsky, S., & Loiselle, D.L. Auditory evoked potentials and selective attention in formerly hyperactive adolescent boys. American Journal of Psychiatry, 1977, 134(7), 742-747.

Lachman, R., Lachman, J.L. & Butterfield, E.C. Cognitive psychology and information processing: An introduction. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1979.

Lambert, N.M. & Hartsough, C.S. Scaling behavioral attributes of children using multiple teacher judgements of pupil characteristics. Educational and Psychological Measurements, 1973, 33, 859-874.

Lambert, N.M. & Hartsough, C.S. Pupil behavior rating scale. In N.M. Lambert, E.M. Bower, & C.S. Hartsough (Eds.), A process for the assessment of effective student functioning. Monterey, CA.: Publisher's Test Service CTB/McGraw-Hill, 1979.

Loeb, M., & Alluisi, E.A. An update of findings regarding vigilance and a reconsideration of underlying mechanisms. In R.R. Mackie (Ed.), Vigilance, theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Lubar, J.F. & Deering, W.M. Behavioral approaches to neurology. New York: Academic Press, 1981.

Luria, A.R. The role of speech in the formation of mental processes in the regulation of normal and abnormal behavior. Washington, U.S. Dept. HEW, Public Health Service, National Institute of Health, 1966.

Magill, R.A. Motor learning, concepts and applications. Dubuque, Iowa: William C. Brown, 1980.

Marteniuk, R.G. Information processing in motor skills. New York: Holt, Rinehart and Winston, 1976.

McIntyre, C.W., Murray, M.E., & Blackwell, S.L. Visual search in learning disabled and hyperactive boys. Journal of Learning Disabilities, 1981, 14(3), 156-158.

Meichenbaum, D. Cognitive factors as determinants of learning disabilities: A cognitive functional approach. Paper presented at NATO Conference on the Neuropsychology of Learning Disabilities, Korson, Denmark, 1975.

Neisser, U. Decision-time without reaction-time: Experiments in visual scanning. The American Journal of Psychology, 1963, 13, 376-385.

Norman, D.A. Memory while shadowing. Quarterly Journal of Experimental Psychology, 1969, 21, 85-93.

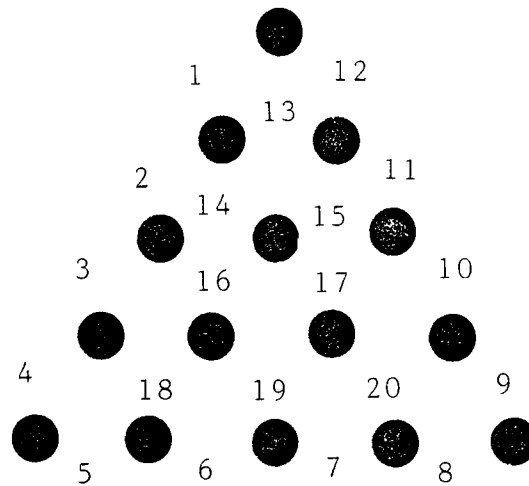
Zaporozhets, A.V. The development of voluntary movements. In B. Simon (Ed.), Psychology in the Soviet Union. Palo Alto: Stanford University Press, 1957.

APPENDIXES

APPENDIX A

CUE COORDINATES

108



Trial	Block 1	Block 2	Block 3	Block 4
1	N	5,8,11	13,15	12
2	2,4,9,11	4,6,10	N	3
3	2,6,9,10	N	3,12	N
4	N	16,18,19	N	N
5	N	N	N	N
6	13,14,15,6	13,15,20	N	15
7	N	N	9,11	N
8	18,13,20,16	1,7,12	3,11	4
9	8,9,10,12	4,7,12	13,19	N
10	N	N	1,11	N
11	17,15,13,18	N	18,20	19
12	14,16,18,19	N	N	N
13	N	3,8,11	N	N
14	N	N	14,17	10
15	N	20,19,13	3,4	1
16	3,4,8,9	1,2,6	17,15	7
17	13,15,17,20	N	N	N
18	N	N	N	16
19	18,19,15,17	N	N	N
20	13,19,20,18	16,17,14	15,18	2
21	N	17,20,18	N	N
22	2,6,7,8	N	N	13
23	1,7,9,11	16,14,18	17,20	20
24	N	N	N	N
25	N	14,15,19	4,11	14
26	N	2,8,10	N	17
27	N	N	N	N
28	2,8,9,10	N	2,10	N

N=Noise or no signal

The numbers listed under blocks corresponds to the 20 numbered points around and within the above tree pattern of dots. The numbers identify the location of cue(s) for each trial.

APPENDIX B

SUBJECT DATA

ST	GROUP	AGE	TOTAL TRIALS				SELF-PACED TRIALS				FORCED-PACED TRIALS				RT	NT
			HITS	FA	d'	B	HITS	FA	d'	B	HITS	FA	d'	B		
01	ND	9	9737	1139	3.01	0.286	9286	2143	2.28	0.460	9910	0536	3.96	0.117	431	662
02	ND	8	8306	9666	2.70	0.630	7857	0893	2.11	1.808	8750	0178	3.50	4.650	467	420
03	ND	10	9820	0535	3.69	0.390	9663	0716	3.22	0.568	9910	0357	4.07	0.023	176	392
04	HL	10	9107	1964	2.18	0.588	9107	0536	2.98	1.476	9107	3392	1.75	0.440	504	165
05	ND	10	9018	1250	2.41	0.830	8750	1071	2.60	1.123	9286	1429	2.55	0.606	982	684
06	ND	8	9664	2054	2.44	0.363	9663	0357	2.49	0.253	9286	1785	2.38	0.527	478	716
07	ND	10	8839	0357	2.92	2.420	9663	0357	3.50	1.000	8036	0357	2.59	1.460	867	479
08	ND	8	4107	2410	0.48	1.250	5535	1607	1.12	1.620	6786	3214	0.91	1.000	867	476
09	LD	8	7857	1607	1.80	1.200	8421	1964	1.76	0.950	7500	1250	1.80	1.563	951	544
10	LD	10	8750	0980	2.46	1.177	8929	0357	2.98	0.290	8570	1607	2.07	0.925	815	704
11	LD	10	8214	2589	1.56	0.808	8214	1964	1.76	0.946	8214	3214	1.38	0.732	573	656
12	LD	9	8929	0982	2.51	1.048	9107	0535	2.98	1.476	8750	1429	2.26	0.915	369	544
13	ND	9	9107	0268	3.22	2.700	9286	0178	3.79	2.770	8929	0536	2.86	1.694	696	194
14	HL	10	9464	0357	3.39	1.423	9286	0357	3.50	1.105	9285	0357	3.22	1.722	477	485
15	LD	9	8393	0714	2.46	1.892	8570	0536	2.72	2.005	8214	0892	2.76	1.616	504	536
16	HL	9	7410	2946	1.16	0.940	5714	3929	0.46	1.020	9107	1960	2.18	0.588	575	544
17	LD	9	9018	0536	2.92	1.581	9821	0357	3.80	0.538	8214	0714	2.38	1.929	627	190
18	LD	10	8750	3390	1.49	0.562	8036	2500	1.52	0.872	9464	4286	1.82	0.283	816	796
19	LD	10	8393	1339	2.12	1.130	8214	0357	2.66	3.364	8570	2321	1.82	0.250	747	483
20	LD	8	8660	1960	1.97	0.766	8036	2321	1.58	0.912	9286	1600	2.46	0.552	668	594
21	LD	8	8928	3929	1.51	0.488	8392	6429	0.63	0.650	9464	1429	2.72	0.698	368	505
22	ND	9	8750	3570	1.54	0.552	9286	3214	1.94	0.375	8214	3928	1.20	0.683	351	467
23	ND	8	9464	0982	2.92	0.632	9286	1250	2.60	0.652	9640	0714	3.22	0.573	640	651
24	HL	9	8125	2321	1.62	0.808	8214	1964	1.76	0.947	8036	2679	1.45	0.842	537	743
25	ND	9	8750	2321	1.92	0.675	9107	1429	2.42	0.730	8390	3214	1.46	0.680	534	343
26	HL	9	7143	1964	1.40	1.236	6250	2143	1.14	1.310	8036	1786	1.76	1.065	404	473
27	LD	8	9017	0803	2.68	1.170	8750	0714	2.64	1.525	9286	0892	2.81	0.819	822	543
28	HL	10	9643	1964	2.59	0.279	9821	2857	1.04	1.207	9464	1070	2.78	0.590	532	477
29	HL	9	7232	2768	1.16	1.000	6429	2857	2.04	1.177	8036	3036	1.36	0.805	738	653
30	HL	8	4375	2768	0.43	1.171	4107	1964	0.61	1.399	9464	3570	0.28	1.061	541	645
31	ND	9	9554	1339	2.88	0.448	9663	0893	3.09	0.476	9464	1786	2.56	0.424	572	581
32	LD	8	8214	1964	2.24	0.947	8036	1250	1.97	1.350	8393	2679	1.60	0.736	343	764
33	ND	8	8750	2321	1.92	0.675	8928	2500	1.90	0.592	8590	2143	1.84	0.780	549	243
34	LD	9	9910	0714	2.70	1.354	8750	0714	2.64	1.530	9107	0714	2.81	1.209	596	543
35	LD	9	5357	2054	0.90	1.399	6250	3035	0.86	1.083	4460	1070	1.10	2.124	619	591
36	LD	10	9285	0267	3.35	2.166	9463	0357	3.39	1.439	9100	0178	3.39	3.608	439	569
37	LD	10	9375	0178	3.60	2.707	9285	0357	3.22	1.658	9460	0178	3.96	2.510	384	569
38	LD	10	9910	0178	4.37	0.593	9821	0357	3.80	0.598	9820	0178	4.64	1.000	473	408
39	LD	10	9664	0178	3.69	2.273	9285	0357	3.22	1.658	9640	0178	4.07	1.749	511	110
40	HL	9	7232	4196	0.78	0.854	6607	3036	0.94	1.050	7857	5357	0.70	0.735	868	892
41	HL	10	9910	0267	4.20	0.411	9999	0000	4.64	1.000	9820	2679	3.69	0.373	294	612
42	LD	8	8660	1429	2.21	0.965	9107	0179	3.39	3.530	8214	2679	1.52	0.794	444	613
43	LD	8	7142	1518	1.60	1.456	7320	1250	1.74	1.598	6960	1785	1.44	1.345	1040	491
44	LD	8	9017	0357	3.03	2.167	9107	0535	2.98	1.460	8928	0178	3.28	1.756	740	546
45	LD	8	7857	2953	1.61	1.029	7678	2857	1.30	0.898	8035	1250	1.97	1.319	852	525
46	LD	9	9821	4643	2.15	0.122	9821	5000	2.05	0.121	9821	4285	2.23	0.123	622	663
47	LD	9	8036	0625	2.39	2.240	8214	0714	2.38	1.954	7857	0536	2.44	2.628	862	540
48	ND	10	9285	1071	2.70	0.739	9464	0714	3.11	0.828	9107	1429	2.42	0.789	379	147
49	ND	10	9643	2946	2.30	0.224	9999	3214	2.79	0.005	9286	2679	2.08	0.406	466	177
50	ND	10	9643	0536	3.39	0.695	9821	0893	3.39	0.298	9464	0179	3.69	2.110	440	286
51	LD	9	9018	2857	1.84	0.517	9286	1607	2.46	0.552	8750	4107	1.40	0.530	740	551
52	LD	9	9018	2411	1.09	1.190	8928	2679	1.84	0.560	4107	2140	0.58	1.340	181	285
53	ND	8	9640	0625	3.28	0.610	9643	0926	3.09	0.468	9642	0357	3.57	1.000	623	191
54	HL	8	7143	5536	0.42	0.858	5000	4464	0.13	1.010	9286	6607	1.06	0.037	609	513
55	HL	8	9821	7500	1.38	0.152	9821	7143	1.50	0.142	9821	7857	1.24	0.166	402	620
56	HL	10	6911	3571	0.34	1.069	5714	3750	0.48	1.036	4107	3392	0.18	1.061	421	453
57	LD	9	8482	4732	1.12	0.586	9107	3036	1.86	0.465	7857	6429	0.44	0.783	344	278
58	LD	8	9375	1696	2.50	0.471	8750	2857	1.73	0.606	9999	0536	3.96	0.160	586	750
59	HL	8	6517	7320	2.22	1.120	5357	6786	2.22	1.111	7678	7857	0.06	1.064	460	374
60	HL	8	9018	0893	2.62	1.081	8929	1250	2.36	0.883	9107	0536	2.98	1.463	566	604

APPENDIX C

SIGNAL DETECTION CALCULATIONS

CALCULATIONS FOR SIGNAL DETECTION MEASURES

$\underline{D}'$ is derived by dividing the total number hits by the total number of trials presented (for each pacing condition and for the sum total of both conditions) giving a hit probability or percentage. A false alarm probability is derived by dividing the total number of false alarms by the total number of noise or non-signal trials presented. These two probabilities are matched on a table for $\underline{d}'$ values for a yes-no procedure (Swets, 1964). The same $\underline{d}'$ values may be calculated by taking the z-score value for the probability of hits (Pr Hit) and subtracting from it the probability of false alarms (Pr FA). The following formula illustrates the process.

$$\underline{d}' = z (\text{Pr Hit}) - z (\text{Pr FA})$$

$\underline{B}$ is calculated by taking the ordinate values of a normal curve for each probability or z-score and dividing the ordinate values for the probability of hits, $f(\text{Pr Hits})$ by the ordinate value for the probability of false alarms, $f(\text{Pr FA})$. The following formula illustrates the process:

$$\underline{B} = f(\text{Pr Hit}) / f(\text{Pr FA})$$

APPENDIX D

COVER LETTER TO PARENTS

Dear Parent:

My name is Tim Winter, and I am a doctoral student at the University of Tennessee at Knoxville, in the Division of Physical Education. This Spring I will be working on a project in which I hope to find out some things about certain abilities that underlie a particular group of perceptual skills which might be called "selective attention." These are skills like picking your name from a list quickly, or spotting a familiar face in a crowd. These skills are basic to much learning.

Specifically, I am interested in finding out the effect of self-pacing (that is, with no time restraint on responding), and forced-pacing (which involves a limited response time interval) on the selective attention abilities of children. A visual display will be presented for a minimal amount of time with distractors presented within the context of the display.

In order to test this relationship I will give: (a) one test which will measure the ability to understand the concept "selective attention", (b) one test which will measure the ability to selectively attend for a visual cue under force-paced conditions, and (c) one test which will measure the ability to selectively attend under self-paced conditions and both errors and reaction times will be measured for tasks B and C.

The testing will be done during school hours, in the school building, with the permission of the school system. Each of the two testing sessions will last from 20 to 30 minutes.

It is hoped that the answers to question investigated in this project will eventually help teachers enhance attention skills of children with special needs.

The tasks will be carefully explained to each participant. He will be given an opportunity to ask questions at anytime during testing, and will be told he may stop at anytime, even after the testing has begun without penalty.

If you decide to permit your child to participate in this project, please read and sign the accompanying permission form and return one of the signed copies to your child's school. The other copy is for your records.

Thank you very much for taking the time to read this letter and for considering my request. If you have concerns or questions, please be advised that you are welcome to contact me.

Sincerely,

Timothy P. Winter

APPENDIX E

PARENTAL PERMISSION FORM

PARENTAL PERMISSION FOR PARTICIPATION

I give permission for _____ to participate in the selective attention project of Timothy P. Winter, described in the attached letter.

I understand that participation in the study consists of spending two sessions, each 20 to 30 minutes in length, and that my child will perform the following activities:

Session I (Day 1):

(A) Screening test: The participant will watch the visual array, a tree pattern and look for the presence of any of the cues, (which are additional lights or dots around the periphery of the tree). This array will remain lit until the subject responds verbally "yes" or "no" for the presence of additional cue(s). There will be five trials of this nature.

(B) Force-paced selective attention: The participant will sit on a chair and watch the visual array appear for a brief amount of time and then respond by depressing either a "yes" or "no" telegraph key if he believes that additional cues were or were not present along with the standard tree pattern. Trials here will be of a continuous nature (i.e., with limited rest between each trial).

Session II (Day 2):

Self-paced selective attention: Procedures under this condition are similar to those of force-paced condition except here the participant initiates each trial and he may take as much time as he believes necessary to respond "yes" or "no" for the presence of cues, although the array will still be presented for only a brief amount of time.

I understand that my child's name will not be reported and that the individual data and information collected in the study will be kept confidential by the investigator. I further understand that he may withdraw from the project at anytime without penalty.

I agree to permit the director of the project, Timothy P. Winter, to have access to the following information about the participant:

- (1) Chronological age
- (2) Educational placement
- (3) Clinical/medical classification (if known and appropriate)
- (4) Intelligence test score

PARENTAL PERMISSION FOR PARTICIPATION
PAGE 2

Participant's Name: _____

Participant's Age: _____

Signature of Parent/Guardian: _____

Date: _____

Project Director: Timothy P. Winter
University of Tennessee-Knoxville
Division of Physical Education
974-5111 or 637-1632

APPENDIX F

INFORMED ASSENT

INFORMED ASSENT OF PARTICIPANT

I volunteer to take part in a research project that will study selective attention.

I know that I will watch a tree pattern and press a "yes" key when extra or special lights or dots appear with the tree pattern and press a "no" key if no special lights or dots appear. I will do this 112 times, and it will not take more than 30 minutes.

I know that I will watch a tree pattern appear briefly after I depress a button. I will then press the "yes" key if I believe that a special light or dot appears with the tree pattern, and I will press the "no" key if I believe that no special lights or dots appear with the tree pattern. For these trials I may take as much time as I want to answer. I will do this 112 times, and it will not take more than 30 minutes.

What I will do has been explained to me.

I have had a chance to ask questions, and I know I may ask more questions anytime I want to.

I know that I may stop at anytime I want to, even after the activities have begun, and that I will not be penalized for stopping.

Participant: _____

Date: _____

Witness: _____

Project Director: Timothy P. Winter
University of Tennessee-Knoxville
Division of Physical Education
974-5111 or 637-1632

VITA

Timothy Paul Winter was born in Northampton, Pennsylvania on July 7, 1955. He is the son of Mr. and Mrs. Allen Winter of Stockertown, Pennsylvania.

He attended Lock Haven State College obtaining a Bachelor of Science degree in Health, Physical Education, and Recreation in June of 1977. In the Fall of 1977 he enrolled in Indiana University, Bloomington, Indiana, and graduated with a Master of Science degree with a specialization in Adapted Physical Education. While at Indiana, he served as a graduate instructor.

Following graduation, he received an appointment for two years as Instructor of Physical Education at Concord College in Athens, West Virginia. In the Fall of 1980 he accepted a Graduate Teaching Assistantship at the University of Tennessee, Knoxville and began study toward a Philosophy Degree in Education. He is currently employed as a Research Assistant at the University of Tennessee. He expects to receive the Philosophy Degree in March, 1984.