VIGILANCE AND SKIN CONDUCTANCE CHARACTERISTICS
IN A POPULATION OF READING DISABLED CHILDREN

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE
in
Psychology

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May, 1974

Blacksburg, Virginia

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ACKNOWLEDGEMENTS

The author is greatly indebted to many for aid and encouragement. The mechanics of designing an auditory vigilance task might have been impossible without technical assistance from of Media Services and especially , who also patiently recited the random numbers on the tape. Appreciation is also due , his wife, for tolerating the soundproofing of her home, including the refrigeration of her telephone. For the basic theme of the experiment and training as well as access to the polygraph, thanks go to my advisor . I am grateful to for encouragement and generosity in giving access to facilities and books and for editorial help, to for succumbing to the urge to guide students--much of their valuable time was spent in helpful argument and advice. The careful editing and encouragement of advisors , who in addition has the special knack of making the student feel like a scientist, is also acknowledged with gratitude. Special mention must be made of who uncovered one of the most critical journal articles, and to and , who shared their literature and ideas. Help also came from undergraduate students who assisted with the many interviews necessary: , and with the most arduous chore, checking figures, . It was good fortune also to have the professionalism and good humor of as typist. interrupted pleasant summer days to help with polygraph measurements. Special thanks are also due for many kinds of help, including meeting the deadline.

INTRODUCTION

Current descriptive accounts of children with reading disability suggest that this group is actually heterogeneous in terms of characteristics relevant to reading proficiency (Anderson et al, 1973; Bannatyne, 1972; deAjuriaguerra et al, 1968; Denkla, 1972; Kucera, 1963). Reading disability, or dyslexia, is commonly defined as a reading achievement level two years or more below grade level, despite normal intelligence, adequate cultural background, and sufficient educational training (Bannatyne, 1971). This definition eliminates major central nervous system malfunction or emotional disturbance. If this group is actually composed of quite different subgroups of children, research with reading disabled children would probably be more definitive if a more specific classification system were available. Experimental investigation and validation of methods for assessing and measuring suspected heterogeneity described by reading specialists would appear to be needed.

Gaining reading facility is a complex process, in which difficulty could occur at any of numerous different points with the end result of poor performance. The implication for many cases is possible malfunction or deficit in different underlying biological mechanisms. A more appropriate interpretation in other cases is a genetic endowment of greater ability in some attributes than others. These points of view are reflected in current descriptive classifications, all of which emphasize etiology (Bannatyne, 1972; de Ajuriaguerra et al, 1968; Denkla, 1972; Kucera, 1963). They all admit to the difficulty of simple classification. While their attempts at differentiating types of disabled readers have produced somewhat different categories, they are in relative agreement on three major groups:

1. A language dysfunction, commonly thought to be hereditary and most common among boys. According to Denkla this is an essentially normal group except for deficiencies in sequential memory skills.

2. Visuospatial disability, characterized by poor written work and arithmetic. Deficiencies occur in skills involving visuo-spatial construction, which suggests perceptual impairment.

3. Dyscontrol syndome, typically presenting poor control over impulses and responses, hyperactivity, or in some cases, hypoactivity. There is an associated immaturity of motor functions in many instances.

Wender (1971) has combined the latter two types of disability and argues that whatever the varying etiologies or symptoms, both are forms of minimal brain dysfunction (MBD, or MND -- minimal neurological dysfunction).

However, research in the area of reading disabilities has typically been conducted using undifferentiated samples of disabled readers. Few attempts have been made to subdivide disabled readers into subgroups. Consequently, interpreting the results of studies where heterogeneous groups have been used is difficult since members of the population may show vastly different sets of characteristics. While significant differences can often be demonstrated, overlap in ranges can reduce the applicability or diagnostic value of an experimental finding. Furthermore, conclusions based on the group as a whole could be misleading since the subgroups appear to have characteristics which in some cases are in diametric opposition to one another.

An example of such a characteristic is attention, long associated with learning difficulties. A deficit in attention might be expected to be a serious factor in the dyscontrol or MBD grouping, while probably not a major element in the poor performance of Group 1, language dysfunction. There is considerable agreement that MBD, or dyscontrol, is implicated in reading dysfunction, and in learning disabilities generally, and is associated with attentional deficits (Boydstun, 1968; Connors and Rothschild, 1968; Kucera, 1963; Millichap, 1968; Wasserman, 1972; Wender, 1971).

Examples of studies which have examined attention as a variable in research on reading disability include Birch, 1967; Hunter et al, 1972; Senf and Freundl, 1971. Hunter et al related attention to the orienting response in a study of reading disabled (RD) children. They utilized measures of autonomic arousal, which, they argued, should be associated with differences in performance. Their data suggest that nonreaders were not only less able to maintain a constant attentional level and were slower in simple learning than matched controls, but also showed lower mean skin conductance levels over trials of a reaction time experiment. This, they contended, indicated a lower level of activation for the RD group, also associated with poorer performance.

Anderson *et al* (1973); Dykman *et al* (1971) and Hunter (1972), approached the study of learning disability with similar convictions about the role of attention. Dykman argued that organically based deficiencies in attention explain the poor performance, slower reaction time, and decreased physiological reactivity of learning disabled children in learning situations.

In Dykman's research it was generally children with MBD symptoms who scored poorest and had longest response latencies on active attention tasks. This prompted Dykman to urge examination of subject populations in terms of hyperactivity, normoactivity and hypoactivity, essentially reflecting presence or absence of MBD symptoms. Anderson (1973) examined attention performance of LDs and controls and found a significant mean difference in performance between the two groups. But he found such a large variance in the performance by LDs that he was prompted to examine that population *post hoc* statistically for differences in hyperactivity, normoactivity and hypoactivity. The normoactive LDs were found to perform in the range of the controls and to be significantly different from the hyperactive LDs. Anderson points out that at a functional level assessment of learning disability does not automatically presume attentional deficit. He suggests that a fruitful line of research would be to investigate further the large within group variance in performance on attention measures found among learning disabled subjects.

In addition to attention deficits, the lower physiological responsivity noted by Hunter is suggestive of reports of underarousal in MBDs. While it would appear incongruous that MBD should be described by hyperactivity, distractibility, and poor impulse control, and at the same time by underarousal and lower physiological reactivity, there is considerable support for this relationship in the literature. For example, Boydstun _et al_ (1968) found that a population of children diagnosed as having minimal neurological dysfunction were less physiologically responsive than controls when tested in a conditioning and generalization procedure. In addition only 62% reached criterion on the task compared with 92% for the control group.

The relationship between lowered arousal levels and MBD is also supported by the response of MBD children to stimulants (Burks, 1965; Wender, 1971). As early as 1937, Bradley had demonstrated increased academic performance by administration of benzedrine to MBD children. More sophisticated research by Connors et al (1967) supported this result. After factor analysis these authors attributed this improvement to greater assertiveness and drive, rather than increased intellectual ability.

In sum, there is increasing interest in the role of attention in dyslexia (and learning disability in general) and there has been sufficient agreement in research reports on the following points to encourage continued exploration and experimentation: 1. Attention is considered an important factor in reading and learning disability, but not in every case; 2. Attention deficits are commonly associated with MBD symptoms; 3. There are indications that attention is related to physiological responsiveness and arousal; 4. MBD has been linked with underarousal.

EXPERIMENTAL METHODOLOGY IN TESTING ATTENTION: THE VIGILANCE TASK

Anderson et al (1973) strongly advocate use of vigilance tasks as the most suitable method of testing attention span and distractibility in children. The parameters of the task, uninterrupted periods of 30 minutes or more of random and infrequent signals presented among irrelevant stimuli, all perceptible but not "attention demanding", require only continuous alertness. Failures in detection can then be identified with failures of attention. This type of task may provide, they feel, the vehicle needed to investigate the complex interaction of neurogenic and psychogenic factors operating in learning disabled children since the only requirement for achieving a nearly perfect performance level is maintaining attention on the task. Sanders (1967) has pointed out that long term performance and attention have traditionally been connected with the view that sustained effort needs a continuous high level of attention. Kirchner and Knopf (1973) suggest that the vigilance paradigm provides a useful analog to the classroom situation because in both instances the child must be sedentary and fairly constricted for long periods in order to identify critical signals.

Arousal is also thought to influence vigilance performance. Activation theory is one of the more commonly used theories for explanation of vigilance performance, especially by Mackworth (1968, 1969, 1970). Both Davies and Krkovic (1965) and Eason et al (1965) found increased activation correlated with high levels of vigilance performance, as measured by galvanic skin response. Semmel (1964), drawing upon Hebb's statement that the cue function of stimuli is dependent upon a foundation of arousal, equated vigilance and arousal level. In a vigilance task comparing average and educable mentally retarded children, he used performance level as a measure of arousal.

Connors and Rothschild (1968) also point out that vigilance tasks have proven sensitive to brain injury. This has been previously shown by de Renzi and Faglioni (1965). According to Blakemore (1967), vigilance and reaction time tasks are apparently the only general indicators of brain damage. In one study of interest here, Grassi (1970) administered an auditory vigilance task to three groups of children designated "normal," "behavior disordered" and "brain damaged," but with approximately equivalent IQ ranges. Grassi found that the normal subjects missed considerably fewer signals than the behavior disordered, while brain damaged children performed poorest.

It has been mentioned above that MBD symptoms are considerably alleviated by use of amphetamines. It is therefore of theoretical importance that vigilance tasks are improved by the use of amphetamines. Jane Mackworth (1969) concludes, after reviewing numerous experiments examining the effects of amphetamines in the vigilance situation, that level of detection is maintained without affecting (increasing) false alarms. In studies with learning disabled children in vigilance tasks, Conners and Rothschild (1968) report detection improvement with use of amphetamine compared with placebo. Mackworth's (1969) analysis of numerous studies concluded that amphetamines act essentially like adrenaline, affecting the reticular activating system, felt to mediate attention, raising arousal level and concommitantly improving performance.

Kirchner and Knopf (1973) note that of the areas of research on attention, vigilance has been carefully defined and examined. The research and literature on vigilance are indeed extensive and there are numerous reviews, symposia and compilations (Buckner and McGrath, 1963; Davies and Tune, 1969; Frankman and Adams, 1962; Mackworth, 1968, 1969, 1970; Sanders, 1967; Stroh, 1971). While not all variables tested in vigilance tasks have produced undisputed results, these authors find relative agreement concerning influence of numerous variables on performance. Among these variables are reward, knowledge of results, effects of extraneous noise, rest periods and certain personality characteristics.

It appears, then, that in terms of MBD symptoms, attention and arousal characteristics a sample of reading disabled children is likely not to be a homogeneous group. It is presumed that children whose difficulty with reading stems from specific language dysfunction would be least impaired. Vigilance tasks appear to be of value in demonstrating these differences.

METHOD

Subjects. Thirty-seven regional children, classified as reading disabled by school psychologists, were compared with twenty-four control children from the same school environments.[1] Control children approximated the experimental group in age, socio-economic status, IQ and sex as far as possible. There were fifty-one males and ten females in the study. Mean age was 10.7 years for RDs and 10.4 years for controls.

Further classification of subjects was made on the basis of two questionnaires (see Appendix). Since the disability category of specific language dysfunction is considered to be hereditary (Bannatyne, 1972; Denkla, 1972), the incidence of reading disability in the subject's family background was explored in Questionnaire 1. Each subject was then classified as Nongenetic, if there was no reported incidence of reading difficulty, or Genetic, if a parent, grandparent, aunt, uncle or sibling was reported as having had more than average difficulty with learning to read.

Questionnaire 2 (see Appendix) listed twenty subject characteristics rated on a five point scale. This form was completed twice for each child, once by the teacher and once by one or both of the parents or a guardian and these two assessments were averaged for each item. Five of the items, typical of the minimal brain dysfunction syndrome were used to form a Dyscontrol score for each of the reading disabled children. Using the mean Dyscontrol score for the experimental group as a separation point, these subjects were then designated as either High or Low Dyscontrol.

Apparatus. Skin resistance was measured by the BSR amplifier of a Lafayette four channel Datagraph, with response frequency 0-40 Hz. Brass electrodes, plated with copper, nickle and chrome, were equipped with velcro fasteners.

The tape-recorded vigilance task signals were heard through Electrophonic stereo headphones Model 03. A Wollensak monaural reel to reel tape recorder Model 1500SS connected to a Telex Listening Station Model 753 to allow headphone connections for both subject and experimenter. A monaural converter jack insured compatibility of the monaural recorder and stereo headphones, providing monaural sound to both ears.

The vigilance tape is approximately 30 minutes of random numbers spoken by a male voice at one per second. The signal number, six, occurs twenty-nine times randomly distributed, with intersignal interval varying from a few seconds to about four minutes. This is similar to the twenty minute task used by Grassi (1970) and Birch (1967).

A signal button, held in the subject's preferred hand, connected to an event recorder on the polygraph and registered the subject's response concurrently with the record of his basal skin resistance.

Procedure. The child was told that he was to be in an attention experiment and that because he was to be connected to the polygraph he must first wash his hands. When he returned he was told casually what was to occur while the electrodes were attached to the second and fourth fingers of his non-preferred hand and a skin resistance baseline measured. He was given the signal button and allowed to test it. He was then told that he would receive his instructions again on the tape recording and he was fitted with the earphones, which had been set at a constant volume. When the tape began the instructions heard by the subject are:

> For thirty minutes I will read numbers rather quickly. You should pay very close attention. When I say the number "six" you should punch the button you are holding in your hand. Never stop listening and continue to pay close attention.
>
> Now, get ready, and I will begin after I say "start."
>
> Ok, start.

This was followed immediately by the random numbers spoken by the same voice.

The polygraph reading for the 30 minute task was divided into $7\frac{1}{2}$ minute quarters for scoring purposes, providing a record of change in performance by comparing the different time periods. Both errors of omission, i.e. no button press on "six", and errors of commission, i.e. button press when there was no "six" were marked by comparing the subject's tape with a correctly marked sample tape. A record was made of total omissions, percent correct detections per quarter and total commissions.

The concurrent record of basal skin resistance was also compared by quarters. Three measurements were made per quarter, at points designated by the sample tape so that records were never taken immediately after an expected motor response. The mean of the three measures for each quarter was converted to log conductance units.

RESULTS

Vigilance - Omissions. As predicted, vigilance performance of control children was superior to that of reading disabled children, as indicated by a two-way repeated measures analysis of variance (Table 1 and Figure 1). Total mean proportion correct for controls was .74 and .60 for RDs. The decrement in performance over quarters of the time period was shown by both groups. There was no measurable interaction between subjects and time periods.

Comparison of reading disabled on the basis of family history of reading difficulties, forming Genetic and Nongenetic subgroups indicated no significant differences in vigilance performance. In addition, chi square showed no relationship between the Genetic-Nongenetic and High-Low Dyscontrol categories.

The Dyscontrol variable did appear to relate to proficiency on the task. Spearman rank correlation of dyscontrol and vigilance scores for the total population gave a correlation coefficient of .335 ($p < .009$). When the reading disabled subjects were subdivided into High and Low Dyscontrol groups (Figure 1), analysis of variance showed a predicted significant difference in errors of omission (Table 2). Both groups showed highly significant decrement in performance over time. There was no apparent interaction between groups and time periods of the task.

Because it was argued that a population of reading disabled children might actually be composed of a group of children with attention deficits who would demonstrate poor vigilance and another group who might possibly do quite well, frequency distributions of vigilance scores were plotted. The expectation was that if this were the case, scores for RDs should cluster around a high mode and a low mode. RDs with scores clustering around the low error mode would be expected to be mainly those subjects who has also been designated as Low Dyscontrol. As shown in Figure 2, there is a marked bimodal tendency for both populations. A Kolgomorov-Smirnoff goodness-of-fit test for normality for the control group tended toward nonnormality, but this did not prove significant. The reading disabled group proved significantly nonnormal ($D= .22$, df-36, $p<.05$). In addition, a chi square test comparing High and Low Dyscontrol designation with High and Low Vigilance designation showed High Dyscontrol subjects to also be largely Low (or poor) Vigilance subjects, which would be expected from the preceding argument ($x = 3.04$, $p<.05$, one-tailed test).

However, dyscontrol scores alone did not satisfactorily explain the rather marked bimodality of score distribution for the RD sample. When other parameters were examined it was found that subjects in the better vigilance group (fewer than 11 errors) had a mean age of 140.32 months (S.D. = 24.78) compared with 115.94 months (S.D. = 16.06) for RDs who made more than 11 errors. A t-test for the difference between these means proved highly significant ($t = 3.5$, $df = 35$, $p < .01$). The relationship of age to vigilance compared by a Spearman rank correlation gave a coefficient of -.38 ($p < .004$) for all subjects and -.41 for reading disabled.

To explore this age-vigilance relationship further, the RD group was subdivided into three age groups. Group I, the youngest, ranged in age from 83 to 116 months. Group II, intermediate in age, ranged from 121 to 141 months. The oldest children, Group III, were aged 152 to 178 months.

Analysis of variance showed the difference in vigilance performance between these age groups to be significant at a $p < .01$, and an interaction between time periods and performance approaching significance (Table 3).

A second ANOVA comparing the youngest (Group I) and the oldest (Group III) reading disabled children indicated vigilance performance difference to be significant with a $p < .005$. Interaction did not reach significance but was considerably greater than chance at $p < .10$ (Table 4).

Groups were too small for adequate comparisons of performance for High and Low Dyscontrol on the basis of age. But a graph of mean performance in each group points to a tendency toward interaction of groups x time intervals, with a particularly marked difference between older Low Dyscontrol subjects and younger High Dyscontrol subjects, especially marked in the third quarter (Figure 3).

Vigilance - Commissions. Mean errors of commissions for RDs was 2.1 (n = 37) compared to a mean for the control population of .83 commissions (n = 24). This is somewhat misleading, however. More controls made errors of commission (58 per cent compared to 46 per cent of the RDs). Only two RD subjects, and no controls, made more than three errors of commission. These two subjects made 15 and 39 false responses. This was decidely unusual, and when these subjects were excluded from the calculations the average number of commissions for RDs was .63 compared to .83 for controls.

It was also noted that subjects making no commissions made a mean of 10 omissions, with subjects scoring one or more false alarms had a mean performance level of 9.5 errors.

Skin Conductance. Although vigilance performance differed between the reading disabled and control subjects, a repeated measures analysis of variance showed no differences in log skin conductance between these groups. This was contrary to expectations, since the RD sample had a high proportion of children with MBD symptoms, associated with lower arousal.

Also at variance with predictions was the direction of change in skin conductance across quarters of the task. As mentioned, it is generally reported that skin conductance levels decline during a vigil. With few exceptions, subjects in this study showed an increase in skin conductance levels and this increase was statistically significant ($p<.01$). Studies which have reported changes in conductance during vigilance have all been done with adult subjects, however (see Discussion).

But when log conductance differences between reading disabled designated Genetic were compared with Nongenetic, a repeated measures analysis of variance indicated that Nongenetics were less aroused, as predicted ($p<.05$). (See Table 6).

Analysis of variance comparison of High Dyscontrol subjects skin conductance levels with that of controls, who were low dyscontrol as a group, showed no differences, however.

There appeared, therefore, no relationship between vigilance and skin conductance, with conductance levels rising significantly rather than falling, while vigilance performance fell as expected. Thus, an anticipated arousal-vigilance relationship was not supported. There was also no relationship demonstrated between dyscontrol and arousal by this measure, although High Dyscontrol--MBD symptoms--is associated with lower arousal. However, the genetic categories were differentiated by skin conductance measures.

Table 1

Repeated Measures Analysis of Variance For
Correct Detections For Reading Disabled (n= 38)
And Control (n= 23) Subjects[1]

Source	SS	df	MS	F ratio
RD/Control				
Between groups	10852.6	1	10852.6	6.033*
Within groups (error)	106127	59	1798.76	
Between Quarters	10131.7	3	3377.25	8.472**
Quarters x Groups	691.394	3	230.465	0.578
Quarters x Subjects (error)	70556.8	177	398.626	

* $p < .05$
** $p < .01$
[1] Mean errors for reading disabled were 11.08 (S.D. = 6.71) and for the control subjects 7.4 (S.D. = 4.7).

Table 2

Repeated Measures Analysis of Variance For Correct Detections for High Dyscontrol And Low Dyscontrol Subgroups of RDs[1]

Source	SS	df	MS	F ratio
High/Low Dyscontrol				
Between groups	.832302	1	.832302	4.277*
Within groups (error)	6.81121	35	.194606	
Between Quarters	.698038	3	.232679	5.613**
Quarters x Groups	7.33960	3	.244653	0.590
Quarters x Subjects (error)	4.35268	105	4.1454	

* $p < .05$
** $p < .01$
[1]Mean errors for high dyscontrol subjects were (13.75 (S.D. = 6.64) and 8.9 for low dyscontrol subjects (S.D. = 6.3). Mean ages for the two groups were 128.25 months (S.D. = 22) and 128.6 months (S.D. = 26.14).

Table 3

Repeated Measures Analysis of Variance For Correct Detections For Reading Disabled By Age Groups: Group I, Under 116 Months; Group II, Under 141 Months; Group III, Under 178 Months

Source	SS	df	MS	F ratio
Groups I, II, III				
Between groups	215.756	2	107.878	6.685**
Within groups (error)	548.631	34	16.1362	
Between Quarters	69.8036	3	23.2679	5.722**
Quarters x Groups	27.8447	6	46.4078	1.141
Quarters x Subjects (error)	414.746	102	4.06614	

** $p < .01$

Table 4

Repeated Measures Analysis of Variance For Correct Detections Comparing RD Age Groups I and III

Source	SS	df	MS	F ratio
Group I/Group III				
Between groups	1.33209	1	1.33209	10.360*
Within groups (error)	3.20499	32	.128578	
Between Quarters	.433141	3	.144380	4.325**
Age Groups x Quarters	.226024	3	.753412	2.257***
Quarters x Subjects (error)	3.20499	32	3.33853	

*p <.005
**p<.01
***p<.10

Table 5

Skin Conductance
Repeated Measures Analysis of Variance For
Genetic and Non-Genetic Reading Disabled

Source	SS	df	MS	F ratio
Genetic/Non-Genetic				
Between groups	.994935	1	.994985	4.443*
Within groups (error)	7.83832	35	.223952	
Between Quarters	.340613	11	3.09648	7.103**
Quarters x Groups	3.91543	11	29.0494	0.666
Quarters x Subjects (error)				

*$p < .05$
**$p < .01$

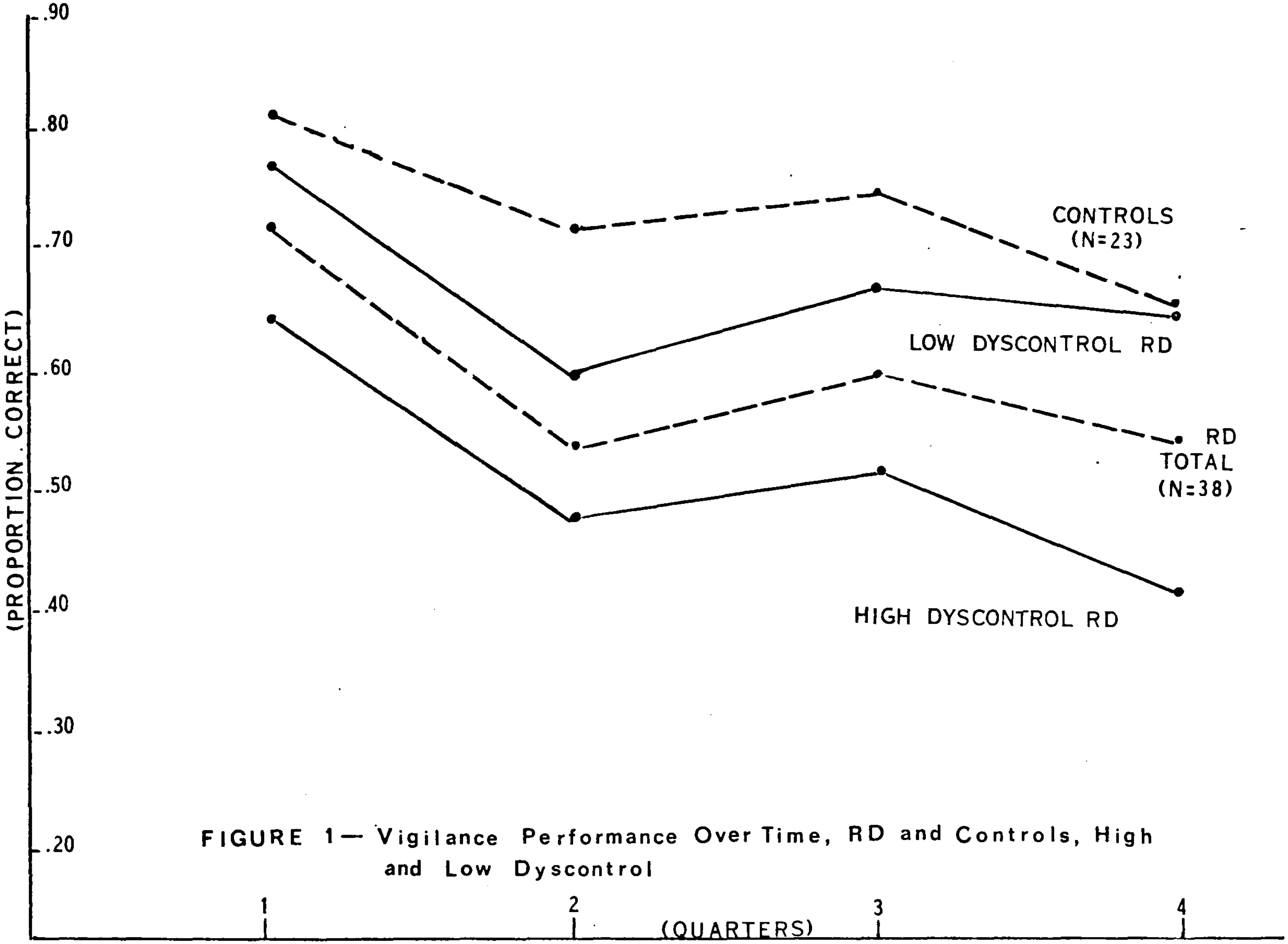

FIGURE 1— Vigilance Performance Over Time, RD and Controls, High and Low Dyscontrol

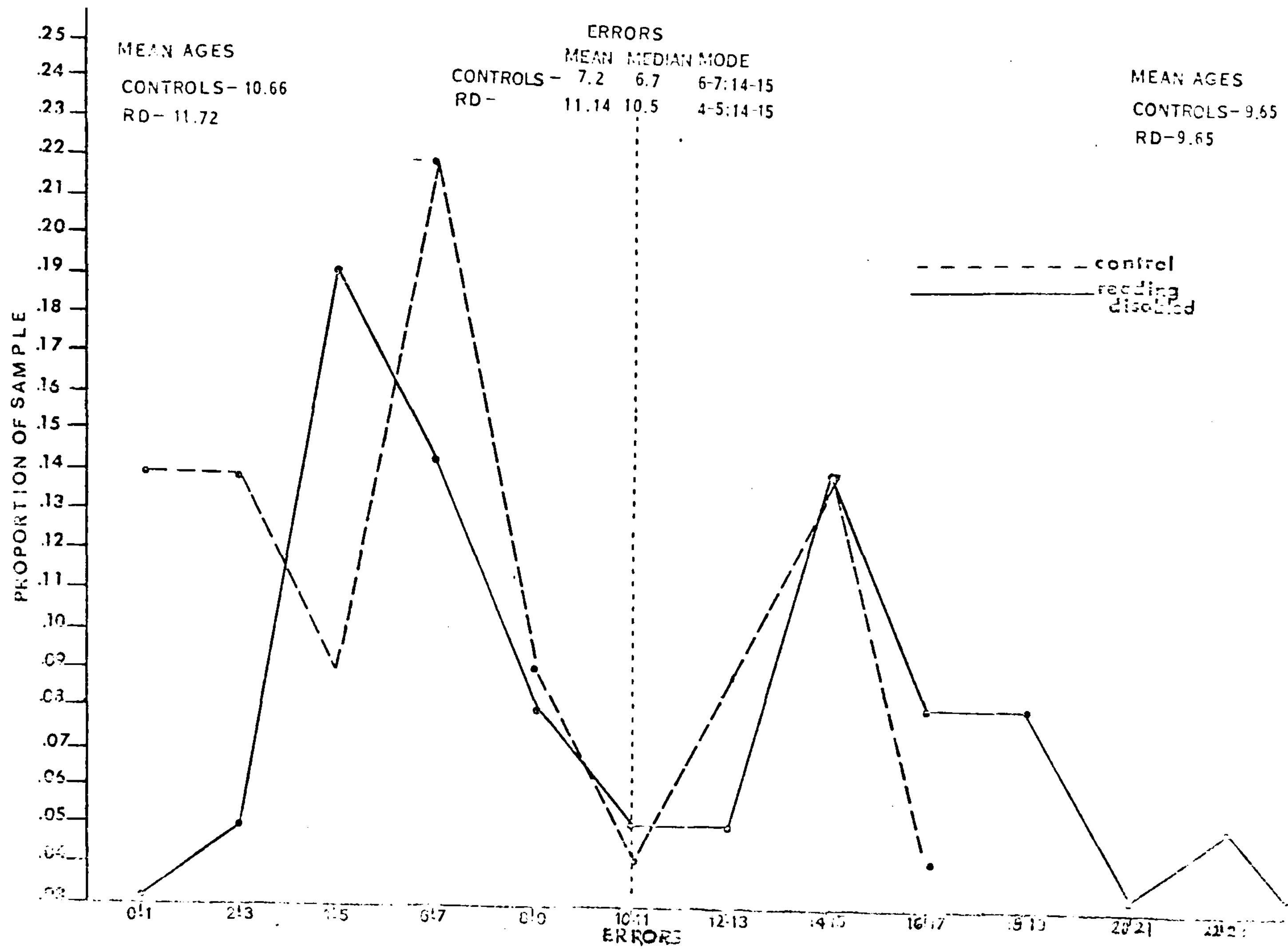

FIGURE 2 - Error Distribution by Group

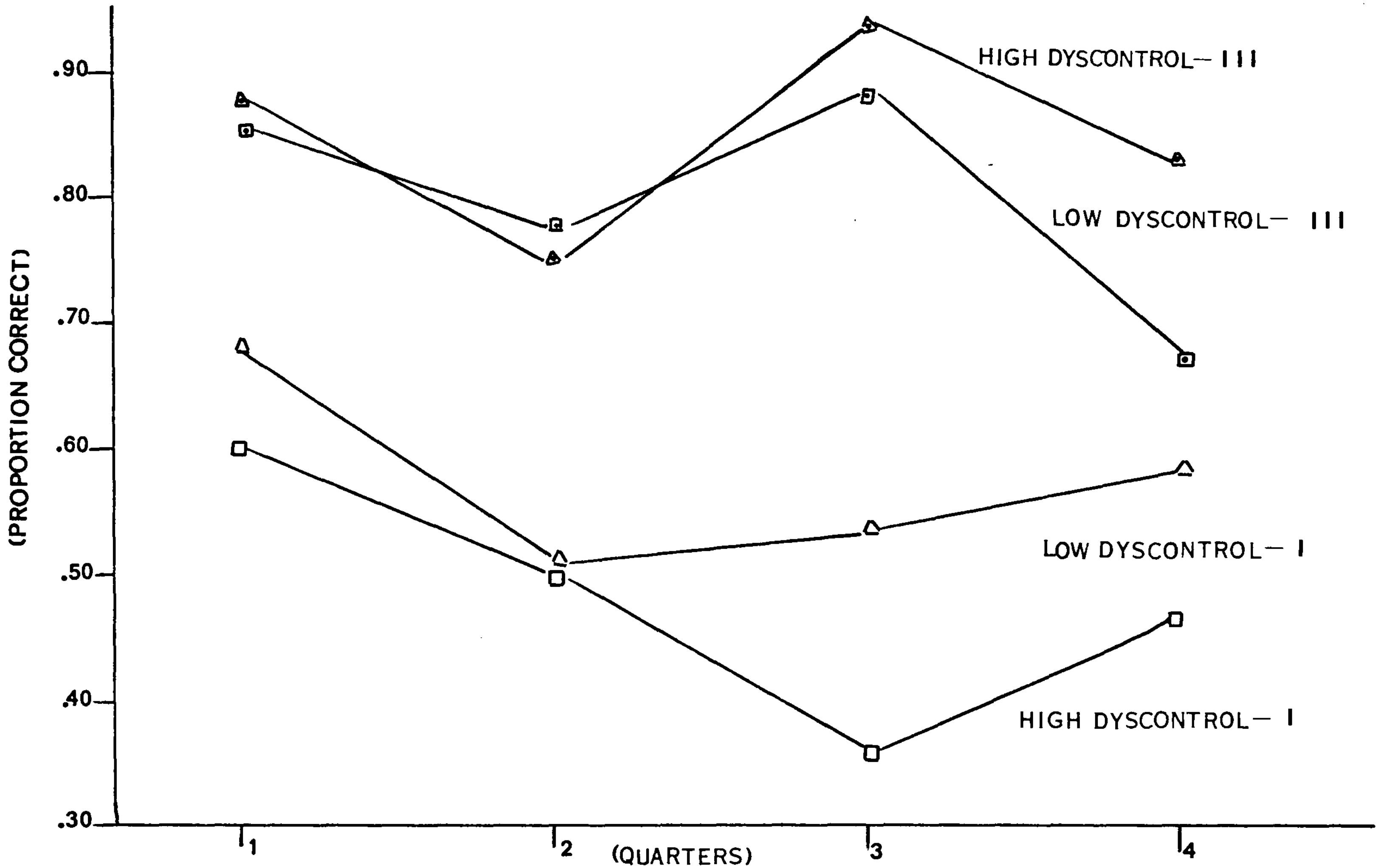

FIGURE 3—Vigilance Performance by Age and Dyscontrol Group

DISCUSSION

Results of this study supported other research in demonstrating that mean performance on an attention task for a group of non-reading disabled children is superior to performance of a reading disabled group. The hypothesis that groups of reading disabled children are, however, heterogeneous and would demonstrate this heterogeneity on a vigilance task was also supported.

It was suggested that the RD sample would probably contain clusters of both high performing and low performing subjects. The assumption was that children with MBD symptoms would make up the bulk of poorer performers on such a sustained attention task. When this experimental population was divided into High and Low Dyscontrol groups, in which dyscontrol was measured by degree of MBD symptoms, vigilance scores did, indeed, prove to be distributed bimodally into good and poor performers. Further, the proportion of MBD among poor performers was significantly higher.

Division of the experimental group into Genetic and Nongenetic subgroups did not show differences in terms of vigilance performance, however.

Age proved to be the most significant variable affecting performance, which had not been anticipated.

Errors of commission, expected to be more characteristic of the reading disabled and especially the High Dyscontrol, did not differ significantly in these groups from control subjects.

The hypothesized covariance of vigilance and arousal was also not supported. Skin conductance levels rose over time intervals while performance declined. This was the reverse of previous research results with adults showing lowered arousal over time with a concommitant fall in performance. There was no significant difference in the mean arousal of Controls and RDs. There was no difference on the arousal dimension between High and Low Dyscontrol subjects, contrary to expectations. Nongenetic RDs, however, proved to be less aroused, as predicted.

The fact that age proved to have an even greater effect on performance was not expected. When a preliminary analysis pointed to the possibility of strong age effects, further investigation was indicated. Such effects had not been predictable from the literature. As Anderson et al (1973) and Kirchner and Knopf (1973) found, there are only a handful of published studies and notes of a few unpublished manuscripts dealing with vigilance performance of children or special groups, such as brain damaged and mentally retarded. These include studies using visual tasks by Anderson, 1973; Dykman, 1971; Kirchner and Knopf, 1973; and Semmel, 1964. Auditory tasks have been reported by Birch, 1967, and Grassi, 1970. A few studies dealt with effects of age on vigilance, but these studies designated young as a minimum of 18 years old (Davies and Griew, 1965; Stroh, 1970; Surwillo and

Quilter, 1964; Tune, 1966; and York, 1962). No research reported age effects on vigilance where subjects were under 18, with the exception of an unpublished manuscript (Gale and Lynn, 1965) mentioned by Fountain and Lynn (1966).

Age effects are found in a number of tasks. For example, a report on age and combinatory skill in children aged 10, 12 and 14 demonstrated improvement with age, with a threshold, or marked improvement, at age 12 (Fischbein, 1970). Buseman verb/adjective ratio is reported increased by age (Pellegrino *et al*, 1970), and qualitative perceptual differences in this general age range are reported by Quina and Pollack (1971). In a study of age changes in attention to irrelevancy, Lehman (1970) concludes that attention is a multifaceted skill with development of its parts progressing at different rates. She observed that focusing attention when what is relevant is clear is well developed by 5 or 6 years old, but it is not until the fourth grade (about 10) that disregard for the unnecessary was reflected in behavior patterns.

The ages included in this study are considered a part of the growth years for special abilities, general intelligence and ability to learn (Pressey and Kuhlen, 1957; Luria, 1961). Distinct changes in quality of performance appear related to age in the present study. Although not anticipated in the original proposal, a *post hoc* analysis seemed relevant. Such an analysis seems particularly important for the reading disability group because descriptive accounts have suggested the importance of a connection between maturation and reading disability (Critchley, 1964) and maturation and MBD (Wender, 1971; Denkla, 1972).

The importance of maturation is emphasized by the single reference to vigilance and age in children (Gale and Lynn, unpub. ms., 1965). In a discussion of arousal change in childhood, Fountain and Lynn (1966) refer to the Gale and Lynn comments on immaturity, specifically immaturity of the cerebral cortex. It is cortical immaturity that is primarily responsible for the fact that children do poorly on measures of vigilance and reaction time, they contend. The frontal lobes, they argue, mature at about 12 years old. They quote Lindsley (1960) as demonstrating that adult EEG frequencies are not attained until about this age. It is about this age also, they note, that vigilance and reaction times also reach adult levels. Studies of vigilance other than the manuscript were not cited, however.

Since age proved to have an even greater significance statistically in this sample than either the RD or Dyscontrol variable, indications are that more precision may be achieved in studies of this sort by careful selection of subjects on the basis of age. Not only would a small range in ages seem to be important for comparison of variables such as reading disability and MBD, but what specific ages are chosen for the comparison samples may possibly be critical. This possibility appears to need further investigation.

The lack of differences in errors of commission for controls and RDs makes comparison of these results with those of other studies of interest. The study by Anderson _et al_ reports that LDs made consistently more false alarms than controls, with hyperactive children making the most such errors. The mean false alarms for controls was given as 3.13 and for LDs as 70.35. However, standard deviation for controls was 7.75 while for the LDs the standard deviation was a rather astonishing 176.69. It would appear possible that in actuality this may reflect a similar distribution to the one encountered in this analysis, where two subjects made an extreme number of commissions. Had their scores been tallied, such a comparison between RDs and controls as Anderson's could be made. But it could be argued that in neither case would it be accurate to conclude that the children with learning difficulties made consistently more false alarms.

Arousal in children would seem to demand considerable exploration before further conclusions can be drawn. The present research raises questions of arousal of children compared with adults and normal children compared to those with MBD symptoms, as measured by skin conductance measures. Particularly pertinent is the finding in this experiment that skin conductance rose for children over time during a monotonous and lengthy task, when one of the most unanimous findings of vigilance research for adults is a fall in skin conductance. On the basis of such results the vigilance task cannot be assumed to reflect arousal in the same sense that researchers using adult subjects have hypothesized.

Fountain and Lynn (1966), on the other hand, point out that reduction of cortical activity can result in a brief increase in arousal, since the cortex exerts an inhibitory influence on the ARAS (Lindsley, 1957; Samuels, 1959). Immaturity of the cortex, they argue, operates to reduce cortical control in childhood, producing the rather paradoxical results of obvious expenditure of energy, and rapid conditionability, while at the same time evidencing slower reaction times, poor vigilance, and slow EEG rhythms characteristic of underaroused adults.

The decrement in performance during vigilance may then have a very different basis for children than adults. Arousal is hypothesized to influence performance (on most tasks) with a U-shaped function, the peak being optimal arousal, with further arousal being detrimental to performance (Duffy, 1957). The vigilance task, however, never provokes high levels of arousal, at least in adults. Instead, falling levels of activation, assumed by Mackworth to be due to habituation (1970), is reflected in the decrement characteristic of performance during long, tedious vigils. It may be that in children the U-shaped function of arousal is a valid hypothesis, but with decrease in activation, as with ingestion of alcohol or barbiturates in adults, there is a brief increase in activation due to release of cortical inhibition (Fountain and Lynn, 1966). Under conditions of monotony, then, children may experience a decrement in performance due to increases in arousal beyond the optimal level. The rise in log skin conductance demonstrated to occur with vigilance decrement in this study would seem to support the possibility of this interpretation. However, comparisons between children and adults on various tasks is needed.

FOOTNOTE

[1]Schools participating were Virginia Heights Elementary, Roanoke; Margaret Beeks and Gilbert Linkous Elementary, Blacksburg; and Christiansburg Primary and Elementary Schools.

REFERENCES

Anderson, R. P., Halcomb, C. G. and Doyle, R. B. The measurement of attentional deficits. *Exceptional Children*, April 1973.

Bakan, P. Extraversion-introversion and improvement in an auditory vigilance task. *British Journal of Psychology*, 1959, 50, 325-32.

Bannatyne, A. *Language, reading and learning disabilities*. Springfield, Ill. Charles C. Thomas, 1971.

Bayley, N. Consistency and variability in the growth of intelligence from birth to 18 years. *Journal of Genetic Psychology*, 1949, 75, 165-196.

Birch, R. W. *Attention span, distractibility and inhibitory potential of good and poor readers*. (Doctoral dissertation, University of Wisconsin) Ann Arbor, Mich.: University Microfilms, 1968, No. 67-16, 894. (*Dissertation Abstracts*. 1968, 28 (B), 4742.)

Boydstun, J. A., Ackerman, P. T., Stevens, D. A., Clements, S. D., Peters, J. E. and Dykman, R. A. Physiologic and motor conditioning and generalization in children with minimal brain dysfunction. *Conditioned Reflex*, 1968, 3 (2), 81-104.

Bradley, C. The behavior of children receiving benzedrine. *American Journal of Psychiatry*, 1937, 94, 577-585.

Bradley, C. Benzedrine and dexedrine in the treatment of children's behavior disorders. *Pediatrics*, 1950, 5, 24-36.

Buckner, D. N. and McGrath, J. J. *Vigilance: A symposium*. New York: McGraw-Hill, 1963.

Burks, H. F. Effects of amphetamine therapy on hyperkinetic children. *Archives of General Psychiatry*, 1965, 11, 604-609.

Connors, C. K. Recent drug studies with hyperkinetic children. *Journal of Learning Disabilities*, 1971, 4 (11), 476-783.

Connors, C. K. and Rothschild, G. H. Drugs and learning in children. In J. Hellmuth (Ed.), *Learning disorders*. Seattle, Wash. Special Child Publications, 1968, 3, 193-218.

Critchley, M. *Developmental dyslexia*. Springfield, Ill.,: Charles C. Thomas, 1964.

Davies, D. R. and Krkovic, A. Skin conductance, alpha activity and vigilance. *American Journal of Psychology*, 1965, 78, 304-306.

Davies, D. R. and Tune, G. S. *Human vigilance performance*. New York: American Elsevier Publishing, 1969.

de Ajuriaguerra, J. P., Antonini, J. P. and Besson, A. Problems posed by dyslexia. *Journal of Learning Disabilities*, 1968, 1 (3), 158-170.

Denkla, M. B. Clinical syndromes in learing disabilities. The case for splitting and lumping. *Journal of Learning Disabilities*, 1972, 5 (7), 401-406.

Duffy, E. *Activation and behavior*. New York: John Wiley & Sons, 1962.

Duffy, E. The psychological significance of the concept of "arousal" or "activation". *Psychological Review*, 1957, 64 (5), 265-275.

Dykman, R. A., Ackerman, P. T., Clements, S. D., & Peters, J. E. Specific learning disabilities: An attentional deficit syndrome. In H. Myklebust (Ed.) *Progress in learning disabilities*. Vol 2. New York: Grune & Stratton, 1971.

Eason, R. G., Beardshall, A. and Jaffee, S. Performance and physiological indicants of activation in a vigilance situation. *Perceptual Motor Skills*, 1965, 20, 3-13.

Fischbein, E., Pamper, I. and Minzat, I. Effects of age and instruction on combinatory ability in children. *British Journal of Educational Psychology*, 1970, 40 (3), 261-270.

Fountain, W. and Lynn, R. Change in level of arousal during childhood. *Behavioral Research and Therapy*, 1966, 4, 213-217.

Frankmann, J. P. and Adams, J. A. Theories of vigilance. *Psychological Bulletin*, 1962, 59, 257-272.

Gale, A. and Lynn, R. Vigilance performance and age. Unpublished Ms., 1965.

Grassi, J. R. Auditory vigilance performance in brain damaged, behavior disordered and normal children. Journal of Learning Disabilities, 1970, 3, 302-305.

Hunter, E. J., Johnson, L. C. and Keefe, F. B. Electrodermal and cardiovascular responses in nonreaders. Journal of Learning Disabilities, 1972, 5 (4), 14-24.

Kirchner, G. L. and Knopf, I. J. Differences in the vigilance performance of second grade children as related to sex and achievement. Emory University, Paper presented at the meeting of the Southeastern Psychological Association, April, 1973.

Kucera, O., Matejcek, Z. and Langmeier, J. Some observations on dyslexia in children in Czechoslovakia. Journal of Learning Disabilities, 1963, 3 (9), 448-456.

Lehman, E. J. B. Age changes in attention to irrelevancy and redundancy. (Doctoral Dissertation, George Washington University) Ann Arbor, Mich.: University Microfilms, 1970, No. 71-12,298. (Dissertation Abstracts. 1971, 31 (11-B), 6942-6943).

Lindsley, D. B. Attention, consciousness, sleep, and wakefulness. In J. Field (Ed.), Handbook of Physiology. American Physiological Society, Washington, 1960.

Luria, A. R. Speech and the regulation of behavior. New York: Liveright Publishing, 1961.

Mackworth, J. Vigilance, arousal, and habituation. Psychological Review, 1968, 75 (4), 308-322.

Mackworth, J. Vigilance and habituation. Penguin Books, 1969.

Mackworth, J. Vigilance and attention. Penguin Books, 1970.

Millichap, J. G. Drugs in management of hyperkinetic and perceptually handicapped children. Journal of American Medical Association, 1968, 11, 1527-1530.

Pellegrino, M. and Giuganino, B. M. The confrontation of some psycholinguistic indications applicable to the written and oral language in evolutive age. Rivista di Psicologia Social e Archivio Italiano di Psicologia Generale e del Lavoro, 1970, 37 (1), 99-101.

Pressey, S. S. and Kuhlen, R. G. Psychological development through the life span. New York: Harper and Brothers, 1957.

Quina, K. and Pollack, R. H. Ponzo figure: one or two illusions? Proceedings of American Convention of American Psychological Association, 1971, 6 (Pt. 1), 175-176.

Samuels, I. Reticular mechanisms and behavior. *Psychological bulletin*, 1959, 56 (1), 5-25.

Sanders, A. F. (ed.) *Attention and performance I. Proceedings of a symposium on attention and performance.* Amsterdam: North-Holland Publishing Company, 1970.

Semmel, M. I. *Arousal theory applied to vigilance behavior of educable mentally retarded and average children.* (Doctoral dissertation, George Peabody College for Teachers) Ann Arbor, Mich.: University Microfilms, 1964, No. 64-50-79. (Dissertation Abstracts. 1964, 24, 5578)

Senf, G. M. and Freundl, P. C. Memory and attention factors in specific learning disabilities. *Journal of Learning Disabilities*, 1971, 4 (2).

Stroh, C. M. Vigilance: *The problem of sustained attention.* New York: Pergamon Press, 1971.

Wagner, R. F. Specific reading disabilities: The incompatability of two systems. *Journal of Learning Disabilities*, 1968, 5 (11), 556-561.

Wasserman, E., Asch, H. and Elkan, E. S. A neglected aspect of learning disabilities: energy level output. *Journal of Learning Disabilities*, 1972, 5 (3), 130-135.

Wender, P. H. *Minimal brain dysfunction in children.* New York: Wiley-Interscience, 1971.

APPENDIX

FAMILY QUESTIONNAIRE

We are interested in whether or not members of your family have had unusual difficulty learning to read. Try and recall from family discussions and your own experience whether you, your own parents, your brothers and sisters, or your children have had unusual difficulty learning to read. Circle yes beside those family members who have had this difficulty and describe it if you can. Otherwise circle no.

I. Father's Family
   1. Father (yourself) Yes No ______________________
   2. Your Father Yes No ______________________
   3. Your Mother Yes No ______________________
   4. Your Brothers
      a. Yes No ______________________
      b. Yes No ______________________
      c. Yes No ______________________
   5. Your Sisters
      a. Yes No ______________________
      b. Yes No ______________________
      c. Yes No ______________________

II. Mother's Family
   1. Mother (yourself) Yes No ______________________
   2. Your Father Yes No ______________________
   3. Your Mother Yes No ______________________
   4. Your Brothers
      a. Yes No ______________________
      b. Yes No ______________________
      c. Yes No ______________________
   5. Your Sisters
      a. Yes No ______________________
      b. Yes No ______________________
      c. Yes No ______________________

III. Your Children
   1. Sons
      a. Yes No ______________________
      b. Yes No ______________________
      c. Yes No ______________________
   2. Daughters
      a. Yes No ______________________
      b. Yes No ______________________

	Behavior Not Exhibited at All	Behavior Exhibited to a Slight Degree	Behavior Exhibited to a Considerable Degree	Behavior Exhibited to an Uncomfortable Degree	Behavior Exhibited to a Large Degree
1. Difficulty running, skipping, jumping					
2. Difficulty with balance - such as in learning to ride a bicycle					
3. Difficulty cutting with scissors, buttoning buttons, tying shoelaces					
4. Difficulty throwing and catching a ball					
5. Excessive motor activity - rushes from one activity to another					
6. Unable to participate because of gaps in attention and concentration - never plays one game for a long period of time					
7. Short attention span					
8. Difficulty in recognizing, by seeing, hearing, touching or moving					
9. Difficulty in accurately duplicating drawings, letters, written words					
10. Lacks persistance, gives up readily					

	Behavior Not Exhibited at All	Behavior Exhibited to a Slight Degree	Behavior Exhibited to a Considerable Degree	Behavior Exhibited to an Uncomfortable Degree	Behavior Exhibited to a Large Degree
11. Low frustration tolerance. Becomes upset when things fail to behave as he would have them					
12. Inability to delay or control impulses					
13. Fearful in new and novel situations					
14. Afraid of other children					
15. Afraid of teachers, principles, and other authorities					
16. Inhibited, shy					
17. Unsure of self					
18. Destructive					
19. Aggressive					
20. Depressed, sad					

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VIGILANCE AND SKIN CONDUCTANCE CHARACTERISTICS IN A POPULATION OF READING DISABLED CHILDREN

by

Zita Annette Mitchell

(ABSTRACT)

Dyslexic children are probably not a homogeneous group in terms of important characteristics assumed to be involved in reading disability since underlying causes may vary widely. Such characteristics as arousal and performance on a vigilance task would differ not only from a control group, but also within the RD sample. It was hypothesized that MBD symptoms would be associated with lowered arousal and poorer vigilance performance whereas children experiencing reading difficulties presumably because of specific language dysfunction would resemble controls in arousal and performance. The results supported vigilance predictions for omissions, but not commissions. Poorer performance was associated with MBD symptoms. Age, however, proved to have an even greater effect on vigilance performance. Arousal results, for the most part, were not in the predicted direction. Arousal, measured by skin conductance, increased over time for children in this sample, rather than decreased as we expected from adult data. This indicated that vigilance and arousal cannot be equated in the same sense that has been suggested for adults.