THE EFFECT OF WHITE NOISE ON SHORT- AND LONG-TERM RECALL IN HYPERACTIVE BOYS

by

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ABSTRACT

Title of Dissertation: The Effect of White Noise on Short- and Long-Term Recall in Hyperactive Boys

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The purpose of this research investigation was to determine whether an auditory arouser in the form of 2-minute bursts of 75 decibels of white noise (WN) might be used to facilitate short- and long-term recall for hyperactive boys. An attempt was made to determine whether the stimulus was most effective if it was presented (a) before acquisition, (b) before the recall tests, or (c) both before acquisition and before the recall tests.

Hyperactivity was operationally defined as a score of eight or more on the Conners' Teacher's Questionnaire. The subjects for the study were 36 boys who had received the criterion score or more on the Questionnaire which had been completed by the regular classroom teacher of each child. The boys were between the ages of 8.50 and 12.75 years.

Ten hypotheses were tested using two types of tasks. A silently read paragraphs task consistently preceded a tape-recorded paragraphs task. Each task was followed by the administration of two halves of a test. The first half of the test for each task was given at a 2-minute interval and the second half of the test for each task was given at a 24-hour interval. The scores for each half test were subjected to a separate analysis. Thus, four half tests were administered and four separate analyses were conducted. The half test analyses were

named for their order of presentation.

Each boy was randomly assigned to one of four noise-condition groups. Each child was retained in the same noise condition for each of the tasks. Nine boys heard no noise (NN) before acquisition and NN before recall tests, nine boys heard WN before acquisition but NN before recall tests, nine boys heard NN before acquisition but WN before recall tests, and nine boys heard WN before acquisition and WN before the recall tests.

The scores obtained on Occasion 1 were analyzed by a 2 x 2 (noise condition prior to acquisition x noise condition prior to recall) analysis of covariance. Age served as the covariate. The scores obtained on each of Occasions 2, 3, and 4 were analyzed by a 2 x 2 (noise condition prior to acquisition x noise condition prior to recall) analysis of variance. Neither the analysis of covariance for Occasion 1, nor the analyses of variance for Occasions 2, 3, or 4 yielded significant $\underline{F}$ values for any of the criterion measures. The mean criterion scores for the four noise-condition groups did not differ significantly on any of the four occasions. However, in the case of the tape-recorded paragraphs task, eight of the ten hypotheses did predict the directionality of the mean scores. Nevertheless, since the findings were not significant, it was concluded that the data did not support the notion that white noise could be utilized to facilitate either short- or long-term recall of either a silently read paragraphs task or a tape-recorded paragraphs task. The temporal location of WN did not appear to be an important variable.

Several possible explanations for the findings were offered.

The difficulties in obtaining hyperactive subjects from a single environment and of ascertaining information about their attributes were discussed. The possibility that the dependent variables used in the study were not reliable or not sensitive to quantitative research was considered.

Finally, it was suggested that a more homogeneous group of boys be used in future research studies, that an attempt be made to obtain larger numbers of subjects than were used in this study, that different dependent variables be utilized, and that white noise be administered over many trials for longer periods of time.

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CHAPTER I

INTRODUCTION

> Hyperactivity is one of the major childhood behavior disorders of our time. It is the single most common behavior disorder seen by child psychiatrists, a problem frequently presented to pediatricians, and a major problem in the elementary school system (Ross & Ross, 1976, p. ix).

Hyperactivity and learning disability are closely related problems. "Minimal brain dysfunction" (MBD) is an umbrella term that has been used to encompass both disorders.

Disagreements about terminology and diagnostic criteria have made estimates of the prevalance of the hyperactive child syndrome difficult to obtain. Various experts have estimated that from 3% to 22% of the nation's elementary school age children are affected by hyperactivity. Boys are reported to be more likely to be affected than girls.

It seems quite clear that many hyperactive children also have severe learning problems. Minde, Lewin, Weiss, Lavingueur, and Douglas (1971) have reported that about 57% of the hyperactive children in their study had repeated one or more grades, while only 16% of the children in a control group had failed a grade. Cantwell (1975, p. 8) reported that 75% of the hyperactive children in his study were educationally retarded in reading, spelling, and math.

The prognosis for hyperactive children who do not overcome the educational and emotional problems associated with learning problems and hyperactivity is extremely poor. Systematic, long-term studies (Cantwell, 1975, pp. 51-63) suggest that the hyperactive child syndrome is a precursor to the development of severe psychopathology in adulthood. Depression, alcoholism, drug addition, sociopathy, hysteria, and psychosis are frequent outcomes of the disability. Hyperactivity sometimes seems to magically disappear at adolescence, but its effects do not.

Many authorities (Cantwell, 1975; Ross & Ross, 1976; Shetty, 1971;

Wender, 1971, 1973) believe that a large number of hyperactive children are hypoaroused. There is a great deal of evidence that psychostimulants calm and improve behavior for some hyperactive children (Freedman, cited in Cantwell, 1971, p. 166; Freeman, cited in Cantwell, 1969, p. 166). School performance has been found to be favorably affected by stimulant medication (Conrad, Dorkin, Shai, & Tobiessen, 1971; Nichamin & Comly, 1964). In addition, some evidence (Cleland, 1961; Cromwell, Baumeister, & Hawkins, 1973) has suggested that maximal-simulation programs can improve school performance for hyperactive children. It may be that psychostimulants and maximal-stimulation programs produce increased arousal and that increased arousal can improve some types of performance, such as short- and long-term recall, in hyperactive children. White noise is thought to be a central nervous system (CNS) arouser and has been reported (Archer & Margolin, 1970; Baumeister & Kistler, 1975) to have affected both short- and long-term recall in college students and normal children. White noise has sometimes been found to impair short-term recall and to facilitate long-term recall (Berlyne, Borsa, Craw, Gelman, & Mandell, 1965; McLean, 1969). It may be that the temporal location of the arousing stimulus is an important factor in producing this crossover effect.

Statement of the Problem

This study was designed to determine whether an auditory arouser (white noise) might facilitate acquisition and recall in hyperactive boys, specifically by answering the following question: Can 75 decibels (dB) of white noise be utilized to facilitate both short- and long-term recall of silently read paragraphs and tape-recorded paragraphs? This study also sought to determine whether the stimulus was most effective if it was presented (a) before acquisition, (b) before a recall test, or (c) both before acquisition and before a recall test.

Research Hypotheses

The following research hypotheses were developed in order to serve as a guide for the investigation:

(1) A 2-minute burst of white noise presented just prior to acquisition but not prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(2) A 2-minute burst of white noise presented just prior to the short-term recall test but not prior to acquisition will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(3) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(4) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear the noise just prior to acquisition but not prior to the recall test.

(5) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear the noise just prior to the short-term recall test but not prior to acquisition.

(6) A 2-minute burst of white noise presented just prior to acquisition but not prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(7) A 2-minute burst of white noise presented just prior to each of the two recall tests but not prior to acquisition will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(8) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(9) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear the noise just prior to acquisition but not prior to the two recall tests.

(10) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear the noise just prior to the recall tests but not prior to acquisition.

Definition of Terms

Hyperactivity is operationally defined in this investigation by a score of eight or more on the Conners' Teacher's Questionnaire (Conners, 1969, 1970; Sprague, Christensen, & Werry, 1974). Thus, as used in this research project, the term "hyperactivity" refers to children who constantly fidget, hum and make other odd noises, are restless or overactive, excitable, impulsive, disturb other children, and who tease other children or interfere with their activities.

White noise is an electronically generated sound spectrum which has been defined by Miller (1951) as a "random noise."

> Random noise is a hishing [sic] sound compounded of all frequencies of vibration in equal amounts . . . . Because all frequencies are present, it is analogous to certain kinds of white light . . . . The spectrum of such a noise is simply a horizontal line up to 10,000 cps (pp. 54-55).

White noise was consistently administered at an intensity level of 75 dB in this study. Each burst of white noise was continuous and lasted for 2 minutes.

Acquisition is defined as the act of gaining, adding, or incorporating something on the part of a subject.

Recall is defined as a method of measuring retention. Retention refers to the degree that a subject can demonstrate an ability to perform an acquired act after an interval in which the performance has not taken place. In order to demonstrate retention, the subject must reproduce, with a minimum of cues, something that he has previously acquired. The term "short-term recall" is operationally defined in this research project as referring to an interval of 2 minutes between the acquisition event and the recall event. The term "long-term recall" is operationally defined in this research project as referring to an interval of 24 hours between the acquisition event and the recall event.

Rationale

Some of the learning problems of hyperactive children may be accounted for by deficits in their ability to recall material as well as deficits in their ability to acquire the material. Dykman, Peters, and Ackerman (1973) studied a learning-disabled group which included hyperactive, hypoactive, and normoactive children. These authors gave their subjects and a control group a silent reading test and discovered that after a "brief" delay, control children recalled more about what they had read than the learning-disabled group.

There are, apparently, very few systematic studies of short- and long-term recall in learning-disabled or hyperactive children. However, parents who drill these children on their spelling lists and multiplication tables the night before a test frequently go to bed assured that their children are well prepared. They are surprised when their children fail the test the next day. Some parents who tutor their own children also complain about short-term recall problems. The authors of Physician's Handbook: Screening for MBD warn, "Providing him a word on line 4 will not at all assure him recognizing it on line 12" (Peters, Davis, Goolsby, Clements, & Hicks, 1973, p. 88).

The Dykman et al. study and some parental observations suggest that hyperactivity and a recall deficit may be related. It is possible that both acquisition and recall problems are a result of attentional deficits--inability to inhibit the irrelevant and attend to the relevant. Wender (1971, 1973) has suggested that such a problem may be neurologically mediated. He suggested that hypoarousal may result in attentional deficits and that this is one part of the MBD child's learning difficulties.

The high level of motor activity, excitability, and impulsiveness of hyperactive children led early investigators to hypothesize that affected children were CNS hyperaroused. Many members of the scientific community, to say nothing of confused parents, met the remarkable revelation that stimulant drugs calmed certain hyperactive children and improved cognitive performance with skepticism which ranged from polite disbelief to outrage. Many of those who did accept the evidence termed the positive response of some children to methylphenidate and amphetamines, a "paradoxical effect."

There is a great deal of controversy and criticism of research methodology in the area of drug research. Many of the problems are related to the terminology and diagnostic criteria difficulties which were mentioned previously. The difficulty of defining and assessing "improvement" has also contributed to research problems. Nevertheless, many studies have reported a wide range of improvement in behavior, attention span, and interest in school activities. In short, many studies suggest that psychostimulants calm and encourage organized behavior in some hyperactive children.

Wender (1971) has hypothesized that the reason CNS stimulants calm many hyperactive children is that such children are CNS hypoaroused. He has suggested that certain drugs are beneficial because they facilitate the inhibitory system. The normal child is thought to have an optimal balance between the excitatory and inhibitory systems of the brain. Wender has suggested that the MBD child may have a deficit in the inhibitory system.

Many investigations have supported the hypothesis that hyperactive children are CNS hypoaroused. Low skin-conductance level is believed to be indicative of low CNS arousal. Lower skin-conductance levels in hyperactive children than in normal children have been reported in many studies. Many hyperactive children exhibit excessive slow- or large-wave activity when their EEGs are analyzed. Longer latency and high amplitude of brain waves are thought to indicate low arousal. The analysis of electronic pupillography responses is also thought to reflect CNS arousal. Many investigators who have worked with pupillography have reported low arousal levels in hyperactive children.

It should be noted that a number of investigators have failed to find evidence to support a low CNS-arousal level theory of hyperactivity.

Satterfield, Cantwell, and Satterfield (1974) have reported that hyperactive children who exhibit the most disturbances in classroom behavior also have the lowest skin-conductance levels. In that study, teachers were asked to rate 18 hyperactive children on scales that evaluated 30 items of classroom behavior. Apparently, some behavior scales can be used to predict the best responders to stimulant medications and do appear to reflect the CNS-arousal level of some hyperactive children.

Experiments have been devised in which distracting stimuli were eliminated or reduced. Quiet environments have not been shown to ameliorate the hyperactive child's problem. Cruse (1962) filled a room with balloons being blown about by a fan, toys on the floor, and mirrors on the wall. Hyperactive children performed no differently under these conditions on a vigilance and reaction-time task than when they took the test in cubicles. On the other hand, auditory stimulation in the form of background noise such as bagpipe music and a drum and cymbal record have been found to reduce activity, increase productivity, and improve attention in some hyperactive children (Cleland, 1961).

Such studies suggest that some sort of arousal is beneficial for some hyperactive children. It may be that arousal is beneficial to both acquisition and recall. There may be ways other than bagpipe music, drum and cymbal records, and drugs to arouse hyperactive children. White noise may be one way.

Many investigators (Berlyne & Lewis, 1963; Davis, 1948; Takasawa, 1972) have reported that white noise is a CNS arouser. It has been demonstrated that white noise is effective in lowering skin resistance (indicative of increased arousal). Skeletal muscular tension has been shown to be directly related to the volume of white noise.

White noise is reported in some studies to have affected both short- and long-term recall. For example, McLean (1969) found that college students who heard white noise and were warned ahead of time that there would be a long-term recall test showed a 24% recall advantage over the no-noise group on the long-term recall test. Most of the research involving white noise, however, has used normal college students and normal children as subjects. It appears that no research has been done which examines the effect of white noise on acquisition or on short- and long-term recall in hyperactive children.

A review of the literature revealed that the temporal location of the arousing stimulus may be an extremely important variable. White noise, as in the case of the McLean experiment, has been found to facilitate long-term recall and impair short-term recall in normal subjects when the noise was presented at the time of acquisition.

White noise may impair short-term recall when it is presented at the time of acquisition because it temporarily overloads the person's short-term recall capabilities for processing information. Such an overload may be the result of the person being stimulated by different signals in several sensory channels. For example, his ears are processing one message but his eyes are processing another (Broadbent, cited in Hilgard & Bower, p. 505). Many researchers have suggested that the short-term recall deficit frequently seen in the studies involving white noise are the result of a reverberating memory trace which temporarily interfers with short-term recall. It is interesting to note that white noise has not consistently impaired short-term recall.

Recently, Baumeister and Kistler (1975) have demonstrated that a 2-minute burst of white noise just prior to a verbal recall test produced substantial improvement in long-term recall in normal subjects. White noise did not have a detrimental effect on short-term recall in this investigation. It appears that white noise is a useful facilitator for long-term recall and does not impair short-term recall if the arouser is presented immediately prior to a recall test rather than at the time of acquisition.

Archer and Margolin (1970) found that white noise presented just prior to acquisition facilitated short-term recall. The effect of the stimulus when presented just prior to acquisition on long-term recall does not appear to have been investigated.

It may be that white noise introduced three times, once just prior to acquisition and again just prior to each of the two recall tests, may facilitate short-term and long-term recall more than if it is introduced only before the two recall tests or only before acquisition.

It is not clear whether white noise is a distractor, a masker, a focuser of attention, a reinforcer, a facilitator of the inhibitory system, an aid in the storage of information, a retriever of stored information, an agent that sets off a reverberating memory trace, or a combination of several or all of these descriptors. This investigator suggested that if white noise presented just prior to acquisition was found to facilitate both short- and long-term recall then this would lend support to the notion that white noise helps store information and thus aids acquisition. If white noise presented just prior to recall was found to facilitate both short- and long-term recall then this would lend support to the idea that white noise is an aid to the retrieval of stored information and thus aids recall. If white noise, presented both prior to acquisition and again just prior to the recall intervals, was found to facilitate both short- and long-term recall more than if presented only once before acquisition, or before each of the two recall intervals, then this would lend support to the hypothesis that white noise serves to facilitate both acquisition and recall by enabling the hyperactive child to selectively attend to whatever lies ahead. It may serve to help focus attention on either the acquisition or recall test situation which is ahead without the impairment which results from processing several different signals at once as in the case of white noise administered at the time of acquisition.

The theoretical framework for this investigation was based on the idea that many hyperactive children are CNS hypoaroused. If hyperactive children are CNS underaroused, then a mechanism which increases arousal--and therefore activates an associated inhibitory control over sensory function--might facilitate the child's ability to inhibit non-meaningful stimuli during the event which lies ahead. An arousing stimulus such as white noise might enable the affected child to selectively attend to both an acquisition or recall-test situation and facilitate both the storage and retrieval processes. If this is the case, then it would certainly seem that white noise could be used as an aid to both acquisition and recall for some hyperactive children.

Significance of the Study

The high incidence of hyperactivity makes it essential that new methods, materials, and classroom aids be developed to help children with the disorder. A better understanding of the effects of noise on attention, acquisition, and recall could lead to the development of those methods and materials. There are not enough highly skilled, special-education teachers to allow individual tutoring and one-to-one treatment methods for all of the affected children in elementary schools. Most hyperactive children who do not have severe learning disabilities remain in regular classrooms without any kind of remedial help. Many of these children might be allowed to remain in regular classrooms and still be helped if we could develop methods and materials to aid them in that situation.

If an arousing stimulus such as white noise could be found to be a helpful aid to acquisition and recall, then it might be of help in opening up new avenues of exploration of ways to arouse hyperactive children besides the use of stimulant medication. Some children cannot tolerate the drugs; many educators, physicians, and parents are opposed to their use.

A simple aid like white noise (properly used) may be found to be useful in helping the hyperactive child in his ability to acquire or recall written or verbal material. It could be easily implemented in regular classrooms. A command console at the teacher's desk could be wired to special desks, allowing affected students to wear headphones to hear the white noise whenever it was appropriate. This would provide help for the hyperactive child and, at the same time, avoid the stigma and cost of placement and maintenance in a special classroom.

CHAPTER II

REVIEW OF THE LITERATURE

The selected review of the research which is relevant to this investigation will be presented in three sections. The first section presents a discussion of the literature relating to hyperactivity. The second section discusses the research pertaining to arousal level and acquisition. The third section reviews previous research which has involved white noise.

Hyperactivity

Problems of Definition

Differences in terminology between professions, geographical locations, and researchers, and the lack of established diagnostic criteria make it difficult to estimate the prevalence of hyperactivity. Prevalence figures are frequently based on teacher questionnaires, education-oriented tests, and surveys of school administrators. Guessing is very popular (Minskoff, 1973).

The syndrome is thought to be more common in boys than in girls with a sex ratio estimated to be from three-or four-to-one (Paine, Werry, & Quay, 1968) to nine-to-one (Werry, 1968). Children in all socioeconomic groups were found to be affected. The U.S. Office of Child Development reported that the hyperkinetic syndrome is found in countries throughout the world. The report states, "A conservative estimate would be that moderate and severe disorders are found in about 3 out of 100 elementary school children" (Report on the Conference, 1971, p. 59).

Huessy (1967) estimated that 10% of the second graders in Vermont were hyperkinetic. The Montgomery County, Maryland, Board of Education reported that 20% of a stratified sample in their elementary schools were affected. "Restlessness" was a problem in 15% of the children, while "problems of attention span" were present in 22% of the children sampled (cited in Wender, 1971, p. 60). Educators have estimated that 15% to 20% of the elementary school population is hyperactive (Yanow, 1973). "Hyperactivity is one of the major childhood behavior disorders of our time" (Ross & Ross, 1976, p. ix).

Differences in terminology and diagnostic criteria have led to confusing and conflicting results in research on hyperactivity. The term "hyperactive child syndrome" generally refers to behavior which has been described as hyperactive, impulsive, distractible, and excitable (Cantwell, 1975, pp. 3-13; O'Malley & Eisenberg, 1973). Disorganized activity is of primary concern rather than simple excessive motor activity (Peters et al., 1973). The hyperactive child is restless, his demands must be met immediately, he displays a short attention span, and he often disturbs others. He is immature and fails to finish things that he starts. He is easily frustrated and frequently has difficulty learning (Conners, 1970, 1973; Laufer & Denhoff, 1957). The child's disabilities may range from mild to severe. It is the cumulative effect of a number of age-inappropriate behaviors that leads to the diagnosis of hyperactivity.

"Hyperactivity" has become an overused rubric which many parents use to label any child who is full of energy. "Minimal brain dysfunction (MBD)," "minimal brain damage," "choreiform syndrome," "chronic brain syndrome," and "hyperkinesis" are terms which are sometimes used synonymously with "hyperactivity."

Some investigators feel that the hyperactive child syndrome is not a distinct category from "conduct disorder" (Quay, 1971; Werry, 1972). O'Malley and Eisenberg (1973) feel that aggression, antisocial behavior, and emotional lability are a part of the syndrome. Some researchers include aggressive hyperactive children, some don't. Others exclude anxious hyperactive children, others don't. These diagnostic and terminology problems play havoc with research results.

Hyperactivity is frequently observed in children who also have "specific learning disabilities." Figure 1 (Peters et al., 1973, p. 5) conceptualizes the notion that a small percentage of affected children are pure hyperactives. Another small group of children suffer from pure learning disability. This second group of children may or may not be "hypoactive." Most common, as this figure indicates, is a mixture of the two types of dsabilities.

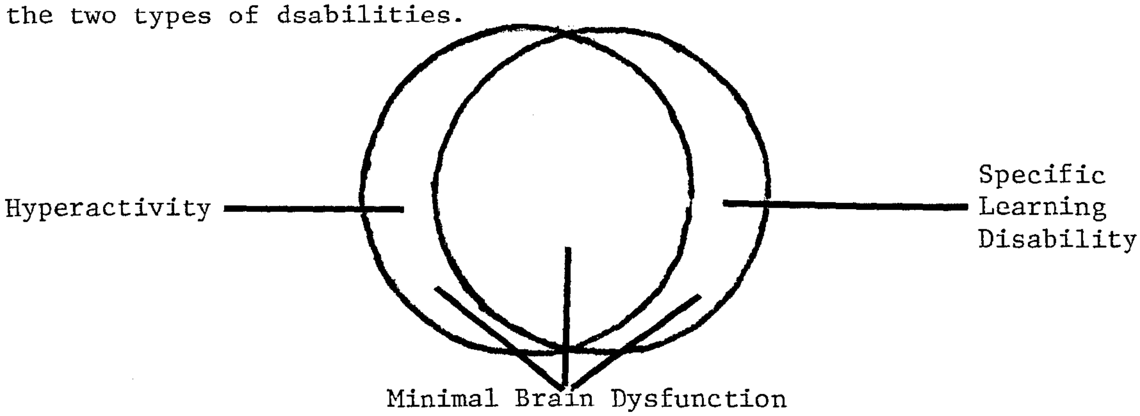

Figure 1. Two overlapping circles illustrating the way in which hyperactivity and specific learning disability may be related.

MBD is an umbrella term which is sometimes used when referring to children who are (a) hyperactive, (b) learning disabled, or (c) suffering from a mixture of the two problems. There is little agreement, and even smaller evidence, on the extent to which these conditions overlap. Although Figure 1 illustrates that the term MBD is frequently used as a synonym for "hyperactivity," this usage is not entirely correct. The National Project on Minimal Brain Dysfunction in Children has defined MBD in the following manner:

> This term as a diagnostic and descriptive category refers to children of near average, average, or above average intellectual capacity with certain learning and/or behavioral disabilities ranging from mild to severe, which are associated with deviations of function of the central nervous system. These deviations may manifest themselves by various combinations of impairment in perception, conceptualization, language, memory, and control of attention, impulse or motor function. These abberrations may arise from genetic variations, biochemical irregularities, perinatal brain insults, or other illnesses or injuries sustained during the years critical for the development and maturation of the central nervous system (cited in Peters et al., 1973, p. 4).

As noted in this definition, MBD children are near average, average, or above average in intelligence. Most definitions of hyperactivity do not evoke this restriction.

Many studies have shown an association between academic problems and hyperactivity. Mendelson, Johnson, and Stewart (1971) reported that 60% of the hyperactive children in their study had failed one or more grades. Minde et al. (1971) followed and compared 37 hyperactive children with 37 normal children. Of the hyperactive group, 57% were forced to repeat one or more grades. Only 16% of the normal children failed a grade.

At present, the diagnosis of hyperactivity usually refers to a very heterogeneous group of children. Wender (1971, p. 88) offers this rationale for regarding MBD children as a homogeneous group:

> It was the common responsiveness to amphetamines which con-

> stituted one of the reasons for grouping this seemingly heterogeneous group of children together under the cognomen "minimal brain dysfunction." (It also suggested the only semi-facetious name "congenital hypoamphetaminemia.")

The research findings provide little evidence of a global syndrome other than the fact that many affected children do respond positively to CNS stimulant. There do, however, appear to be a number of medical and behavioral disorders which have hyperactivity in common. It also should be noted that the secondary symptoms that are associated with hyperactivity do suggest a syndrome (Ross & Ross, 1976).

Theories of Etiology

The etiology of hyperactivity is not clearly understood. The term "hyperactive child syndrome" is used to describe a heterogeneous group of children (Satterfield, Cantwell, Lesser, & Podosin, 1972). A wide range of factors are thought to be potential contributors for the disorder. Many theories have been developed in an attempt to understand, manage and prevent the problem.

The first major well-known theory regarding hyperactivity was that affected children were "brain damaged" (Strauss & Lehtinen, 1947). Structural abnormality of the brain has been shown to result in hyperactivity. However, the majority of hyperactive children do not exhibit major neurological abnormalities (Werry, 1972). Brain damage should never be inferred from behavioral signs alone (Bax & MacKeith, 1963; Werry, 1968).

A great deal of evidence suggests that there is a genetic basis for the disability (Cantwell, 1975, pp. 93-105; Mendelson et al., 1971; Morrison & Stewart, 1973; Safer, 1973; Wender, 1971). However it has been noted that the disorder does not always "breed true" (Wender, 1971, p. 42).

Some evidence exists which suggests that hyperactivity can occur as a defense against depression (Huessey, 1967; Friedland, 1973). There is evidence that pathological family interaction, poor emotional climate in the home, poor parental mental health, and punitive child-rearing practices are associated with hyperactivity (Mendelson et al., 1971; Minde et al., 1971; Rappaport, 1964). However, these associational data may be interpreted in a child-to-parent direction as well as vice versa. Many hyperactive children have a negative effect on family interaction. It cannot be inferred from these observations that a poor emotional climate results in hyperactivity (Huessy, 1967).

It has been claimed that some hyperactive children suffer from vitamin deficiencies, food additive allergies, and dietary problems (Cott, 1972; Feingold, 1973; Rimland, 1972). There is a high association between hyperactivity and maternal smoking during pregnancy (Denson, Namson, & McWatters, 1975).

Radiation stress may be an important source of some hyperactivity. Frey (1965) found that animals repeatedly exposed to radio and television experienced behavioral changes and transient changes in the CNS. Fluorescent lighting has been implicated in a study by Mayron, Ott, Nations, and Mayron (1974).

Oettinger, Majovski, Limbeck, and Gauch (1974) have demonstrated that two-thirds of the children diagnosed as MBD in their study were significantly retarded in bone age, $p < .01$. This finding is consistent with a delayed-development hypothesis.

The lack of cerebral dominance has been proposed as an explanation for the disordered behavior of the hyperactive child (Gazzaniga, 1973). It has been suggested that in such a situation, cerebral signals conflict with one another. It is easy to imagine how a dual-based decision system in one person would result in disorganization, distractibility, and a short attention span.

In 1974, Psychology Today published an article titled "Drugging the American Child: We're Too Cavalier About Hyperactivity" (Walker). The physician who wrote the article suggested that many cases of hyperactivity are due to cardiac problems, inability to tolerate and assimilate glucose, pica, glandular problems, lead or carbon monoxide poisoning, and subtle seizure activity. He expressed the belief that some children are hyperactive because of traumatic childhood experiences, unresolved conflicts, "or even because their underwear is too tight" (p. 43).

Some investigators have suggested that learning problems such as dyslexia, a reading disability which is frequently associated with hyperactivity, can be the result of poor self-concept (Lamy, 1963; Berretta, 1970) and poor child-rearing techniques (Purkey, 1970; Smith & Brachce, 1965).

Bronfenbrenner (1968, p. 754) concluded that general stimulus deprivation in infancy can produce hyperactivity and impair cognitive functioning.

Teachers are frequently blamed for the child's problems. Cohen (1973, p. 253) made the following statement in regard to the MBD child: "If he does not learn the behavior, we assume that our instruction was ineffective; we do not assume that the child is 'defective.'"

Thus, there are numerous theories regarding the etiological basis of hyperactivity. One can selectively produce data to support almost any theory that one wishes to advance. Hyperactive children are a heterogeneous group. There may be a dozen nosological categories involved in the disorder (McMahon, Deem, & Greenberg, 1970). Ney (1974) has proposed that there are four types of hyperactivity: (1) genetic, (2) behavioral, (3) minimal brain dysfunction, and (4) reactive. Bender (1953) has designated three types: (1) constitutional, (2) organic, and (3) environmental. At present, there is insufficient empirical data to establish an unequivocal cause-effect relationship for hyperactivity.

The Low-Arousal Model

Subsequent to the discovery that stimulants sometimes calm hyperactive children, numerous investigators found evidence which supports a low-arousal theory of hyperactivity. Duffy (1962) has suggested that a low skin-conductance level is indicative of a low level of CNS arousal. It is generally believed that high skin resistance, fewer and smaller fluctuations in skin resistance and low electrodermal activity are also characteristics associated with, and assumed to indicate, low arousal. The most common type of clinical EEG abnormality in hyperactive children is excessive slow- or large-wave activity. Slow- or large-wave activity is thought to be indicative of low arousal.

Satterfield and Dawson (1971) reported lower skin-conductance levels in 24 hyperkinetic children than in 12 control children. They also found lower nonspecific electrodermal activity in the hyperkinetic children. Low skin-conductance levels predicted those who would respond best to stimulant medication (Satterfield et al., 1972).

In a series of three experiments (Satterfield, 1973; Satterfield et al., 1972; Satterfield, Cantwell, & Satterfield, 1974), evidence was obtained that suggests that hyperactive children who respond best to methylphenidate treatment demonstrate an initial low CNS arousal level. Dependent variables included power spectral analysis of the EEG, skin-conductance level measures and auditory-evoked cortical responses. CNS stimulants were found to raise the arousal levels as indicated by the same electrophysiological measures.

Satterfield, Cantwell, and Satterfield (1974) investigated the relationship between skin-conductance level and maladaptive classroom behavior. Teachers were asked to rate 18 hyperactive children on scales reflecting 30 items of classroom behavior. Children who exhibited the most classroom disturbance also had the lowest arousal levels; in other words, they had the lowest skin-conductance levels. These children were also found to be the best responders to methly-phenidate.

Capute, Niedermeyer, and Richardson (1968) studied a group of MBD children, all of whom had "soft" neurological signs. They found that 43% of the children had mild to moderate EEG abnormalities.

Stevens, Sachdev, and Milstein (1968) found a positive correlation between hyperactivity and occipital slow waves. Hughes (1971) compared 214 children who were underachievers with 214 control children. EEG abnormalities were found in 41.2% of the children in the underachieving group, while only 29.8% of the children in the control group had abnormalities, $p < .007$.

Evoked cortical response measures appear to be different in hyperactive children. Buchsbaum and Wender (1973) studied 24 hyperactive children and compared them to 24 sex- and age-matched normal controls. Visual-evoked responses were reported to be of larger amplitude in hyperkinetic than in normal children. Satterfield, Lesser, and Saul (1973) compared the EEGs of 31 MBD children with 21 normal children matched for age and sex. Auditory-evoked cortical responses in the MBD group had lower evoked-response amplitudes and longer latencies, than children in the control group. Longer latency, decreased amplitude of the evoked response, and occipital slowing are believed to be measures of decreased arousal.

Yoss (1970) studied a group of hyperactive children and found that 20-25% of the group had a narcoleptic-like pupillograph response. Davies and Maliphant (1971) studied children who were unresponsive to punishment and approval and who had poor self-control, characteristics associated with hyperactivity. They found that these children had slower heart-rate and decreased heart-rate responsiveness to stress.

Knopp, Arnold, Andras, and Smeltzer (1973) also found evidence to support the view that hyperactive children have low arousal levels. Using electronic pupillography as an indicator of arousal, they reported that hyperactive children with low CNS arousal were found to be good responders to stimulant medication.

A number of studies do not support the notion that hyperactive children are hypoaroused. Dykman, Ackerman, Clements, and Peters

(1971) reported that they found no difference in resting skin resistance in hyperactive children compared to normal children. They did report lower autonomic responsiveness to stimulation in the patient group.

Cohen and Douglas (1972) found no difference in skin-conductance levels between hyperactive children and normal children. However, they also found lower specific electrodermal responsiveness in hyperactive children.

Werry (1972) failed to find evidence of hypoarousal in hyperactive children. He compared 20 hyperactive children, 20 neurotic children, and 20 normal children and found no group differences in the incidence of EEG abnormalities.

In a second Satterfield study conducted in 1974, Satterfield, Atoian, Brashears, Burleigh, and Dawson (1974) reported that they found higher skin-conductance levels in hyperactive children. In the previously discussed 1974 Satterfield study, Satterfield, Cantwell, and Satterfield found that the group mean score indicated hypoarousal. However, two of the children in that study were hyperaroused. Spring, Greenberg, Scott, and Hopwood (1974) have reported that hyperactive children do not differ from normal children in CNS-arousal level as measured by skin-conductance levels, EEGs while the child is resting, and sensory-evoked cortical response.

Decreased arousal has been shown to be associated with an increased level of activation (Conrad, Dorkin, Shai, & Tobiessen, 1971). Satterfield, Atoian, Brashears, Burleigh, and Dawson (1974) found that the lower the level of arousal, the greater the restlessness reported by teachers.

Cantwell (1975) has hypothesized that "Associated with the low CNS arousal levels in hyperactive children there is insufficient CNS inhibition and that CNS arousal and inhibition vary together" (p. 75).

Insufficient inhibitory control could result in the excitability, impulsiveness and distractibility of the hyperactive child. Stimulants, such as methylphenidate and amphetamines, are known to increase central nervous system arousal as measured by EEG and autonomic responses (Shetty, 1971; Satterfield & Dawson, 1971).

It has been proposed that arousal, as induced by stimulant drugs, probably results in increased inhibitory control. It is thought that the pharmacological agents act by reducing the disorganized and inappropriate behaviors which interfere with learning (Cantwell, 1975; Knobel, 1962; Lytton & Knobel, 1958). In other words, a stimulus or drug which raises the level of arousal may also increase cortical inhibition.

In summary, there is a great deal of evidence that many hyperactive children are hypoaroused. However, a number of studies do not support this conclusion. Differences in diagnostic criteria, test environment, and experimental methodology may explain these conflicting reports. Perhaps hyperactive children are heterogeneous when it comes to arousal as well as almost everything else. The inconsistency of these reports may be a reflection of the marked variability of the hyperactive child. It should be noted, however, that regardless of their arousal level many hyperactive children respond well to stimulant medication (Ross & Ross, 1976).

Wender's Two Primary-Deficit Hypotheses

Wender (1971, 1973) has suggested that the MBD child has an abnormality in the metabolism of one or more of the monamines: serotonin, noradrenaline, and dopamine. Wender has hypothesized that the child has two primary deficits which result from this biochemical abnormality: (1) an impairment of the reward mechanism of the brain which results in a diminished ability to experience pleasure or pain--the child has a diminished sensitivity to positive and negative reinforcement, and (2) a disturbance in the activation level, which is described as "An apparent increase in arousal, accompanied by an increased activity level and a decreased ability to concentrate, focus attention, or inhibit responses to the irrelevant" (1973, p. 20).

The low cortical noradrenalin level is suspected by Wender as the primary agent which is responsible for the deficiency in the inhibitory system. In this theory, if the excitatory system (mediated by monamines) is at a high level, then high activity results. If the inhibitory system is functioning normally, the child is controlled. The normal child has an optimal balance between the excitatory and inhibitory systems.

When noradrenalin is at a low level, Wender has postulated, the hyperactive child suffers a decreased activation of the inhibitory system and a high level of activity results. Amphetamines are known to be chemically similar to noradrenalin. They can, therefore, substitute for it with a subsequent calming effect on the child.

Wender has suggested that the psychopathy seen in adults (i.e., alcoholism, depression, hysteria, drug addiction, sociopathy, etc), is a result of secondary reactions to the two primary deficits. The child feels stupid or bad and suffers severe loss of self-esteem as a result of his many failures at home and in school. He is constantly criticized, corrected, blamed, and punished for his shortcomings, but because of the two primary deficits he is unable to change his ways.

The Effects of Hyperactivity on Cognition

The definition of cognition is broad and includes not only the major academic skills such as reading, arithmetic, and science, but also intelligence and skills involving insight, intuition, and knowledge, which for many years were considered to be a part of perception.

Although the term hyperactivity has been used to describe children with certain attentional and school-related disorders, there have been relatively few investigations seeking to determine the extent to which hyperactivity and recall problems are related. Specifically, the effect of hyperactivity on short- and long-term recall is not understood. Hyperactivity is generally believed to be a medical problem, and many educators believe it to be outside of their purview (Cohen, 1972).

It is a frequent observation that reading is difficult for the hyperactive child. He seems to need attention-evoking materials to stay alert. Many clinicians report that the child is best able to concentrate on quick-moving games, TV cartoons, and adventure-packed movies (Peters et al., 1973). Static symbols, such as printed reading material, do not arouse his interest or hold his attention. Consequently, the information contained in written material may not be available for either short- or long-term recall.

The child's teacher frequently complains that the child cannot stay in his seat or finish his work. He has problems keeping his mind on one task. He cannot refrain from calling out or inhibit aggression. He does not pause to think and consequently his written and oral work is full of errors. Children who are particularly affected in auditory perception have a great deal of difficulty following verbal directions. The teacher is frequently irritated by his impulsiveness. The child's peers sense the teacher's attitude and ridicule the child. This attention, even though it is negative, may be welcomed by the child (Ross & Ross, 1976).

The academic performance of the hyperactive child is extremely unpredictable. Teachers are frequently convinced that the child's behavior is within his control because his performance may fluctuate under a variety of conditions. The great variability on WISC Performance IQ scores confirms the erratic quality of his work (Douglas, 1974).

Cantwell (1975, p. 8) found that 75% of the hyperactive children that he studied were educationally retarded in reading, spelling, and math. Keogh (1971) reported that the overall academic achievement is low for the hyperactive child. He is deficient in visual-motor tasks, and tasks which require attention (Sykes, Douglas, Weiss, & Minde, 1971).

Minde et al. (1971) followed and compared 37 hyperactive children with 37 normal children. By the age of 11, 21 of the hyperactive group had repeated one or more grades, while only six of the children in the control group had failed a grade in school. The hyperactive children scored significantly lower in school subjects except for physical activity and art. The unevenness of their cognitive patterns was striking. These inferior performances held true even when the two groups were matched for IQ. Hyperactivity had not, as had often been supposed, disappeared in the later middle-childhood years. Instead, hyperactivity, lack of concentration, and distractibility persisted. In addition, the follow-up study revealed that day-dreaming and delinquent behavior had become a part of the problem by age 14. Mendelson et al. (1971) found that 60% of the hyperactive children in their study had failed one or more grades. They confirmed that poor school performance persisted beyond the latency years.

Dykman et al. (1973) reported on the follow-up data of 82 learning-disabled (LD) children who were classified as hyperactive (n-29), hypoactive (n=19), or normoactive (n=34). These authors reported on 31 of the LD cases and 22 control cases when they reached 14 years of age. When initially seen, the LD children were deficient in Verbal IQ but not on the Performance or Full-Scale WISC. When retested at age 14, the LD children were found to be inferior to controls in Full-Scale, Performance- and Verbal IQ scores. On the Gray Oral Reading Test, at follow-up, only two of the 22 controls scored below grade level, whereas 22 of the 31 LD children were retarded in this test. At follow-up, the children were tested on delayed recall of paragraphs read silently using a modified version of the Gray Oral Reading Test as a measure of retention. The delay was described as "brief." There was a significant difference between the two groups. Controls recalled a mean of 8.5 out of 12 answers and the LD children recalled a mean of 7.3.

In a systematic study of attention in the hyperactive child (Douglas, 1972, 1974), it was found that the child performs as well as his normal peers when he is helped to focus his attention prior to presentation of the test. Deadening the environmental sound and eliminating distracting stimuli did not improve his performance.

Campbell, Douglas, and Morgenstern (1971) reported that when the task required the affected child to select one of several answers to a multiple-choice type problem, he responded impulsively and made frequent errors. He had problems of attention; in other words, he had trouble excluding irrelevant information and focusing on relevant aspects of the test stimulus. These authors found that in an embedded-figure test the child was easily drawn away by attention-directing clues in other parts of the field.

In Grades 1 and 2 the mean IQ of hyperactive boys (Loney, 1974) and hyperactive girls (Prinz & Loney, 1974) did not differ from that of controls. These studies indicated that by Grades 5 and 6, however, the IQs of hyperactive children were significantly lower than those of controls.

Palkes and Stewart (1972) compared 32 hyperactive elementary school children who had been referred to a psychiatric clinic with 34 controls who had no known behavior problems. IQs were measured by the WISC. The mean IQ scores of the hyperactive group were lower than those of the control children, $p < .001$. These authors concluded that hyperactive children learn at a rate that is normal for their IQs, a conclusion which contradicts the findings of Minde et al. (1971).

Wilker, Dixon, and Parker (1970), also found significantly lower WISC Performance- and Full-Scale IQ scores for their hyperactive group. It has been noted that most comparisons of this type have revealed that variability is greater on the performance portion of the test than on the verbal portion (Ross & Ross, 1976, p. 45).

It may be that the hyperactive child exhibits a performance deficit rather than an IQ deficit when he is tested on measures such as the WISC. His short attention span, impulsiveness, and expectations of failure may result in the inaccurate assessment of his intelligence. While this does not mean that the IQ score is inaccurate in predicting success in school, it may mean that it is possible that his test performance, and consequently his IQ score, can be improved by providing increased CNS arousal. Pemoline, a weak CNS stimulant, produces improvement on the Performance Scale of the WISC for hyperactive children (Conners, Taylor, Meo, Krutz, & Fournier, 1972; Millichap, 1973).

There is a strong suggestion of a downward spiral in the academic functioning of the hyperactive child (Cantwell, 1975; Denhoff, 1973; Dykman et al., 1973; Huessy, 1974; Mendelson et al., 1971). In other words, it may be that there is an interaction between inattention and cognitive function on the one hand, and the child's sense of failure, poor self-image, difficulties at home and school, rejection by parents and siblings, and lack of social and game skills on the other (Ross & Ross, 1976).

Educational Intervention

Although clinical reports frequently suggest that the hyperactive child is easily distracted by irrelevant extraneous stimuli, quiet circumstances have not always been shown to effectively remedy the problem. Researchers (Cleland, 1961; Cromwell, Baumeister, & Hawkins, 1963; Cruickshank, Bentzen, Ratzeburg, & Tannhauser, 1961; Cruse, 1962; Douglas, 1972, 1974; Rost & Charles, 1967; Strauss & Lehtinen, 1974) have conducted experiments in which distracting stimuli were eliminated or reduced.

Strauss and Lehtinen (1947) made one of the first major efforts to develop a program in which stimulus elements in the environment were sharply reduced. Visual distractors such as pictures and bulletin boards were removed. Patterns were eliminated by frosting the lower parts of windows. Walls and ceilings were painted in neutral tones. Auditory stimulation was reduced. Teachers were required to dress inconspicuously with no ornaments. Spaces were created between desks, and some of the most distractible hyperactive children were placed in corners facing the wall. An attempt was made to see that no stigma was associated with this procedure.

In the Strauss and Lehtinen program, the ratio of pupils to teachers was low and lessons were designed with frequent activity breaks. Strauss and Lehtinen were enthusiastic about the changes that occurred. One child is quoted as commenting, "I'm glad I'm not in that other room any more; there were just too many kids in there; I couldn't stand it" (pp. 132-133).

Because Strauss and Lehtinen failed to use adequate statistical control procedures, their work has been subject to much legitimate criticism. Although they were important pioneers in the field of special education, experimental tests of their approach have not confirmed the notion that eliminating distracting stimuli improves behavior or performance in the hyperactive child.

Gardner, Cromwell, and Foshee (1959) reported that both hypoactive and hyperactive mentally defective children were significantly more active under reduced-stimulation conditions. "Increased distal stimulation" was provided in the study by pieces of brightly colored cloth covered with toys and trinkets and multi-colored Christmas lights. A "ballistograph" measured both amplitude and frequency of movement and activity on the experimental platform. Hyperactive children had a significantly greater variability in activity and movement from one condition to another than did the hypoactive subjects.

Cruickshank et al. (1961) devised a classroom experiment which incorporated the procedures developed by Strauss and Lehtinen. Five basic principles were employed:

1. Environmental space was reduced. Cubicles were utilized. Each child had a three-sided cubicle approximately 3 feet square which was painted the same neutral color as the walls.

2. Visual and auditory stimulation was reduced by optimal location of the experimental classrooms. As much extraneous social and nonsocial stimulation was reduced as was possible.

3. Emphasis was placed on a structured approach to lessons and events. Choice situations were eliminated. Failure experiences were completely eliminated.

4. Teaching materials were designed to be maximally stimulating. Letters and numbers were brightly colored in an attempt to focus the child's attention on the task.

5. A multisensory teaching approach was used. For example, letters and numbers were in a three-dimensional form.

The Cruickshank et al. experiment was conducted in four classrooms in three public elementary schools. Two of the classes were experimental and two were designated control groups. Forty children with learning and behavior problems were selected from a population of 460 children. Half the subjects in each classroom had neurological evidence of CNS impairment. Each of the four groups were matched as to chronological and mental age, achievement level, school experience, diagnostic evidence of CNS damage, degree of hyperactivity, and perseveration. The mean IQ score was 80.3 and the mean chronological age was 8 years, 1 month.

Each of the classrooms had an experienced teacher and one teacher's aide. Both teachers and aides were given an intensive, 6-week training program. Control group teachers were free to use traditional teaching methods or any aspect of the experimental program.

There was no convincing evidence that the specially engineered classrooms benefited the hyperactive children in the Cruickshank et al. study. The experimental group gained on the Bender-Gestalt Test, but the pattern of test gains was similar for both experimental and control groups on the Vineland Scale of Social Maturity, the Stanford Achievement Test, and the Syracuse Visual Figure-Background Test. Neither group improved on the Stanford-Binet or the Goodenough Intelligence Tests. One experimental group showed a significant drop on the latter test.

The low student-to-teacher ratio may have operated to produce gains in both groups. This would support the notion that individual attention is an arousing stimulus for hyperactive children (Peters et al., 1973; Ross & Ross, 1976).

Data collected one year after the Cruickshank et al. experiment indicated that when these children returned to regular classrooms there was still no gain in IQ scores. The differences which favored the experimental group on the Bender-Gestalt had disappeared. Both groups had significantly lower social quotients on the Vineland Scale of Social Maturity. Both groups had improved on the Syracuse Visual Figure-Background Test.

Cruse (1962) studied vigilance and reaction time for hyperactive children when they were placed in a room filled with distracting stimuli. There were balloons being blown about by a fan, toys on the floor, and mirrors on the wall. The performance of these children was compared with that of hyperactive children placed in a bare cubicle. Cruse found no difference in scores.

In another attempt to evaluate the use of cubicles, Rost and Charles (1967) had ten hyperactive and brain-injured children sit together for lessons that required teachers' explanations, but study in cubicles for workbook assignments and silent reading. For one semester the children studied in the cubicles for 1.5 to 2 hours per day. A matched control group of 11 children followed the same general procedures, but did not use cubicles. Pre- and post-tests on the Wide Range Achievement Test (WRAT) indicated that both groups made substantial progress over the semester. There were no significant differences between the two groups on the WRAT scores. The authors concluded "Isolation in a booth in the classroom is not beneficial . . . there was no evidence to suggest that having a brain-injured or hyperactive child spend his study time in a separate booth has any effect whatever on his achievement" (p. 125).

It may be that achievement tests are not sensitive to the use of cubicles. Shores and Haubrich (1969) used as their dependent variables reading rate, arithmetic rate, and measurements of attention. Three hyperactive children of normal IQ were studied under two conditions. In the control condition the children were seated at their desks for independent work in arithmetic and reading. The experimental condition was having the children work in three-sided cubicles. The academic rate was not affected by the experimental condition, but the children's attention was increased by 10% or more.

Scott (1970) reported that the use of a booth resulted in an increase in completing arithmetic problems. Statistical comparisons were not possible because there were only three children in the study. Inspection of the data, however, does suggest that booth isolation may increase productivity.

Productivity under regular classroom conditions has been compared with productivity under cubicle conditions (Cromwell et al., 1963). In both situations auditory stimulation was provided in the form of background music. Regular classrooms were found to be superior to cubicle conditions in reducing activity and increasing productivity.

Cleland (1961) increased stimulation in hyperactive, mentally retarded boys by introducing bagpipe music, and a drum and cymbal record at three different volumes. There was a sharp reduction in activity level and a concomitant improvement in attention under the loudest volume condition. Cleland also found that maximal visual stimulation resulted in a significant decrease in level of activity.

Douglas (1972, 1974) and her associates at the McGill University Laboratory introduced "distracting stimuli" in the form of white noise while hyperactive and normal children were performing a choice reaction-time task and a continuous-performance test. Eighty dB of noise was intermittently piped into the room at random intervals <u>during the continuous-performance test</u>. Performance for both groups was disrupted equally. Douglas concluded that this evidence seems to negate the assumption that hyperactive children are more distractible than normal children. The fact that white noise did not improve performance in this experiment may be due to the time at which the noise was introduced.

According to Mrs. E. A. Hawthorne, director of the Specific Reading and Learning Difficulties Association of Roanoke, Virginia, the late Charles L. Shedd devised a program for children with learning disabilities and hyperkinesis. Mrs. Hawthorne explained (Appendix A) that Dr. Shedd experimentally administered white noise to LD students in a research project. Communication with Dr. Shedd's widow revealed that she is unable to find either the results or a description of his research. Mrs. Hawthorne suggested that because of the results of Dr. Shedd's experimentation, background noise is deliberately sought at the Shedd School which is run by the Specific Reading and Learning Difficulties Association of Roanoke. A visit to the school by this investigator revealed that at least seven basic principles have been incorporated into the Shedd School program.

1. Classes are taught in an open situation with background noise deliberately sought. The intensity level of noise is very high.

2. Parents have been trained as tutors and are deeply involved in the program.

3. Behavior modification procedures are being used.

4. A modified Montessori system is being utilized.

5. Auditory discrimination, social studies, human physiology, grammar, arithmetic, spelling, history, science, and a social-value system are being taught. Most of these classes are using the APSL Approach to Literacy, a system which was apparently devised by Shedd.

6. A low-carbohydrate diet is encouraged.

7. The children are all drug free.

The Shedd School appears to have an enrollment of about 75 students. The entire program is conducted in one large room. On the day that this investigator visited the school, the following was observed:

For several hours, 16 parent-tutors worked with 16 pairs of children in a space that appeared to be approximately 250 square feet in size. The tutors shouted their instructions and questions, the children shouted their responses. The noise-intensity level produced by 48 people shouting at one another was very high.

In the afternoon, teachers taught classes in another area that also appeared to be about 250 square feet in size. About seven classes were taught simultaneously. The teachers shouted their instructions and questions, the children shouted their responses. Again, the noise-intensity level was very high.

The children appeared to be calm and attentive. They appeared not to be distracted by the noise. They seemed to be able to attend to their teachers or tutors for long periods of time.

An April, 1977, newsletter from the association states that the following gains were made by the pupils in the school:

> Shedd School average rading [sic] level gain = 1.2 years; comprehension = 1.4 years; spelling = .9 year, first semester. In addition utilizing the Stanford Achievement Tests forms W and Z in October and again in January, the following gains were measured for our upper school population: Paragraph meaning = 1.2 years; World [sic] meaning = 1.3; Spelling = .8; Social Studies = 1.0; Math computation = .5; Math application = 1.0; Science = .7; Language = 1.0 . . . .Schools with normal populations aim for 1.0 per school year . . . . These results were for 1 semester, 1/2 school year (p. 4).

Medical Intervention

A positive response to methylphenidate or amphetamines is consistent with the hypothesis that the pathophysiology of the majority of hyperkinetic children is a low CNS arousal level. The fact that many hyperactive children respond favorably to psychostimulant medications suggests a biochemical deficiency as a cause of the disorder.

It is not the purpose of this paper to review all the studies which have shown improvement for hyperkinetic children through drug treatment. A few typical investigations will be cited in order to establish that there is a wide range of types of improvement noted, and in order to emphasize that some hyperactive children do respond positively to arousing stimuli.

Freeman (cited in Cantwell, 1969, p. 162) reviewed the studies dealing with the effect of medication. Twenty-two of 45 studies reported an improvement in behavior as a result of a CNS stimulant, while 10 of 32 studies reported an improvement in learning. The U.S. Department of Health, Education, and Welfare and the Office of Child Development (Freedman, cited in Cantwell, 1971, p. 166) reported that a survey of the studies indicated that in about 60% to 70% of hyperactive children, the hyperactivity will respond to stimulant medication.

Bradley and Bowen (1941) and Bender and Cottington (1942) were among the first researchers to find evidence that stimulants improve attention span, increase interest in school activities, subdue emotional responses, calm, and encourage the organized behavior of children with behavior disorders. More recent studies have used careful controls and improved rating systems. The early findings of improvement have been confirmed (Conners, 1969; Eisenberg & Barcai, 1967; Denhoff, 1973).

Nichamin and Comly (1964) reported a 70% improvement rate among medicated hyperactive children when a rise in letter grades for classroom conduct was a criterion. Conrad et al. (1971) randomly assigned 68 hyperactive children to one of four experimental groups: placebo and no tutoring, placebo and tutoring, dextroamphetamine and no tutoring, dextroamphetamine and tutoring. The group that received dextroamphetamine alone showed the most improvement. The group that received dextroamphetamine and tutoring also were benefited by the treatment, but surprisingly, not as much as the drug group with no tutoring.

Rapoport, Lott, Alexander, and Abramson (1970) studied 19 hyperactive boys, ages 5 to 10 years. A control group of six age- and sex-matched normal children was also studied. The subjects were rated by observers during 10-minute playroom sessions at 2-week intervals. Each of the hyperactive children was given a placebo, dextroamphetamine, and chlorpromazine. Dextroamphetamine was found to significantly decrease playroom activity and distractibility. Lytton and Knobel (1958) have reported that methylphenidate decreased the absolute amount of motor activity and increased the amount of goal-directed behavior.

Dextroamphetamine was found to improve attention, new learning, and school behavior, according to a report by Conners and Rothschild (1968). This drug did not increase auditory perception or motor inhibition. Interestingly, dextroamphetamine did not increase short-term memory. Shetty (1971) found an increased amount of alpha rhythms following dextroamphetamine administration. Thus, it would appear that arousing drugs also arouse brain waves as measured by EEGs. Satterfield and Dawson (1971) also reported that treatment with stimulant drugs tended to change autonomic response measures in the direction of normality.

When effective, some CNS-stimulant drugs have been noted to have a profound influence on the activity level, distractibility, attention span, social behavior, and cognition of hyperactive children. It is essential to note, however, that although many children respond dramatically and positively to stimulant drugs, some are made worse (Fish, 1971). Hyperactive children are a heterogeneous group of children. The lack of consistent selection criteria and terminology differences make research inconsistent and unreliable. Some hyperactive children may respond well to stimulant medication, while others may not.

This review of the literature suggests that the validity of the stimulus-reduction strategy is questionable. The strategy has been seriously questioned by recent theorists (Douglas, 1972; Dykman et al., 1971; Satterfield & Dawson, 1971). The assumption that extraneous stimuli impair a hyperactive child's cognitive processes has not been supported by the evidence. The elimination of extraneous visual and auditory stimulation does not seem to result in a significant improvement in learning, performance, or attention. When some improvement has been noted it has been unclear whether the improvement was a result of the reduction in extraneous auditory and visual stimulation, or whether the diminished teacher/pupil ratio was responsible for the changes which occurred. Reducing stimulation may even increase restlessness (Cleland, 1961; Cromwell et al., 1963; Gardner et al., 1959; Scott, 1970). If hyperactive children are CNS hypoaroused, then it may be that certain types of arousing extraneous stimulation, introduced at the appropriate time, could even be helpful to learning.

Arousal Level and Acquisition

Definitions of Acquisition Concepts

Hilgard and Bower (1966) point out that it is difficult to write a definition of learning. Nevertheless, they conclude as follows:

> Learning is the process by which an activity originates or is changed through reacting to an encountered situation, providing that the characteristics of the change in activity cannot be explained on the basis of native response tendencies, maturation, or temporary states of the organism (e.g., fatigue, drugs, etc.) (p. 2).

The term "acquisition" is sometimes used as a loose synomym for "learning." However, because induced arousal may be considered a "temporary state," the term "learning" will not be utilized by this writer in the following review of the literature. Acquisition means simply the process or the act of acquiring something. Many of the writers to be reviewed have used the terms "learning" and "acquisition" interchangeably. In this paper, the terms "acquisition," or "the associative event" are used when describing the presentation of the stimuli which are to be recalled.

When a time interval lapses between acquisition and testing, there is often a loss of acquired material which is sometimes called "forgetting," "action decrement," "inhibition of recall," etc. These terms are used synonymously in this paper. Sometimes, however, there is an increased recall of acquired material over a period of time. When this occurs it is sometimes described as "latent learning" or "reminiscence." Reminiscence occurs when the recall of an incompletely acquired task is more complete after a delayed interval following the associative event than it is immediately after acquisition.

The most confusing concept to be clarified in the studies to be discussed is the use of the terms "immediate," "short-term," "long-term," and "delayed" intervals. Some writers refer to a 12-minute period of time as an immediate interval. Usually, however, 0 minutes is regarded as an immediate interval while all other intervals are regarded as short- or long-term or delayed.

Some authors refer to a "long-term retention test" and then describe a 30-minute time interval. This is, to say the least, confusing, since the majority of writers seem to regard an interval of less than 24 hours as short-term and an interval of longer than 24 hours as long-term or delayed.

Frequently, the writers to be reviewed here discuss memory, recall, and retention as though the terms were synonyms. Many authors discuss their findings in terms of consolidation theory, which is a theory of psychological memory. Psychological memory refers to a change in the CNS as a result of motor, conceptual, or sensory experience. Recall of pictures, written paragraphs, stories, lectures, paired-associates, serial lists, etc. are examples of conceptual memories. Virtually all of the studies discussed here concern conceptual memory.

The advent of computers has led to an information-processing approach in the attempt to understand human learning. Few theorists are naive enough to believe that the present state of computer technology provides an adequate model of human learning or memory. Nevertheless, the vocabulary of the information-processing approach has crept into our language. "Storage" and "retrieval" are two terms which are sometimes used to describe the processes which occur when a human subject attempts to solve a problem. The acquisition, learning, or encoding stage is thought to be analogous to the storage process of the computer and the recall stage is generally compared to the retrieval process.

Definition of Arousal

Arousal is a concept which was first introduced to refer to a pattern of increased brainstem reticular-formation activity as measured by EEGs (Lindsley, 1951). Since that time, arousal as a concept has been applied to stimulus variables which produce neurophysiological and behavioral changes. Affectively toned material is also sometimes regarded as an arouser. This refers to a judged degree of associative connections. Another use of the concept refers to autonomic-response measures such as muscle-action potential, skin resistance, etc. The effects of arousal have been investigated using all of these definitions of arousal (Uehling & Sprinkle, 1968).

Consolidation Theory

The consolidation theory of memory was first proposed by Muller and Pilzecker (1900). In 1949, D. O. Hebb brought attention to the theory as he speculated about the neurophysiological basis of behavior. In essence, the consolidation theory posits that acquisition is a result of a stimulus event which produces reverberation of neural circuits comprising the memory trace (Walker, 1958). Sometimes the consolidating memory trace is also referred to as the perservative trace or reverberating trace. This event is thought to be followed by organic changes between nerve cells.

The state of arousal of the organism is thought to influence the reverberating memory trace. Little nonspecific neural activity is available to support the reverberating memory trace when the organism is underaroused, while the opposite is true under conditions of high arousal.

It has been proposed that an increase in arousal during the associative event produces a more intense reverberating memory trace activity, rendering the association less available for immediate memory, but consolidating it for greater permanent memory. The temporary inhibition of the memory trace may serve to protect it from interference. Walker and Tarte (1963) have made the following hypotheses:

> (1) The occurrence of any psychological event sets up an active perseverative trace process which persists for a considerable period of time. (2) the perseverative process has two important characteristics: (a) permanent memory is laid down during this phase in a gradual fashion; (b) during the active period there is a degree of "temporary inhibition of recall;" i.e., action decrement. This negative bias against repetition serves to protect the consolidating trace against disruption. (3) High arousal during the associative process will result in more action decrement (p. 113).

These hypotheses have been supported by several studies (Berlyne, Borsa, Craw, Gelman, & Mandell, 1965; Kleinsmith & Kaplan, 1963, 1964; Walker & Tarte, 1963). Other investigations, however, have suggested that the theory should be modified since the facilitation of long-term recall may occur under certain conditions without impairment of short-term recall (Baumeister & Kistler, 1975; Farley, cited in Lambert, 1969; Maltzmann, Kantor, & Langdon, 1966; Uehling & Sprinkle, 1968).

The Crossover Effect

Most of the studies reviewed here have been done with normal populations. College students have been very popular subjects. Verbal acquisition is the most studied dependent variable.

Walker and Tarte (1963) varied the recall intervals (2 and 45 minutes, and 1 week) in their experiments and presented high-arousal, low-arousal, and a mixed list of arousing-stimulus words. Low-arousal associates were forgotten as time increased while recall of numbers associated with high-arousal words dropped at 45 minutes and rose slightly after 1 week. Thus, their hypothesis that there is a crossover effect between short- and long-term recall was confirmed.

Kleinsmith and Kaplan (1963) conducted a paired-associate (P-A) learning experiment using eight arousing-stimulus words and eight single digits as response items. The P-A items were associates such as kiss-2, vomit-4, and dance-6. Intervals were 0, 2, 20, and 45 minutes, 1 day, and 1 week. The arousing effects of the words were confirmed by galvanic skin response (GSR) recorded during acquisition. Low-arousal associates showed good short-term retention and poor long-term retention. In other words, a typical forgetting curve was plotted.

High-arousal stimulus terms, however, produced worse short-term (45 minutes) retention and better long-term (1 week) retention. Thus, Walker and Tarte's interaction hypothesis was confirmed. Kleinsmith and Kaplan (1964) replicated these results by using six nonsense syllables of zero-association value as stimulus terms and six digits as responses.

Levonian (1967) tested short-term and delayed retention of drivers' education subjects observing a traffic safety film. GSRs to each of the 16,080 frames of the film were analyzed. A 15-item, yes-no retention test was administered immediately after the film and again a week later. Subjects were not aware that they were to be tested. A crossover effect, similar to the Kleinsmith and Kaplan and the Walker and Tarte findings was reported. A high level of arousal was associated with poor short-term retention and superior long-term retention. Furthermore, high arousal produced reminiscence in this study.

Fifty subjects in five retention groups listened to a 20-minute taped lecture on a Supreme Court decision regarding wiretapping, with high- or low-arousal words preceding selected passages (Lavach, 1973). Subjects were then tested on the content of the lectures. Arousal was measured by GSRs. Five intervals were studied: 0 minutes, 1 hour, 1 day, 1 week, and 1 month. Lavach reported that the interaction of arousal and retention interval was significant, that is, that under high-arousal conditions subjects have poor short-term memory and good long-term memory. Low-arousal associates were characterized by good short-term memory and poor long-term memory. This experiment also produced a strong reminiscence effect for the high-arousal associates. Lavach suggested that classroom teachers should identify information which is important enough to be stored for long-term recall. Care should be taken to either induce arousal or introduce important material only when the learner is in an aroused state. On the other hand, Lavach recommended that if short-term memory is the objective, then low arousal is desirable.

The crossover effect was not obtained when Maltzman et al. (1966) used the Walker and Tarte (1963) words in a free-recall learning study. Maltzman et al. interpolated part of the Differential Aptitudes Test Battery for the "delayed retention" group. GSRs confirmed the arousing effects of the words. Immediate retention was significantly superior to delayed retention, $\underline{F}$ (1, 64) = 15.50. High-arousal words were more frequently recalled than low-arousal words, $\underline{F}$ (1, 64) = 110.41. It should be pointed out that the "delayed-retention" interval was shorter than the usual long-term retention interval. The delay was the 30 minutes it took to give the Differential Aptitudes Test.

It may be that the interpolated activity interferred with the consolidation process, making the memory less accessible at the time of the delayed-retention test for the high-arousal words. Nevertheless, it appears that under some experimental variations, arousing words facilitate recall at an immediate interval.

Individual Differences in Level of Arousal

Several writers have hypothesized that measures of performance are curvilinearly related to arousal (Duffy, 1962; Malmo, 1959; Schlosberg, 1954). In other words, too much or too little arousal is thought to be debilitating. Eysenck (1965) and Berlyne (1967) have suggested that it is an inverted U function.

Innate arousal characteristics have been investigated in a variety of experiments. Eysenck and Maxwell (1961) reported that a high level of drive did not affect prerest performance on a rotary-pursuit learning task but did improve performance after a rest interval. Although high-drive subjects did not perform better than low-drive subjects prior to rest, they did show greater improvement after a rest interval.

In a study using dexedrine to induce arousal, Batten (1967) administered the drug to half of his introductory-psychology student subjects along with "ego involvement" directions: "Performance on this task is related to intelligence." Just before the experiment began, these subjects were also given the Stroop Test, a test which produces a strong conflict of response tendencies. The other half of the subjects were given phenobarbital, no ego involving directions, and no Stroop Test. The task was the learning of neutral words and their associated single-digit responses. Intervals were 20 and 45 minutes, 1 day, and 1 week following a single acquisition trial. The results were not significantly different, but were in the direction of the studies which had shown a crossover effect. Batten interpreted his findings as supportive of the notion that CNS-arousal level affects recall.

In an experiment performed by Farley (cited in Lambert, 1969), he selected high- and low-arousal college students using salivary response to lemon juice as a criterion (Eysenck & Eysenck, 1967). Farley found a significant interaction between arousal level and recall interval. Greater recall of the P-A terms was demonstrated on the immediate test by low-arousal subjects than high-arousal subjects. The results were reversed for the long-term retention test.

White Noise

The Effect of Noise on the Human Ear

The intensity level of white noise selected for this study was 75 dB. The following is a brief discussion of noise and its effect on the human ear.

Normal speech varies greatly in amplitude, but a level of 65 dB at one meter is fairly representative (Bell, 1966). Speech usually ranges from about 55 dB to 75 dB (Carpenter, 1962). Bell's book, Noise, was published by the World Health Organization. He presented the following table of average sound-pressure levels of familiar noises:

Table 1. Familiar Noises

Non-Industrial	Industrial
Whisper - 20 dB	Lathes - 85-95 dB
Tick of watch at 1 meter - 30 dB	Punch presses - 95-105 dB
Conversation - 60 dB	Circular saw (wood) - 100-110 dB
Street noises - 40-70 dB	Sand blasting - 118 dB
Sports car - 80-90 dB	Riveting and chipping on steel plates - 130 dB

The ear undergoes a temporary threshold shift when it is exposed to loud noise. This is an acoustic reflex which partially protects the ear. Significant shift is not produced by a continuous steady noise with a sound-pressure level of less than 78 dB (Glorig, Ward, & Nixon, cited in Bell, 1961). This suggests that the ear is not bothered by noises of less than 78 dB of intensity. This is true for up to 100 minutes of exposure to the noise when the noise is presented over ear-phones. Bell suggests that sound may be uncomfortable at 100-120 dB and painful at 130-140 dB. Short exposure to 160 dB of noise may rupture the eardrum.

The Effect of White Noise on Performance

White noise (WN) is defined by Miller (1951) as a "random noise."

> Random noise is a hishing [sic] sound compounded of all frequencies of vibration in equal amounts . . . . Because all frequencies are present, it is analogous to certain kinds of white light . . . . The spectrum of such a noise is simply a horizontal line up to 10,000 cps (pp. 54-55).

The assumption that WN is arousing is supported by the findings of Davis (1948). WN was shown to increase skeletal-muscular tension. This response was found to be directly related to the volume of WN. Berlyne and Lewis (1963) reported that continuous WN causes skin resistance to drop significantly over a 10- to 15-minute period under conditions that normally leave skin resistance unchanged. Gibson and Hall (1966) found evidence to suggest that WN activates the reticular-activating arousal system. Heart rates were found to increase under WN conditions during performance of a mental task (Costello & Hall, 1967). Takasawa (1972) found that WN increased tapping pressure and galvanic skin response in correspondence to the intensity of WN which was introduced.

The effects of noise on human performance have been studied for four decades, with conflicting results. White noise is no exception. Detrimental effects of WN on performance have been reported (Lehmann, Creswell, & Huffman, 1965; Douglas, 1972, 1974; Fenton, Alley, & Smith, 1974). Occasionally, WN has been reported to have no effect or ambiguous effect on performance (Park & Payne, 1963; Lambert, 1969). Many investigators have reported a striking interaction between WN and interval level. WN presented during acquisition was found to impair short-term recall and facilitate long-term recall (Berlyne et al., 1965; McLean, 1969).

In some cases, white noise has been found to have a facilitating effect on long-term recall without impairing short-term recall (Berlyne et al., 1966; Farley & Lovejoy, cited in Lambert, 1969; Uehling & Sprinkle, 1968). The temporal location of the stimulus appears to be a very important variable.

Temporal Location of the Stimulus

Arousal during acquisition. Practically all of the recent literature dealing with WN and acquisition refers back to two original studies by Berlyne et al. (1965) and Berlyne, Borsa, Hamacher, & Koenig (1966). In the 1965 investigation, a crossover effect was observed, while in the 1966 study, no interaction between noise and interval level occurred.

Berlyne et al. (1965) used single adjectives, homogeneous double pairs of adjectives, and heterogeneous double pairs of adjectives as stimulus terms. Disyllabic male first names were used as response items. Subjects were administered five levels of WN (35 to 75 dB). One-quarter of the items were acquired under WN and tested under WN, 1/4 were acquired under WN and tested with no noise (NN), 1/4 were acquired with NN and tested under WN, and 1/4 were acquired with NN and tested with NN.

Items acquired with WN were recalled significantly less than those that were acquired with NN if subjects were tested on the same day that they acquired the P-A items, F (1, 850) = 6.8, $p < .01$. Twenty-four hours later the situation was reversed. This finding is consistent with the observations reported by the Michigan group (Kleinsmith & Kaplan, 1963, 1964; Walter & Tarte, 1963). WN during testing did not facilitate performance. Berlyne et al. interpreted this result to mean that WN has an effect on learning rather than on performance.

In another P-A experiment using 40 disyllabic adjectives as stimulus terms and disyllabic, familar, male names as response terms, Berlyne et al. (1966) varied the time of WN presentation in a 24-hour recall test. Subjects were 64 female undergraduate psychology students. In a second part of the study, Berlyne et al., used 64 different female undergraduates taken from honors courses. "Furthermore, by the time they took part in the experiment, they, unlike the Ss of experiment 1, had learned about pair-associated learning in their course work" (p. 4). This group was tested immediately after aquisition. The two groups of subjects were then compared.

Both groups of subjects were assigned to each of four experimental conditions which were as follows:

Condition 1. WN was administered during the stimulus and response acquisition, but not after acquisition.

Condition 2. NN was presented during stimulus and response acquisition, but WN was presented after the acquisition session.

Condition 3. WN was presented during stimulus and response acquisition and after acquisition.

Condition 4. NN was presented during stimulus and response acquisition and NN was presented after acquisition.

Berlyne et al. reported that WN, presented during stimulus and response acquisition (Conditions 1 and 3), increased 24-hour recall, $p < .025$. WN or NN presented after acquisition (Conditions 2 and 4) produced no difference in mean number of correctly recalled response terms at the 24-hour interval. WN did not impair or improve immediate recall whether presented during or just after acquisition. In other words, there was no crossover effect.

It could be that the differences between subjects in regard to their innate arousal level confused the results of the 1966 investigation. Honor students are probably relatively aroused people, particularly late in the semester. Furthermore, they are likely to be quite proficient in any kind of recall, or they wouldn't qualify for an honor's program at a major university.

McLean (1969) reported that when P-A nonsense syllables were presented to 80 male graduate students under a NN condition, they had better immediate recall than 80 students who had the items presented with WN. The learning was incidental; that is, the subjects were not aware that they were going to be tested on the presented material.

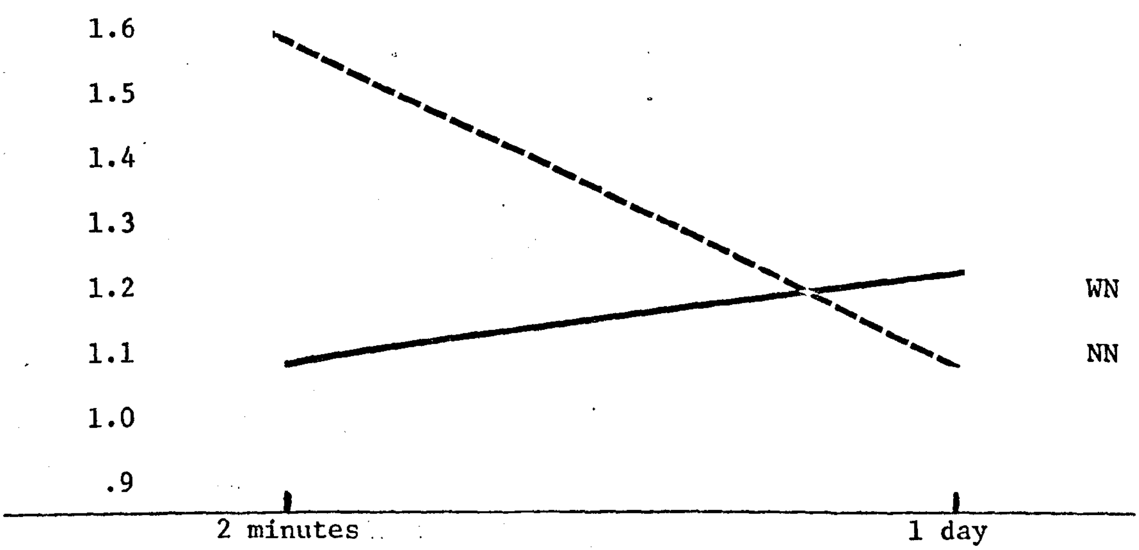

Figure 2. Mean recall rates for incidental acquisition groups in a P-A acquisition task (Experiment 1).

Twenty-four hours later, however, the WN group recovered from a

32% impairment to gain an 11% advantage over the NN subjects. Scores of students who heard WN were improved 14% when tested at the 24-hour interval. Scores of those who heard NN were lowered 30% on acquired associations over the same period of time. The interaction between noise and recall interval was significant, F (1, 156) = 4.44.

WN was effective in lowering skin resistance (indicative of increased arousal) during P-A presentation. Thus, WN presented at the time of acquisition seems to have been an effective inducer of arousal for these students.

McLean collapsed the noise conditions for a within-subject analysis of arousal. "Skin-resistance deflexions [sic]" were the measure of arousal.

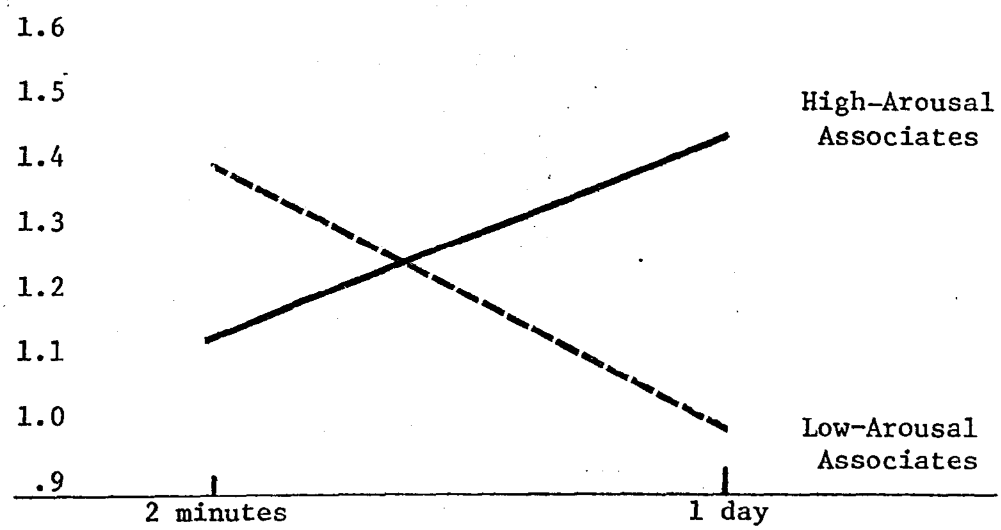

Figure 3. Mean recall rates. Analysis within subjects on incidental acquisition task (Experiment 1).

High-arousal associates climbed from an 18% disadvantage on the immediate test to a 53% advantage on the long-term test. The forgetting rate for low-arousal associates was significant, $p < .01$. Delayed recall of high-arousal associates was superior, $p < .01$.

Thus, there was a crossover effect similar to that reported by the Michigan group and Berlyne et al. in their 1965 study.

In a second experiment, McLean warned 40 male graduate students that they were going to be tested on the presented material. Twenty-three percent association-value nonsense syllables were used. Again, WN effectively lowered skin resistance during P-A presentation. The WN group was 41% worse on the immediate recall test but climbed to a 24% advantage on the 24-hour test, $\underline{F}$ (1, 36) = 5.48, $\underline{p} < .025$.

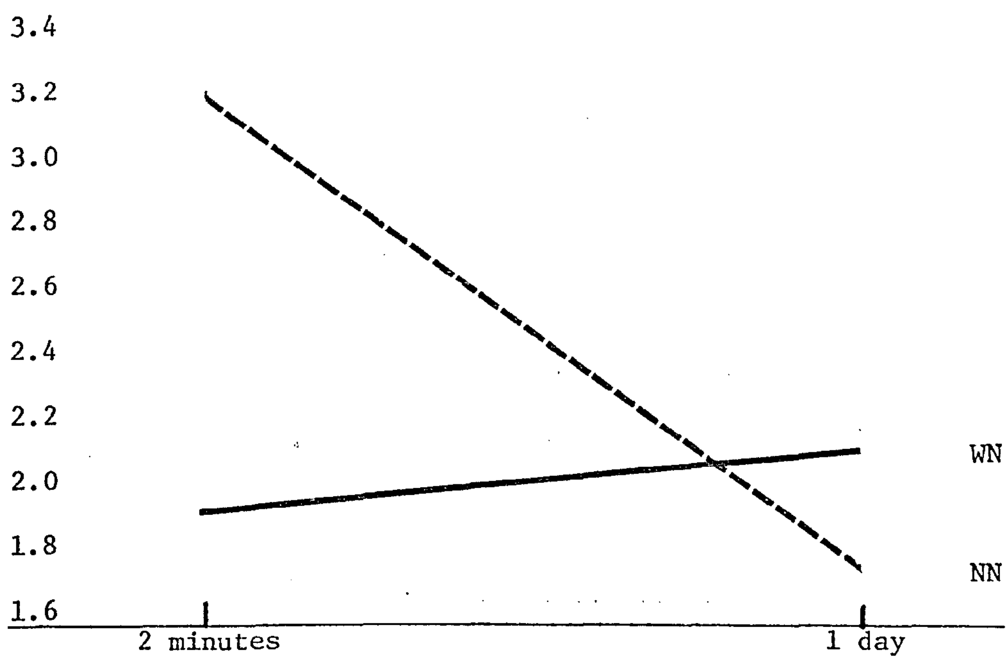

Figure 4. Mean recall rates for intentional acquisition groups (Experiment 2).

Within-subjects analysis for high- and low-arousal associates revealed no crossover effect in the intentional learning experiment (Figure 5). It is possible that motivation effects influenced arousal effects. It is also possible that the increased associational value of the nonsense syllables acted in concert with motivation to generally increase recall performance.

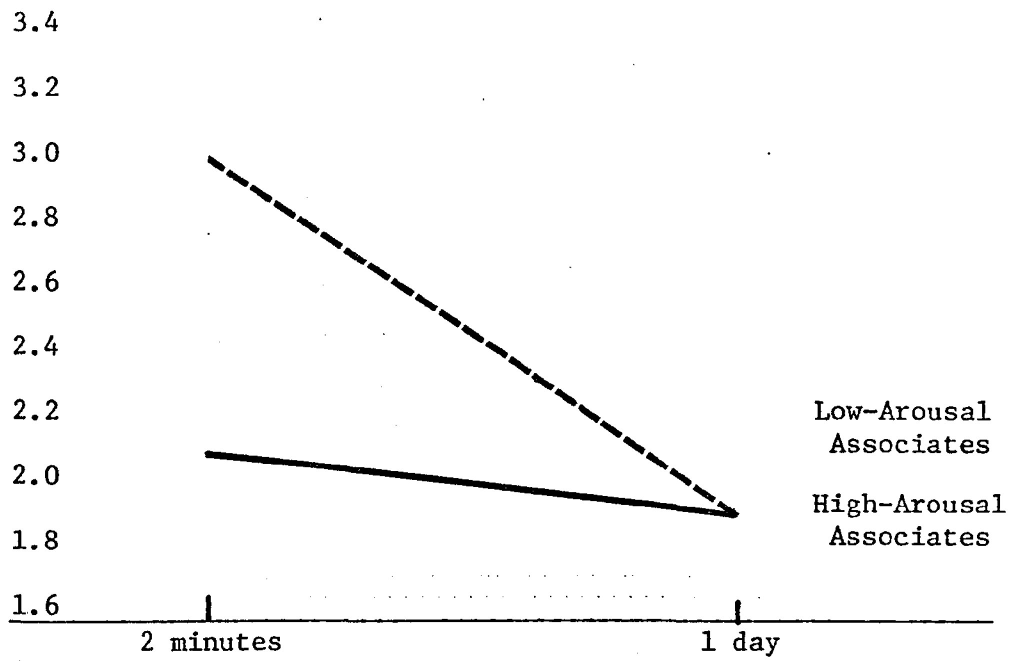

Figure 5. Mean recall rates. Within-subjects analysis for intentional acquisition groups (Experiment 2).

The McLean investigation seems to confirm the consolidation-process hypothesis. The magnitude of delayed memory can apparently be increased by an arousal mechanism. In the case of immediate recall, however, the use of an arouser results in the relative inaccessibility of the memory trace if the stimulus is introduced during acquisition.

McLean noted that verbal learning studies may obtain unreliable performance measures when they use short-term interval conditions. If the consolidation process does act to protect the reverberating trace at the expense of short-term memory, then short-term acquisition intervals are not an accurate assessment of the actual acquisition that has occurred. High-arousal material to be associated may also result in an apparent impairment in recall if the interval between acquisition and testing is short.

Fenton, Alley, and Smith (1974) introduced five levels of WN (22 to 72 dB) to ten normally achieving 9.0- to 11.0-year-old boys and 10 age-matched LD boys. The children were asked to memorize 12 sets of four-digit numbers presented on a tape recorder. WN was presented at the time that the voice was heard. A "quiet" condition was introduced as a control.

High levels of WN were found to have a debilitating effect on the auditory short-term recall scores for both LD and normal children. WN did not differentiate the scores of the normal children from the LD group.

These authors reported that younger children were more impaired by WN than older. Their data, presented in table form, indicated that children older than 12 years 3 months performed better under WN conditions than those younger than 12 years 3 months. Since all the children in this study were described as being 9.0 to 11.0 years old, it is not clear how these authors came to the conclusion which they did.

Arousal just after acquisition. In two experiments by Farley and Lovejoy (1968), described in Lambert (1969, pp. 18-19), WN was administered to four groups of eight subjects at various intervals (0, 3, and 6 minutes) during an interpolated task following two training trials on a P-A acquisition task. The interpolated task was rating random polygons. At the various intervals, WN was presented to three of the groups for 3 minutes during the interpolated task. The fourth group was a control group and received NN. The first experiment concerned an "immediate" (there was a 12-minute delay consisting of the time it took to perform the interpolated task) recall task and the second experiment had essentially the same design but tested long-term (24-hour) recall. The two experiments were then compared.

At the 24-hour interval, recall under the three WN conditions was significantly greater than under the NN condition. Immediate tests for retention revealed no significant differences between the WN groups and the NN controls. The interaction between recall interval and arousal condition was significant, $p < .05$.

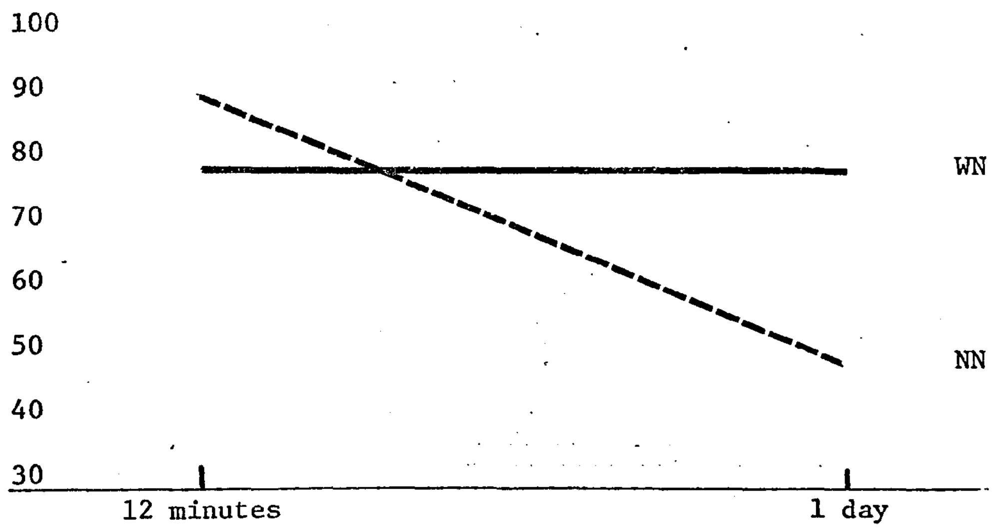

Figure 6. Mean percent of correct responses on a P-A acquisition task.

The results of this investigation contradict the findings of Berlyne et al. (1966). Berlyne and his colleagues did not find that WN presented after acquisition facilitated performance.

The Farley and Lovejoy report suggests that the facilitating effects of WN are not confined to events at the acquisition stage. WN was not presented until after acquisition. Furthermore, it was presented while subjects were concentrating on arranging random numbers. WN presented after acquisition did not have a significant debilitating effect on "immediate" memory.

Arousal just prior to recall. Uehling and Sprinkle (1968) investigated the effect of arousal presented just prior to recall on a serial learning task. One hundred and eight introductory psychology students acquired the task to a "perfect" criterion. In this study, immediately prior to recall, subjects were instructed to (a) "relax," (b) "sit in this chair and exercise ...," and (c) "relax." This last condition was accompanied by WN. Three retention intervals were studied (immediate, 24 hours, and 1 week).

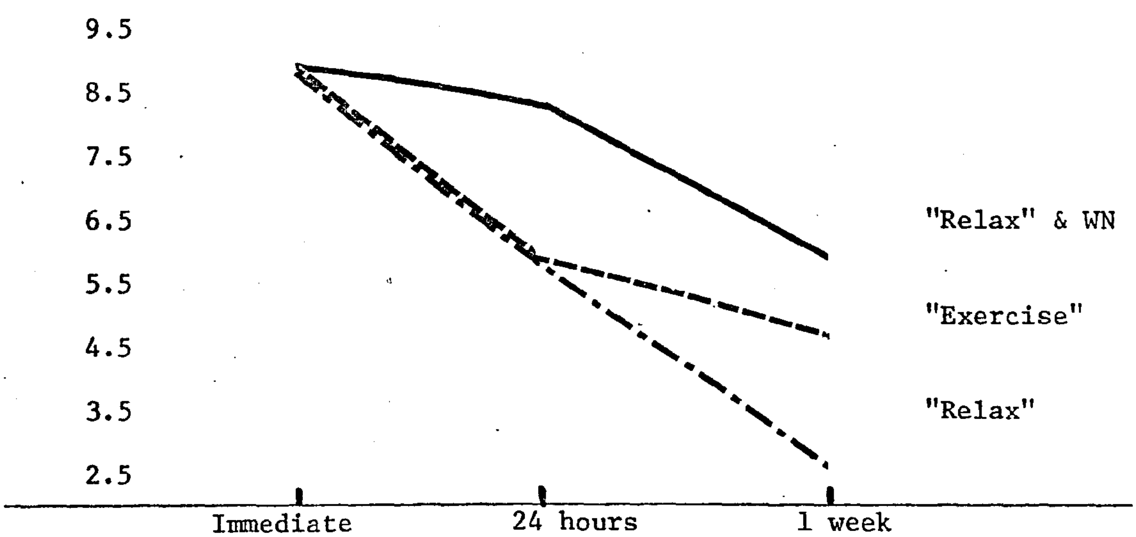

Figure 7. Mean number of correct responses on a serial learning task.

The effect of the arousal conditions was significant, $F\ (2, 99) = 4.80$, $p < .025$. Immediate testing produced almost no difference in performance, but the subjects who heard WN and were tested after 24 hours were superior, $p < .01$. Instructions to exercise did not significantly increase recall at either the 24-hour or 1-week interval.

When stimulus-response items are acquired to a perfect criterion, immediate performance is at an optimum. Thus, WN cannot produce reminscence as it seems to under some conditions (Baumeister & Kistler, 1975; Berlyne et al., 1965; McLean, 1969). It does, however, seem to inhibit forgetting.

Baumeister and Kistler (1975) gave second and fifth graders three types of learning tasks: serial learning (SL), free-recall (F-R) and P-A. Half the 160 subjects acquiring SL and F-R items heard a 2-minute burst of WN just prior to the retention test at "immediate" (2 minutes) and long-term (1 week) intervals. Half the 40 subjects acquiring the P-A items heard a 2-minute burst of WN just prior to the "immediate" (2 minutes) and long-term (48 hours) tests.

All subjects in the SL and F-R conditions were required to reach a perfect criterion before the training session was terminated. The P-A acquisition criterion was 50%.

The grade level of the subjects had a significant effect. Fifth graders recalled more than second graders with or without the noise. WN did not improve performance more for second graders than for fifth graders, however.

WN immediately prior to recall facilitated delayed performance and did not impair immediate memory. Materials that had not been practiced thoroughly appear to have been very susceptible to WN arousal. It is probable that P-A learning is more difficult than either SL or F-R learning. It may be that lowering the criterion lowered the scores.

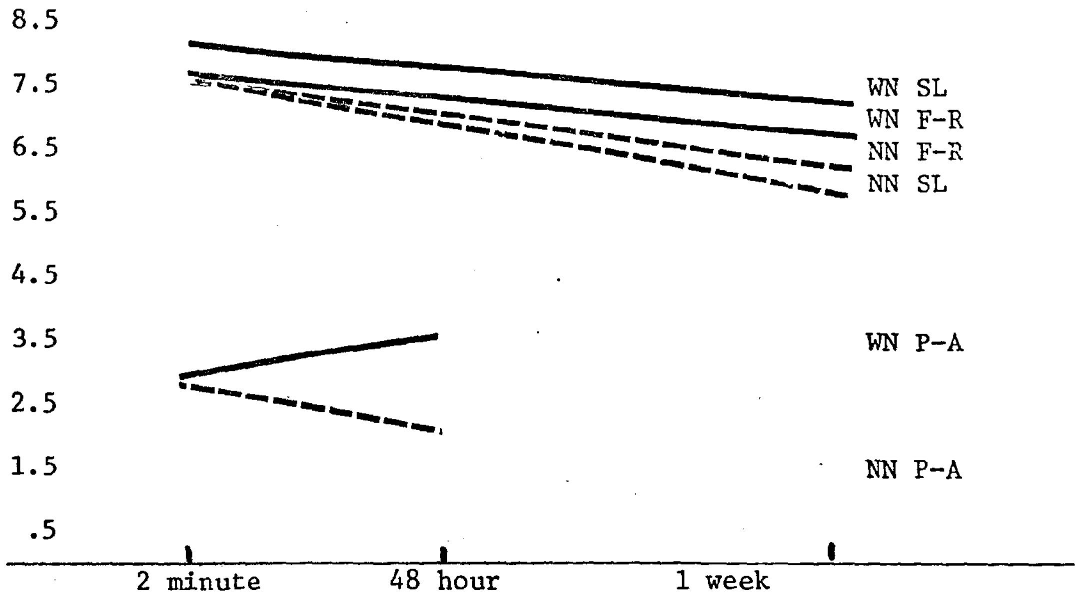

Figure 8. Mean number of correct responses for fifth graders at each interval level where SL and F-R are taken to a "perfect" criterion and P-A task to a 50% criterion before testing.

Again, the facilitating effect of WN is not confined to events at the acquisition stage. It can be induced just prior to testing. Baumeister and Kistler interpreted their findings to mean that WN "has its effect by reducing the subject's attention to task-irrelevant stimuli" (p. 20).

Arousal just prior to acquisition and just after acquisition. Archer and Margolin (1970) presented 16 tape-recorded, two-digit numbers to 24 male and 24 female undergraduate students. Male subjects heard a man's voice, female subjects heard a woman's voice. After the subjects heard the voice they were instructed to "remember it" or "don't remember it." WN was introduced, or not introduced in the control situation, just prior to acquisition for half of the subjects and just after acquisition for the other half, but prior to instructions to remember or not remember. Subjects were tested immediately after the experimental conditions; there was no delayed-recall test.

WN had no effect on intentional forgetting, but did enhance "remember" items, $F(1, 44) = 13.38$, $p < .001$. Men were more aided by WN at recall on "remember" items than women, $F(1, 44) = 4.27$, $p < .05$. It did not matter whether WN was introduced just prior to acquisition or just after acquisition, both temporal locations of the stimulus enhanced acquisition equally for both sexes.

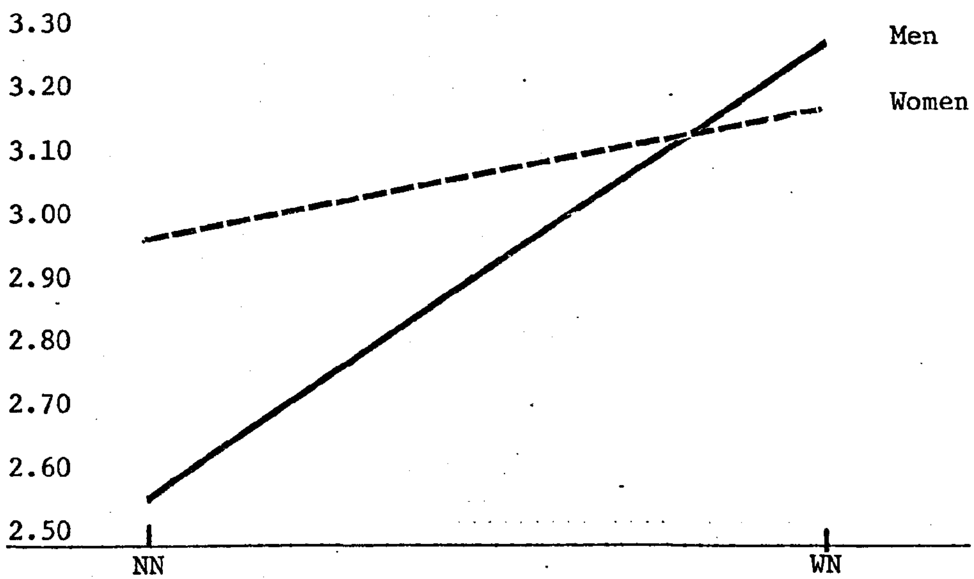

Figure 9. Mean number of correct responses for intentionally acquired items on an immediate recall test.

Interpretation of the results of this study should be made cautiously. Males heard a masculine voice, females heard a woman's voice giving orders. Perhaps the undergraduate female students at Emory University are not male-oriented; but then again, perhaps they are. Prejudice against female authoritarianism could account for the sex differences in this study.

The important point, however, is that WN, whether heard prior to acquisition or just after acquisition, enhanced short-term recall. This finding appears to be in contradiction to the consolidation theory of memory and suggests that WN may be an agent which serves to help the subject focus attention on the task ahead.

Reinforcement and Arousal

It is not clear just how arousal and reinforcement are related. Reinforcement is any factor, other than the elements to be associated, that strengthens the stimulus-response association (Kimble, 1961, pp. 5-6).

Verbal acquisition must be susceptible to some sort of reinforcement since it is not ensured by contiguity alone. The facilitating effect of arousal on recall qualifies arousal to be regarded as a reinforcer. Most known reinforcing agents, however, evidence themselves immediately after acquisition. It is a strange reinforcer that acts to impair performance at one point and facilitate it at another.

Berlyne et al. (1966) have suggested that the consolidation process and the reinforcement process may work in opposite directions and cancel each other out under short-term recall conditions. They suggest that it could be that sometimes the reinforcement process wins out and sometimes the consolidation process conquers.

The Intensity of White Noise Which Improves Recall

Berlyne et al. (1965) found 72 dB and 75 dB of white noise improved long-term recall. Subjects heard five different intensities of the noise ranging from 35 to 75 dB. There was some indication that 58 dB of WN improved long-term recall when compared to a control group; however, the difference was not significant. The 72 dB group differed from the 58 dB group at the .001 level. The 75 dB group was not significantly different from the 72 dB group.

Subsequently, Berlyne et al. (1966) used 75 dB of WN to facilitate long-term recall in their study involving P-A learning.

Fenton and Smith (1974) used five levels of WN (22 dB to 72 dB) in a study involving short-term recall. The noise was presented at the time of acquisition. As the level of WN increased, scores decreased.

In short, 75 dB of WN seems to be a completely safe level of noise for the human ear. Berlyne and his colleagues at the University of Toronto appear to have researched the effect of the different intensity levels of WN most thoroughly. Their selection of 75 dB of WN in their 1966 study suggests that they prefer that level of intensity in their research.

Summary

Numerous investigators have manipulated drugs, white noise, intrinsic arousal levels, arousing stimulus and response terms, and have discovered that arousal facilitates long-term retention (Baumeister & Kistler, 1975; Berlyne et al., 1965, 1966; Eysenck & Maxwell, 1961; Farley, 1969; Farley & Lovejoy, cited in Lambert, 1968; Kleinsmith & Kaplan, 1963, 1964; McLean, 1969). These results suggest that arousal is a reinforcing agent.

Much of the research manipulating WN has been shown to support a consolidation theory of memory (Berlyne et al., 1965; Fenton et al., 1974; McLean, 1969). However, all of these studies have in common the fact that WN was introduced during acquisition. Some research has indicated, however, that the temporal location of the stimulus is an extremely important variable.

WN introduced just after acquisition or just prior to testing appears to have a facilitating effect on long-term recall without impairment to short-term recall (Baumeister & Kistler, 1975; Farley & Lovejoy, cited in Lambert, 1968; Uehling & Sprinkle, 1968). In one instance, WN just prior to acquisition or just after acquisition facilitated short-term recall (Archer & Margolin, 1975). The effect of WN introduced just prior to acquisition on long-term recall appears not to have been investigated.

These results suggest that consolidation theory needs to be modified since in some cases the recall facilitator was not presented until after acquisition and it did not impair short-term recall.

Intentional, as opposed to incidental, acquisition appears to generally increase scores. Subjects under this motivational influence are more improved in a NN condition on short-term recall but they are impaired on a long-term recall task when compared to a WN group (McLean, 1969).

Grade level does not appear to influence response to WN; that is, WN did not improve performance more for second graders than for fifth graders in the Baumeister and Kistler (1975) investigation. However, Fenton et al. (1974) reported that age is an important variable. This finding was questionable, however.

The intrinsic level of arousal of the subject appears to be an important factor in acquisition. High innate arousal appears to impair short-term recall and facilitate long-term recall, while the opposite is true of low-arousal subjects (Eysenck & Maxwell, 1961; Farley, 1969; Levonian, 1968). However, the administration of phenobarbital or dexedrine did not significantly impair or improve short- or long-term recall for college students (Batten, 1967).

Sex may be an important variable. Archer and Margolin (1970) reported that men are more aided by WN than women. The methods used in their experimental design were questioned in this paper and their research report should be interpreted with caution.

There is evidence that the effects of arousal are dependent upon the nature of the material to be learned. P-A learning tasks are generally thought to be more difficult than SL or F-R learning tasks. P-A learning tasks appear to be more facilitated by WN than the easier tasks, at least after a 48-hour interval. Material that is less well learned is less likely to be recalled but it also seems to be more susceptible to WN facilitation on a delayed test of recall (Baumeister & Kistler, 1975).

The volume of WN may be an important variable. Skeletal-muscular tension has been shown to be directly related to the volume of WN (Davis, 1948) and GSR has been shown to correspond to the intensity of the noise (Takasawa, 1972). Berlyne et al. (1965) reported that both 72 dB and 75 dB of WN improved long-term recall. Fenton et al. (1974) reported that increasing levels of WN had a debilitating effect on auditory short-term recall.

The researchers that have used white noise in their investigations have each administered different intensities of the stimulus. Table 2 briefly summarizes the temporal location of the stimulus, the intensity of the stimulus, the type of task utilized, and the results of each of the studies that have been reviewed in this investigation.

Table 2. Summary of the Effects of WN on Performance Found in Previous Investigations

Investigators	Temporal Location of the Stimulus	Type of Task	Intensity of the Stimulus	Short-Term Results	Long-Term Results
Berlyne at al. (1965)					
Exp. II	During Acquisition and During Testing	Visual	58 dB	Insignificant Improvement	
	Same as Above	Visual	72 dB	Impairment	
Exp. III	Same as Above	Visual	35-75 dB	Impairment at 72 & 75 dB	Improvement at 72 & 75 dB
Berlyne et al. (1966)	During Acquisition	Visual	75 dB	No Effect	Improvement
	After Acquisition	Visual	75 dB	No Effect	No Effect
McLean (1969)	During Acquisition	Visual	85 dB	Impairment	Improvement
Fenton et al. (1974)	During Acquisition	Auditory	72 dB	Impairment	
Uehling & Sprinkle (1968)	Just Prior to Recall	Visual	80 dB	No Effect	Improvement
Baumeister & Kistler (1975)	Just Prior to Recall	Visual	80 dB	No Effect	Improvement
Archer & Margolin (1970)	Just Prior to Acquisition & Just After Acquisition	Auditory	100 dB	Improvement	

CHAPTER III

METHODOLOGY

Subjects

In order to obtain subjects for the study, this investigator attended a teacher's meeting at a large elementary school in the Virginia suburbs. The third, fourth, fifth, and sixth grade teachers were verbally requested to refer boys for the study who were unusually active, distractible, excitable, and/or impulsive. The term "hyperactive" was not used in the request for referrals. Instead, the term "superactive" was stressed in order to avoid preconceived ideas that the teachers might have had regarding the definition of the term "hyperactive."

The teachers were asked to refer only boys for the study. Girls were not utilized as subjects in the study because of the high boy/girl sex ratio thought to be involved in hyperactivity. Since the sex ratio for the syndrome has been estimated to be from three-to-one (Paine et al., 1968) to nine-to-one (Werry, 1968), it would probably have been necessary to select girls from three to nine schools in order to match the 36 boys who were finally selected at the school involved in the study.

In addition, the teachers were asked to refer only those boys who were reading at a Grade 3 level or more. The teachers were also requested not to refer a boy for the study if the teacher felt that the child might be substantially below normal in intellectual ability. The principal checked the referral sheets as they were returned and eliminated the names of the boys who had been given IQ tests and were thought to have a Full-Scale score of 80 or less.

The school secretary mailed permission slips (Appendix B) home to parents of the boys who had been referred to the study. Five parents refused permission for their children to be in the study.

After the permission slips were returned, each referring teacher was requested to complete a Conners' Teacher's Questionnaire (Appendix C) for each child. Children were accepted for the study only if they received a total score of eight points or more on the Questionnaire. Five children were eliminated from the study because they did not meet this criterion.

As a result of the selection procedures which were described above, 38 hyperactive boys were chosen for the investigation. Two additional boys were dropped from the study because they were absent on one of the four occasions involved in the study. The 36 boys in the study ranged in age from 8.50 to 12.75 years. The mean chronological age of the boys was 10.89 years with a standard deviation of 1.07 years.

The mean hyperactivity score for the 36 boys in the study was 12.00 with a standard deviation of 2.99 points. The scores ranged from 8 to 18 points.

The boys varied in their ability to hear white noise. A threshold level for the noise was obtained for each child after the study was completed. The mean threshold level for the noise was 21.42 dB with a standard deviation of 5.60. The threshold level ranged from 14 to 38 dB.

The children in the study also varied in their reading speed. The mean time to read the silently read paragraphs task, which will be described below, was 98.18 seconds. The standard deviation for reading time was 25.76 seconds. The range was from 60 to 145 seconds.

Apparatus

White noise was presented at 75 dB by a Beltone White Noise Generator, Model NB-102 which had been especially modified for this investigation by Biocoustics Inc., of Rockville, Maryland. The changes were made in order to introduce WN simultaneously and at equal levels in both ears. The headphones were produced by the Telephonics Company. Model TDH-39 was used (Appendix D).

Instruments

Conners' Teacher's Questionnaire

The Conners' Teacher's Questionnaire (Appendix C) has 6 items, thought to reflect a hyperactivity factor (Kupietz et al., 1972; Werry, Sprague, & Cohen, 1975), which are embedded in a 39-item rating scale. Each item is rated on a four-point scale in which "Not at all" is scored 0, "Just a little" is 1, "Pretty much" is 2, and "Very much" is 3. The items which are scored and thought to make up the hyperactivity factor are numbers 1, 2, 5, 6, 14, and 29.

The Conners' Teacher's Questionnaire is a widely used diagnostic tool for identifying hyperactive children. The scale has been recommended for use in evaluating hyperactivity (Cantwell, 1975, p. 40; Ross & Ross, 1976, p. 272). Although Conners (1969) did not obtain normative data when he published the rating scale, several investigators have obtained normative, comparative data on the instrument. According to norms based on 101 normal boys and 64 hyperactive children (Sprague, Christensen, & Werry, 1974), the criterion score of eight which was used in this study suggested that there was a .08 risk of making a false positive error. These norms also suggested that there was a .06 chance of making a false negative error when eight was used as the criterion score.

Evidence regarding the validity of the Questionnaire has been presented by Kupietz, Bailer, and Winsberg (1972). These authors reported that the rating scale empirically differentiated 92 normal children from 86 behaviorally deviant children who were either emotionally disturbed and brain-injured children at a special school or outpatient psychiatric subjects. All of the disturbed children had been found to exhibit hyperactivity, impulsivity, short-attention span, and aggressiveness.

Evidence regarding the reliability of the Questionnaire has been presented by Sprague et al. (1974). These authors found that the scale was a stable instrument. No significant variations as a function of time were observed when 13 teachers rated 291 children across a 16-week period. The authors state that since "the overall scale F was not significant. . . . individual items were not further analyzed" (p. 156). The non-significant values were not reported.

Silently Read Paragraphs Task and Test

A story, also called the "silently read paragraphs task" (Appendix E), was devised by this investigator. The task was read silently by all the boys in the study. The test (Appendix E) that accompanied that story had 26 questions.

The objective of the silently read paragraphs test was not to test comprehension or word recognition, only recall. Therefore, the story was composed of words and material which was suitable for boys who might be having reading difficulties. Using the Fry (1975) Readability Scale to assess readability level, an estimate was obtained that the story was written at about a Grade 2 readability level.

In order to ascertain an estimate of the reliability of the test, a pilot study was undertaken in March, 1977, which involved six 9- to 12-year-old children. After the children silently read the story and a 2-minute interval had passed, they were orally presented with all 26 questions. The odd-even product-moment coefficient of correlation was

.85. Using the Spearman-Brown prophecy formula, the reliability of the entire test was estimated to be .92.

The product-moment coefficient of correlation between the 13 items on the first half and the 13 items on the second half of the test was .90. The mean, standard deviation, and the standard error of the measurement for the first half of the test were 8.33, 1.74, and .49, respectively. The mean, standard deviation, and standard error of the measurement for the second half of the test were 7.67, 1.97, and .56, respectively. The inter-rater reliability coefficient was 1.0.

In order to ascertain a measure of validity, the silently read paragraphs task and test were reviewed by a specialist in reading. According to this specialist, the test seemed to have face validity. The specialist suggested that the test seemed to require "the ability to retrieve details from memory--after silently reading a highly factual selection." The specialist concluded that the test "measures almost verbatim recall of material." The reviewer also stated that a child could answer the items on the test correctly, "only by chance," if he had not read the story, and that the items were "passage dependent." It was also noted that the test was "much more highly factual than typical Level 2 material."

Tape-Recorded Paragraphs Task and Test

A story, also called the "tape-recorded paragraphs task" (Appendix F), was devised by this investigator. The task was played on a tape recorder for all the boys in the study. The test (Appendix F) that accompanied that story had 16 questions.

In order to ascertain an estimate of the reliability of the test, a pilot study was undertaken in March, 1977, which involved five 10- and 11-year-old children who listened to the tape-recorded story. The story was repeated twice on the tape for the pilot study. Because the scores were extremely high for the children in the pilot study, the final recording was comprised of only one reading of the story. After the children in the pilot study listened to the tape-recorded story and a 2-minute interval had passed, they were orally presented with all 16 items. The odd-even product-moment coefficient of correlation was .87. Using the Spearman-Brown prophecy formula, the reliability of the entire test was estimated to be .93.

The product-moment coefficient of correlation between the eight items on the first half and the eight items on the second half of the test was .88. The mean, standard deviation, and standard error of the measurement for the first half of the test were 6.2, 1.3, and .35, respectively. The mean, standard deviation, and standard error of the measurement for the second half of the test were 6.0, 1.3, and .33, respectively. The inter-rater reliability coefficient was 1.0.

In order to ascertain a measure of validity, the tape-recorded paragraphs task and test were also reviewed by the specilist in reading. According to this reviewer, this test also seemed to have face validity. The specialist's review for the tape-recorded paragraphs task and test was similar to that reported for the silently read paragraphs task and test. The reviewer commented that the test seemed to require "the ability to retrieve details from memory--after listening to a highly factual selection." Again, it was noted that the test "measures almost verbatim recall of material." The reviewer pointed out that a child could answer the items on the test correctly, "only by chance," if he had not read the story, and that the items were "passage dependent." Again, it was noted that the task and test were "much more highly factual than typical Level 2 material."

Data Collection Procedures

There were four noise conditions involved in the study. The four noise conditions were defined as follows: (Condition I or Control Condition) no noise before acquisition and no noise before recall tests, (Condition II) white noise before acquisition but no noise before recall tests, (Condition III) no noise before acquisition but white noise before recall tests, and (Condition IV) white noise before acquisition and white noise before recall tests.

Each child was randomly assigned to a noise condition by utilizing test sheets which had been randomly assigned a noise-condition number prior to the beginning of the study. Once assigned to a noise condition, each child was retained in that condition for both of the tasks which were administered.

The data were collected in May, 1977, utilizing two methods of task presentation, visual and auditory. The first task presented was the visual task which was also called the "silently read paragraphs task." The second task presented was the auditory task which was also called the "tape-recorded paragraphs task." Because of the difficulty in obtaining subjects, it was not possible to counterbalance the order of task presentation. Each task was tested at both a 2-minute interval and at a 24-hour interval. Thus, there were four test occasions involved in the study.

Occasion 1 involved a recall test of a visually presented task at a 2-minute interval. This Occasion was consistently associated with the first half of the 26-item silently read paragraphs test.

Occasion 2 involved a recall test of a visually presented task at a 24-hour interval. This test referred to the material which each subject had read 24 hours earlier. This Occasion was consistently associated with the second half of the 26-item test.

Occasion 3 involved a recall test of an auditorily presented task at a 2-minute interval. This Occasion was consistently associated with the first half of the 16-item tape-recorded paragraphs test.

Occasion 4 involved a recall test of an auditorily presented task at a 24-hour interval. This test referred to the material which each subject had listened to 24 hours earlier. This Occasion was consistently associated with the second half of the 16-item test.

Table 3 presents a schematic representation of the temporal location of WN before acquisition, before the 2-minute interval half test, and before the 24-hour interval half test for each of the noise conditions.

Table 3. Schematic Representation of Temporal Location of White Noise for Each Task

Noise Condition	Number of Subjects	Before Acquisition	Before 2-Minute Interval Test	Before 24-Hour Interval Test
I (Control)	9	■	■	■
II	9	□	■	■
III	9	■	□	□
IV	9	□	□	□

White noise = white boxes

No noise = black boxes

Many of the boys were involved in school activities such as field trips, camping trips, assemblies, sports contests, etc. Therefore, it was impossible to control the interval level between Occasion 2 and Occasion 3. This interval level ranged from 1 day to 1 week. The mean number of days between Occasions 2 and 3 was 3.08 with a standard deviation of 1.83 days.

The study took place in a windowless spare room provided by the school. All of the children were tested in the same room with the same lighting, noise, and environmental stimuli. This investigator administered both of the tasks and all of their tests for all of the children in the study.

The investigator refrained from verbally communicating with talkative children during no-noise intervals. However, motions for silence and pointing at the stop watch were used as a means of communication.

Occasion 1--Silently Read Paragraphs Task and 2-Minute Interval Half Test

Once the teacher and this investigator had agreed upon a time which was convenient and it was determined that the child would be available for the 24-hour interval test, the child was escorted to the experimental room. On the way, each child was told that he had been selected to be in an experiment which was testing funny noises. He was asked if he had ever been in an experiment. Most of the children had not been in an experiment. The child's feelings and comments about being in an experiment were discussed. An effort was made to help the child feel relaxed about the experience.

After the child entered the experimental room, he was seated at a table next to the investigator. The following is a brief scenario of the directions which were read to each child and the events which took place:

Directions: "This is an experiment to test a funny noise. In a minute I'm going to help you put these earphones on your head. Some of the kids in the experiment hear the funny noise, but some of the kids don't hear any noise at all. Don't worry about it if you don't hear any noise at all. We have to listen for 2 minutes."

Event: Two-minute interval of white noise (WN) or no noise (NN).

Directions: "I want you to read this story as carefully as you can. You can take as long as you need to read the story, but you can only read it one time. Read it very carefully. Try to remember as much about the story as you can. I'll be asking you some questions about the story in a few minutes. Read it to yourself."

Event: Child read story.

Directions: "Now we have to wait for two more minutes while you listen to the earphones again."

Event: Two-minute interval of WN or NN.

Directions: "O.K., now I'm going to ask you some questions about that story that you read."

Event: Items 1-13 of silently read paragraphs test orally administered. Oral responses of children marked as correct or incorrect.

Directions: "You'll be coming back to this room tomorrow at about the same time. I'll be asking you some more questions about that story that you read."

Occasion 2--Silently Read Paragraphs Task and 24-Hour Interval Half Test

After 24 hours had passed, this investigator again sought out the child. In a few cases the boys were not available at exactly a 24-hour interval. However, all of the children were tested within 1 hour of the time which was appropriate. The scenario continues:

Directions: "Do you remember how we sat here yesterday and listened to the earphones for 2 minutes? Well, we are going to do that again today."

Event: Two-minute interval of WN or NN.

Directions: "Here are some more questions about that story you read yesterday."

Event: Items 14-26 of silently read paragraphs test orally administered. Oral responses of children marked as correct or incorrect.

Directions: "You'll be coming back to this room again. I'm going to let you hear a new story and you'll be answering some more questions about the new story."

Occasion 3--Tape-Recorded Paragraphs Task and 2-Minute Interval Half Test

The children who had participated in the study on both Occasions 1 and 2 were escorted to the experimental room and seated at a table next to this investigator. The following directions and events took place:

Directions: "First of all, we need to listen to the earphones for 2 minutes."

Event: Two-minute interval of WN or NN.

Directions: "Today we will be listening to a tape-recorded story instead of reading a story. After you have finished listening to the story, you will be listening to the earphones again. Remember, some of the kids in the experiment don't hear any noise at all. Don't worry about it if you don't hear any noise at all. Try to remember as much about the story as you can because I will be asking you some questions about it."

Event: Child listened to tape-recorded story.

Directions: "Now we have to wait for two more minutes while you listen to the earphones again."

Event: Two-minute interval of WN or NN.

Directions: "O.K., now I'm going to ask you some questions about that story that you heard."

Event: Items 1-8 of tape-recorded paragraphs test orally administered. Oral responses of children marked as correct or incorrect.

Occasion 4--Tape-Recorded Paragraphs Task and 24-Hour Interval Half Test

After 24 hours had passed, this investigator again sought out the child. In a few cases the boys were not available at exactly a 24-hour interval. All of the boys were tested within 1 hour of the time which was appropriate. The scenario continues:

Directions: "Do you remember how we sat here yesterday and listened to the earphones for 2 minutes? Well, we are going to do that again today."

Event: Two-minute interval of WN or NN.

Directions: "Here are some more questions about that story that you heard on the tape-recorder yesterday."

Event: Items 9-16 of tape-recorded paragraphs test orally administered. Oral responses of children marked as correct or incorrect.

Directions: "I want you to raise a finger like this when you first begin to hear a funny noise on the earphones."

Event: Four or five attempts to establish WN threshold level were made.

Each child was then thanked for his cooperation, told that the study was complete, and escorted back to his room.

Analytical Procedures

Each of the four half tests was analyzed separately. The two independent variables for each of the four half tests were defined as follows: (1) the noise condition, and (2) the temporal location of the stimulus. The number of correct responses obtained for each of the half tests was the dependent variable for that half-test analysis. Table 4 presents the design utilized in each of the four half-test analyses.

Table 4. 2 x 2 Factorial Design for Each Half Test Analysis

Temporal Location of WN		Before Recall	
		WN	NN
Before Acquisition	WN	Condition IV	Condition II
	NN	Condition III	Condition I (Control)

WN = white noise

NN = no noise

Age, degree of hyperactivity, reading time, and WN threshold level were allowed to serve as covariates in each of the four half-test analyses. When an analysis of covariance resulted in significant regression effects, then the comparison of means were computed using the t test.

When the analysis of covariance resulted in non-significant regression effects, then an analysis of variance was utilized. In these cases, the F test (Winer, 1962, p. 120) was computed in order to compare the means.

In this paper, the term "significance" is defined as corresponding to a probability level of less than .05. In other words, the hypotheses were rejected if they were beyond the .05 level of confidence.

No posteriori comparisons of means were computed.

CHAPTER IV

RESULTS

This investigator sought to determine whether white noise (WN) might be used to facilitate acquisition and recall for hyperactive boys. An attempt was also made to determine whether the stimulus was most effective if it was presented (a) before acquisition, (b) before the recall tests, or (c) both before acquisition and before the recall tests.

The subjects for the study were 36 hyperactive boys who were between the ages of 8.50 and 12.75 years. Each boy was randomly assigned to one of four noise-condition groups. Each child stayed in the same noise-condition group on each of the four experimental occasions. One-quarter of the boys heard no noise (NN) before acquisition and NN before recall tests (Condition I or Control Condition), one-quarter of the boys heard WN before acquisition but NN before recall tests (Condition II), one-quarter of the boys heard NN before acquisition but WN before recall tests (Condition III), and one-quarter of the boys heard WN before acquisition and WN before recall tests (Condition IV).

A silently read paragraphs task and a tape-recorded paragraphs task were administered to all of the children in the study. Each task was followed by two halves of a test. The first half of the test for each task was given at a 2-minute interval and the second half of the test for each task was given at a 24-hour interval. The scores for each half test were subjected to a separate analysis. Thus, four analyses were conducted.

The analyses of covariance and the analyses of variance which were utilized in this study were computed by means of MANOVA. Age, degree of hyperactivity, reading time, and WN threshold level were allowed to serve as covariates in each of the four half-test analyses.

Examination of the results of the analyses of covariance revealed that there was a significant regression effect of a covariate only on Occasion 1. Degree of hyperactivity, reading time, and WN threshold level did not have a significant regression effect on Occasion 1. Age, however, was found to be a significant covariate on this occasion. When age was combined with the three above-mentioned covariates, the results were not significant. Therefore, a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of covariance, with age serving as the covariate, will be presented for the scores obtained on Occasion 1.

The regression effects of age, degree of hyperactivity, reading time, and WN threshold level were not significant in the analyses of the scores obtained on Occasions 2, 3, and 4. Therefore, a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of variance will be presented for the scores obtained on each of Occasions 2, 3, and 4.

Hypotheses Relating to Short-Term Recall (Hypotheses 1-5)

The following research hypotheses relating to short-term recall were tested in this investigation:

(1) A 2-minute burst of white noise presented just prior to

acquisition but not prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(2) A 2-minute burst of white noise presented just prior to the short-term recall test but not prior to acquisition will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(3) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the recall test.

(4) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear the noise just prior to acquisition but not prior to the recall test.

(5) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the short-term recall test will facilitate short-term recall for hyperactive boys more than if they hear the noise just prior to the short-term recall test but not prior to acquisition.

Briefly stated, hypothesis 1 predicted that subjects in Condition II would achieve higher scores than subjects in Condition I, hypothesis 2 predicted that subjects in Condition III would achieve higher scores than subjects in Condition I, hypothesis 3 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition I, hypothesis 4 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition II, and hypothesis 5 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition III.

Hypotheses 1 through 5 were first tested using a visually presented task. Table 5 presents the unadjusted means, adjusted means, and standard deviations for the silently read paragraphs, 2-minute interval half test, which was administered on Occasion 1.

Table 5. Means and Standard Deviations for Criterion and Covariate Scores Obtained on Occasion 1

		Criterion (Silently Read Paragraphs--2-Minute Interval Half Test)			Covariate (Age in Months)	
Noise Condition	Number of Subjects	Unadjusted Means	S.D.	Adjusted Means	Means	S.D.
I (Control)	9	8.222	1.302	8.492	126.444	14.976
II	9	8.000	2.398	7.957	131.333	14.335
III	9	6.778	2.224	6.586	133.667	7.858
IV	9	8.000	2.958	7.964	131.222	14.263

Table 6 presents a summary of the findings of the analysis of covariance.

Table 6. Analysis of Covariance Summary Table for Scores Obtained on Occasion 1

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	Probability Less Than
Within Cells	146.259	31	4.718		
Regression	22.852	1	22.852	4.844	.035
Before Acquisition	7.963	1	7.963	1.688	.203
Before Recall	1.596	1	1.596	.338	.565
Before Acquisition x Before Recall	8.072	1	8.072	1.711	.200

The raw regression coefficient between the age scores and the scores obtained on Occasion 1 was .064. Thus, .004 of the variance observed on Occasion 1 was accounted for by the differences in ages.

Hypotheses 1 through 5 were not confirmed. As indicated by Table 5, the results were in the opposite directions from those predicted by hypotheses 1, 2, and 3. The differences between the means, therefore, were not tested. Furthermore, no post-hoc comparisons in data were made since the analysis of covariance failed to show significance. Hypothesis 4 was not supported by the data since Table 5 indicated that subjects in Conditions II and IV obtained exactly the same scores on the unadjusted-criterion measure and more or less the same scores on the adjusted-criterion measure. The results, however, were in the direction predicted by research hypothesis 5. Table 5 indicated that subjects in Condition IV obtained higher scores than subjects in Condition III on both the unadjusted- and adjusted-criterion measures. The _t_ table showed that it takes a _t_ of 2.052 to be significant when there are 31 df. Comparison between the adjusted means of these two groups revealed that the difference was not significant, _t_ (31) = .912.

Hypotheses 1 through 5 were also tested using an auditorily presented task. Table 7 presents the means and standard deviations for the tape-recorded paragraphs, 2-minute interval half test, which was administered on Occasion 3.

Table 7. Means and Standard Deviations for Criterion Scores Obtained on Occasion 3

Noise Condition	Number of Subjects	Criterion (Tape-Recorded Paragraphs--2-Minute Interval Half Test)	
		Means	S.D.
I (Control	9	5.111	1.537
II	9	5.222	1.922
III	9	5.222	1.302
IV	9	6.111	1.453

Table 8 presents a summary of the findings of the analysis of variance.

Table 8. Analysis of Variance Summary Table for Scores Obtained on Occasion 3

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	Probability Less Than
Within Cells	78.889	32	2.465		
Before Acquisition	2.250	1	2.250	.913	.347
Before Recall	2.250	1	2.250	.913	.347
Before Acquisition x Before Recall	1.361	1	1.361	.552	.463

Again, hypotheses 1 through 5 were not supported by the data. As Indicated by Table 7, all of the scores were in the directions predicted by the first five research hypotheses. The subjects in Condition IV, who heard WN before acquisition and WN before the 2-minute recall half test, achieved the highest scores on the criterion measure. Subjects in the Control Condition, who heard NN before acquisition and NN before the 2-minute recall half test, achieved the lowest scores. Comparisons among the means were performed using the F test. The F table showed that it takes an F of 4.15 to be significant when there are 1 and 32 df. Comparison between Condition II and Condition I revealed that the difference was not significant, F (1,32) = .022. The difference between Conditions III and I was not significant, F (1,32) = .022. The difference between Conditions IV and I was not significant, F (1,32) = 1.825. The difference between Conditions IV and II was not significant, F (1,32) = 1.442. The difference between Conditions IV and III was not significant, F (1,32) = 1.442. Thus, none of the differences between the means were significant when short-term recall of a tape-recorded paragraphs task was tested.

Hypotheses Relating to Long-Term Recall (Hypotheses 6-10)

The following research hypotheses relating to long-term recall were tested in this investigation.

(6) A 2-minute burst of white noise presented just prior to

acquisition but not prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(7) A 2-minute burst of white noise presented just prior to each of the two recall tests but not prior to acquisition will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(8) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear no noise prior to acquisition or the two recall tests.

(9) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear the noise just prior to acquisition but not prior to the two recall tests.

(10) A 2-minute burst of white noise presented just prior to acquisition and again just prior to the two recall tests will facilitate long-term recall for hyperactive boys more than if they hear the noise just prior to the recall tests but not prior to acquisition.

Briefly stated, hypothesis 6 suggested that subjects in Condition II would achieve higher scores than subjects in Condition I, hypothesis 7 predicted that subjects in Condition III would achieve higher scores than subjects in Condition I, hypothesis 8 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition I, hypothesis 9 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition II, and hypothesis 10 predicted that subjects in Condition IV would achieve higher scores than subjects in Condition III.

Hypotheses 6 through 10 were first tested using a visually presented task. Table 9 presents the means and standard deviations of the silently read paragraphs, 24-hour interval half test, which was administered on Occasion 2.

Table 9. Means and Standard Deviations for Criterion Scores Obtained on Occasion 2

Noise Condition	Number of Subjects	Criterion (Silently Read Paragraphs--24-Hour Interval Half Test) Means	S.D.
I (Control)	9	4.667	2.062
II	9	5.333	2.398
III	9	4.556	2.351
IV	9	4.333	2.828

Table 10 presents a summary of the findings of the analysis of variance.

Table 10. Analysis of Variance Summary Table for Scores Obtained on Occasion 2

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	Probability Less Than
Within Cells	188.222	32	5.882		
Before Acquisition	2.778	1	2.778	.472	.497
Before Recall	.444	1	.444	.076	.785
Before Acquisition x Before Recall	1.778	1	1.778	.302	.586

Hypotheses 6 through 10 were not supported by the data. As indicated by Table 9, the results were in the direction predicted by hypothesis 6. Subjects in Condition II, who heard WN before acquisition but NN before either of the two recall half tests, achieved the highest scores on the criterion measure. The F table showed that it takes an F of 4.15 to be significant when there are 1 and 32 df. Therefore, the difference between the means of the scores obtained by the subjects in Conditions I and II was not significant when the data was subjected to an F test, F (1,32) = .340. On the other hand, Table 9 also indicated that the scores were in the opposite directions from those suggested by hypotheses 7, 8, 9, and 10. No post-hoc comparisons in data were made, however, since the analysis of variance failed to show significance.

Hypotheses 6 through 10 were also tested using an auditorily presented task. Table 11 presents the means and standard deviations for the tape-recorded paragraphs, 24-hour interval half test, which was administered on Occasion 4.

Table 11. Means and Standard Deviations for Criterion Scores Obtained on Occasion 4

Noise Condition	Number of Subjects	Criterion (Tape-Recorded Paragraphs--24-Hour Interval Half Test Means	S.D.
I (Control)	9	3.000	1.936
II	9	3.556	1.590
III	9	3.000	1.323
IV	9	3.556	1.509

Table 12 presents a summary of the findings of the analysis of variance.

Table 12. Analysis of Variance Summary Table for Scores Obtained on Occasion 4

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	Probability Less Than
Within Cells	82.444	32	2.576		
Before Acquisition	.000	1	.000	.000	1.000
Before Recall	2.778	1	2.778	1.078	.307
Before Acquisition x Before Recall	.000	1	.000	.000	1.000

Again, hypotheses 6 through 10 were not supported by the data.

As indicated by Table 11, the results were in the direction predicted by research hypothesis 6. The mean of the scores of the subjects in Condition II was higher than the mean of the scores of the subjects in the Control Condition. Comparison between the means was made using an F test. The F table indicated that it takes an F of 4.15 to be significant at the .05 level of confidence when there are 1 and 32 df. Therefore, the difference between the means of the subjects in Conditions II and I was not significant, F (1,32) = .540. Table 11 also indicated that the results were in the direction predicted by research hypothesis 8. Subjects in Condition IV, who heard WN before acquisition and WN before each of the recall half tests, achieved higher scores than subjects in Condition I. Again, the F test indicated that the difference between means of the subjects in Conditions IV and I was not significant at a .05 level of confidence, F (1,32) = .540. Table 11 also indicated that the results were in the direction predicted by research hypothesis 10. Subjects in Condition IV achieved higher scores than subjects in Condition III. Again, the F test did not indicate that there was a significant difference between subjects in Conditions IV and III, F (1,32) = .540. Table 11 revealed that research hypothesis 7 was not supported by the data since subjects in Conditions III and I obtained exactly the same scores on the criterion measure. Likewise, Table 11 also revealed that hypothesis 9 was not confirmed since subjects in Conditions II and IV received exactly the same scores on the criterion measure. No post-hoc comparisons in data were made since the analysis of variance failed to show significance.

Interesting Auxiliary Findings

This investigation was not designed to test the data which will be presented in the following section. The intercorrelations which will be discussed were auxiliary to the main study. These data are presented only because they are somewhat interesting and may suggest future avenues of research.

This method of analysis involved the calculation of a number of coefficients of correlation between the various variables involved in the study. These coefficients were obtained using two groups of subjects. For the first group of subjects, the coefficients were based on the scores of the nine boys who had been assigned to Condition I. Condition I has been defined as a control group since these boys heard neither WN before acquisition nor WN before recall intervals. For the second group of subjects, the coefficients were based on the scores of all 36 boys involved in the study. The scores of all the boys in the study were utilized since neither the analysis of covariance nor the analyses of variance indicated that WN had an effect on the criterion measures.

Intercorrelations for Subjects in Condition I (Control Condition)

Pearson correlation coefficients were computed between the various variables involved in the study. Table 13 presents the results of these analyses. These analyses involved only those scores for the boys who were randomly assigned to Condition I. Condition I has been defined as the Control Condition.

As indicated in Table 13, neither age, WN threshold level, reading time for the silently read paragraphs task, scores obtained on Occasion 1, scores obtained on Occasion 2, scores obtained on Occasion 3, nor scores obtained on Occasion 4 were significantly related to one another at a .05 level of confidence. There did, however, appear to be a number of trends. "S" is used as an abbreviation for "significance level."

Table 13. Correlation Coefficients and Significance Levels for Subjects in Control Condition

	Variable							
					Occasions			
	Age	Thresh-old	Hyper-activity	Read Time	1	2	3	4
Age	1.0000	.5024 S=.084	.3331 S=.191	.2350 S=.271	-.2686 S=.242	-.5169 S=.077	.0193 S=.480	-.0388 S=.461
Threshold		1.0000	.0762 S=.423	.5193 S=.076	.0206 S=.479	-.3050 S=.212	-.4267 S=.105	-.3974 S=.145
Hyper-activity			1.0000	.4209 S=.130	.1463 S=.354	.1732 S=.328	.2712 S=.243	.4426 S=.116
Read Time				1.0000	.0209 S=.479	-.1448 S=.355	-.2963 S=.219	.3621 S=.169
Occasion 1					1.0000	.4969 S=.087	-.5138 S=.079	.0992 S=.400
Occasion 2						1.0000	.3288 S=.194	.1252 S=.374
Occasion 3							1.0000	.2941 S=.221
Occasion 4								1.0000

In this paper, the terms "trend" or "tendency" are defined as corresponding to a probability level in excess of .05 and less than .10.

Age had a tendency to have a negative correlation with the scores obtained on Occasion 2. In other words, as age increased, scores on the 24-hour interval half test of the silently read paragraphs task decreased ($\underline{r} = -.5169$, $p < .077$). Age had a tendency to be positively correlated with the WN threshold level ($r = .5024$, $\underline{p} < .084$). The WN threshold level had a tendecy to be positively related to the amount of time the children spent reading the silently read paragraphs ($\underline{r} = .5193$), $\underline{p} < .076$).

The scores that the Control-Condition children received on the 24-hour interval test of the silently read paragraphs task exhibited a tendency to increase in conjunction with the scores they received on the 2-minute interval test of the same task ($\underline{r} = .4969$, $\underline{p} < .087$). As the scores on the 2-minute interval half test of the silently read paragraphs task increased, the scores on the 2-minute interval half test of the tape-recorded paragraphs task had a tendency to decrease ($\underline{r} = -.5138$, $\underline{p} < .079$).

Intercorrelations for the 36 Subjects in the Study

Again, Pearson correlation coefficients were computed between the various variables associated with the study. Table 14 presents the results of these analyses. Since none of the experimental treatment effects were found to be significant, all of the scores of all of the boys who were involved in the study were utilized. A number of significant correlation coefficients were found.

Table 14. Correlation Coefficients and Significance Levels for All of the Children in the Study

	Age	Thresh-old	Hyper-activity	Read Time	Occasions 1	2	3	4
Age	1.0000	.3197 S=.029	.0899 S=.301	-.2116 S=.108	.3074 S=.034	.0761 S=.329	.2038 S=.117	.2833 S=.047
Threshold		1.0000	-.0017 S=.496	.1278 S=.229	.0983 S=.284	.1676 S=.164	.0451 S=.397	-.0431 S=.402
Hyper-activity			1.0000	.1947 S=.128	-.0211 S=.451	-.1670 S=.165	.0184 S=.457	-.1411 S=.206
Read Time				1.0000	.0492 S=.388	-.0331 S=.424	-.2622 S=.061	-.0796 S=.322
Occasion 1					1.0000	.4468 S=.003	-.1959 S=.126	.2538 S=.068
Occasion 2						1.0000	.1732 S=.156	.3489 S=.018
Occasion 3							1.0000	.3628 S=.015
Occasion 4								1.0000

As indicated by Table 14, age had a significant, positive relationship with WN threshold level (r = .3197, $p <$ .029). There was a significant and positive correlation between the ages of the 36 subjects and their performance on the 2-minute interval half test of the silently read paragraphs task (r = .3074, $p <$ .034). Table 14 also indicated that there was a significant and positive correlation between age and performance on the 24-hour interval half test of the tape-recorded paragraphs task (r = .2833, $p <$ .047).

For the silently read paragraphs task, the analysis involving 36 subjects revealed a significant, positive correlation between the scores the boys received for the 2-minute interval half test and the scores they received for the 24-hour interval half test (r = .4468, $p <$ .003). There was a significant and positive relationship between the 2-minute interval half-test scores and the 24-hour interval half-test scores when the tape-recorded paragraphs task was considered (r = .3628, $p <$ .015).

There was a trend for the reading-time scores to be negatively related to the scores the boys received on the 2-minute interval half test of the tape-recorded paragraphs task (r =-.2622, $p <$ .061). The scores on the 2-minute interval half test of the silently read paragraphs task exhibited a tendency to be positively related to the 24-hour interval half-test scores on the tape-recorded paragraphs task (r = .2538, $p <$ .068). There was a significant and positive relationship between the scores on the 24-hour interval half test of the silently read paragraphs task and the scores on the 24-hour interval half test of the tape-recorded paragraphs task (r = .3489, $p <$ .018).

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

This chapter presents a discussion of the findings of this investigation. The first section is devoted to a summary of the research. The second section provides a discussion of the conclusions relevant to the study. The final section presents a discussion of the implications of the study for further research.

Summary of the Research

The purpose of this research investigation was to determine whether a 2-minute burst of 75 dB of white noise (WN) might be used to facilitate acquisition and recall for hyperactive boys. An attempt was made to determine whether the stimulus was most effective if it was presented (a) before acquisition, (b) before the recall tests, or (c) both before acquisition and before the recall tests.

The subjects for the study were 36 boys who received a score of eight or more on the Conners' Teacher's Questionnaire which had been completed by the regular classroom teacher of each child in the study. The boys were between the ages of 8.50 and 12.75 years. Each boy was randomly assigned on one of four noise-condition groups. Each child was retained in the same noise-condition group for each of the two tasks which were administered. Nine boys heard no noise (NN) before acquisition and NN before recall tests (Condition I or Control Condition), nine boys heard WN before acquisition but NN before recall tests (Condition II), nine boys heard NN before acquisition but WN before recall tests (Condition III), and nine boys heard WN before acquisition and WN before the recall tests (Condition IV).

Ten hypotheses were tested using two types of tasks. A silently read paragraphs task consistently preceded a tape-recorded paragraphs task. Each task was followed by the administration of two halves of a test. The first half of the test for each task was given at a 2-minute interval and the second half of the test for each task was given at a 24-hour interval. The scores for each half test were subjected to a separate analysis. Thus, four separate analyses were conducted.

Briefly stated, hypotheses 1, 2, and 3 suggested that WN before acquisition, before the short-term recall test, and both before acquisition and before the short-term recall test would facilitate short-term recall for hyperactive boys more than if they heard NN before acquisition and NN before the short-term recall test. Hypotheses 4 and 5 predicted that WN heard both before acquisition and before the recall test would facilitate short-term recall more than if WN was presented only before acquisition or if it was presented only before the recall test.

Hypotheses 1 through 5 were tested using a visually presented task. The data for the 2-minute interval half test of the silently read paragraphs task (Occasion 1) were analyzed by a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of covariance. Age served as the covariate. No significant differences among the adjusted means of the four noise-condition groups were found. Therefore, research hypotheses 1, 2, 3, 4, and 5 were not confirmed. Again, hypotheses 1 through 5 were tested using an auditorily presented task. The data for the 2-minute interval half test of the tape-recorded paragraphs task (Occasion 3) were analyzed by a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of variance. No significant differences among the means of the four noise-condition groups were found. Therefore, once again, research hypotheses 1 through 5 were not supported by the findings.

Hypotheses 6, 7, and 8 suggested that WN before acquisition, before the two recall tests, and both before acquisition and before the two recall tests would facilitate long-term recall for hyperactive boys more than if they heard NN before acquisition and NN before the two recall tests. Hypotheses 9 and 10 predicted that WN heard both before acquisition and before the recall tests would facilitate long-term recall more than if WN was presented only before acquisition or if it was presented only before the recall tests.

Hypotheses 6 through 10 were tested using a visually presented task. The data for the 24-hour interval half test of the silently read paragraphs task (Occasion 2) were analyzed by a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of variance. No significant differences among the means of the four noise-condition groups were found. Therefore, research hypotheses 6 through 10 were not supported by the findings. Again, hypotheses 6 through 10 were tested using an auditorily presented task. The data for the 24-hour interval half test of the tape-recorded paragraphs task (Occasion 4) were analyzed by a 2 x 2 (noise condition before acquisition x noise condition before recall) analysis of variance. No significant differences among the means of the four noise-condition groups were found. Therefore, once again, research hypotheses

6 through 10 were not confirmed.

Figure 10 presents a schematic representation of a summary of the results of the data obtained on Occasions 1 and 2. Adjusted means are presented in the case of Occasion 1.

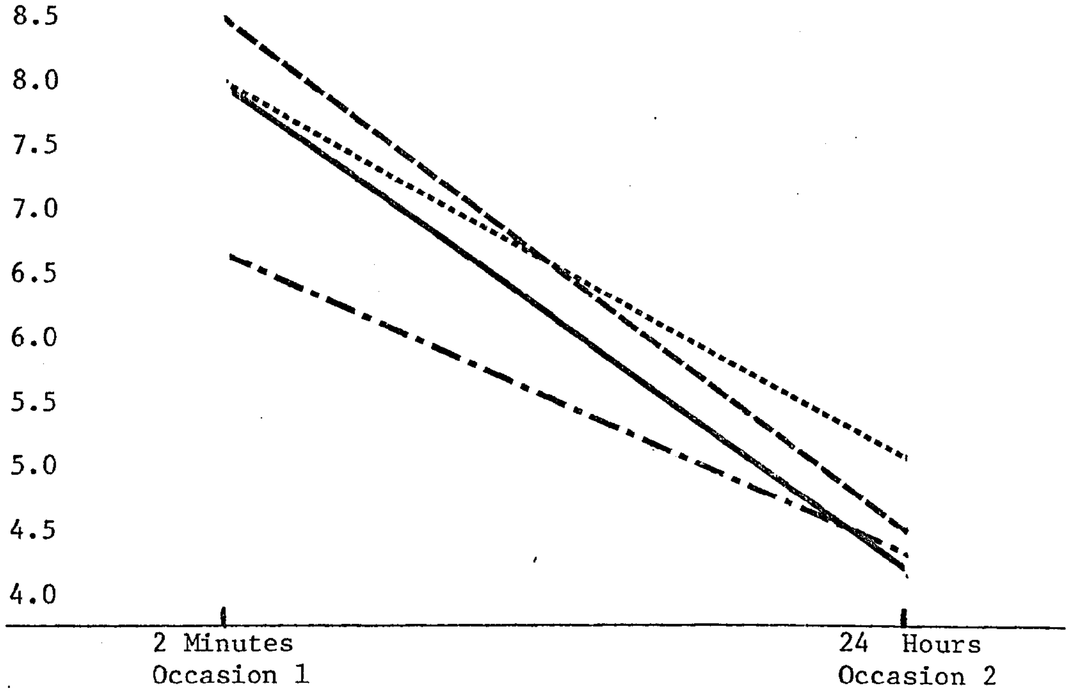

Figure 10. Mean recall rates for the silently read paragraphs task.

Group I =
Group II =
Group III =
Group IV =

Figure 11 presents a schematic representation of a summary of the results of the data obtained on Occasions 3 and 4.

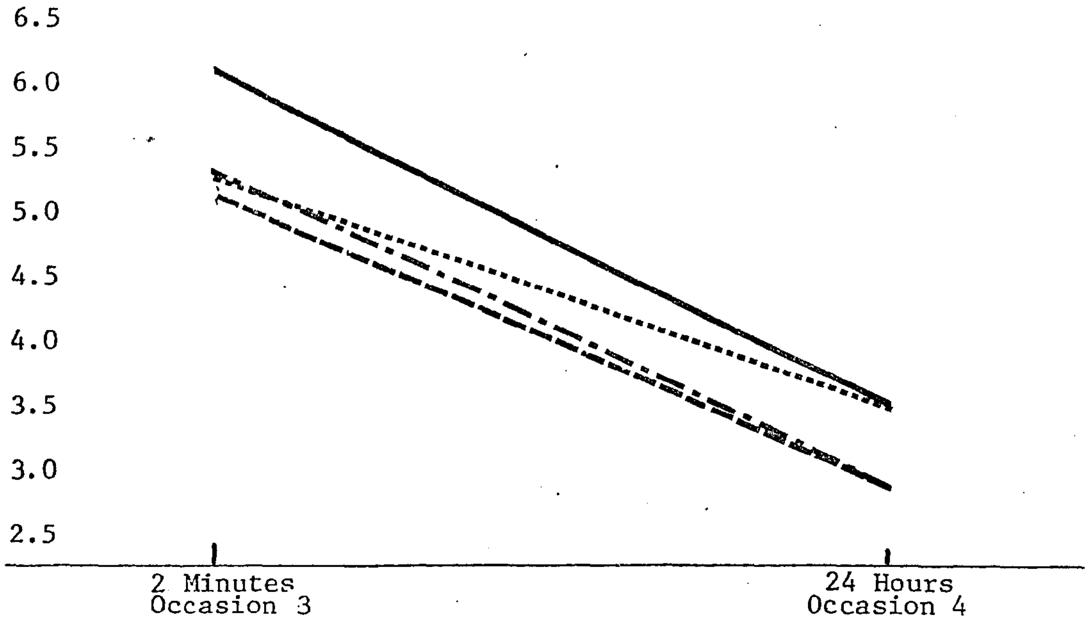

Figure 11. Mean recall rates for the tape-recorded paragraphs task.

Group I =
Group II =
Group III =
Group IV =

In an auxiliary analysis which was not related to the testing of the hypotheses, Pearson correlation coefficients were computed for the four variables and for the four criterion measures involved in the study. No significant correlations were observed when the data concerning the nine boys who had been randomly assigned to Condition I (Control Condition) were considered. However, a number of trends were noted. Trends toward positive correlations were noted between age and WN threshold level, WN threshold level and reading time, and scores obtained on Occasion 1 and scores obtained on Occasion 2. Trends toward negative correlations were observed between age and scores obtained on Occasion 2, and scores obtained on Occasion 1 and scores obtained on

Occasion 3.

In another auxiliary analysis which involved the data of all the boys who had participated in the study, Pearson correlation coefficients were again computed for the four variables and for the four criterion measures. Significant positive correlations were noted between age and WN threshold level, age and scores obtained on Occasion 1, age and scores obtained on Occasion 4, scores obtained on Occasion 1 and scores obtained on Occasion 2, scores obtained on Occasion 2 and scores obtained on Occasion 4, and scores obtained on Occasion 3 and scores obtained on Occasion 4. No significant negative correlations were noted when the data of the 36 subjects were considered. Several trends were observed, however. A tendency toward a positive relationship was noted between scores obtained on Occasion 1 and scores obtained on Occasion 4. A trend toward a negative correlation was observed between reading time and scores obtained on Occasion 3.

Conclusions and Discussion Related to the Study

This investigation provided no support for the theory that WN can be used as a helpful aid to acquisition or recall for hyperactive boys. Furthermore, the findings do not support a consolidation theory of memory. WN did not impair short-term recall nor did it facilitate long-term recall in this study.

The fact that the noise-condition group mean differences failed to reach statistical significance has several possible explanations. The most salient explanation is that WN is not a helpful aid to acquisition and recall for hyperactive boys and that the temporal location of the stimulus is not an important variable.

An alternative explanation for the failure to find statistical significance might be attributed to the large variability encountered within each of the noise-condition groups. Each of the half-test analyses seemed to be marked by greater variability than was expected from the results of the pilot studies which were undertaken to estimate the reliability of the tests. Subjects in Conditions II and IV consistently yielded greater standard deviations than the subjects in the pilot studies. Subjects in Condition I demonstrated greater variability in the cases of Occasions 2, 3, and 4. Subjects in Condition III exhibited larger standard deviations in the cases of Occasions 1 and 2. This variability may have been due to initial differences among the subjects on attributes such as intelligence, reading ability, listening ability, recall ability, and/or acquisition ability.

It is also possible that the tasks and their tests which were developed by this investigator contributed to the failure to find statistical significance in the study. Although the results of the pilot studies which were conducted indicated that the tests were reasonably reliable, it is possible that the tests were unreliable. It may be that they were insensitive to quantitative research. The possibility that the tests were unreliable is supported by the observation that the reliability coefficients, based on the Spearman-Brown prophecy formula, dropped from .92 for the silently read paragraphs task and .93 for the tape-recorded paragraphs task in the case of the pilot studies, to .66 and .45, respectively, for the Condition-I analysis, and to .62 and .53, respectively, for the 36-subject analysis.

Another possible explanation of the failure to find significant differences among the noise-condition groups is that some of the boys may have been on stimulant drugs. It is also possible that some of the boys in the study experienced CNS arousal merely from the knowledge that they were participating in an experiment. If arousal, as speculated by Eysenck (1965) and Berlyne (1967), is an inverted U function, then it is possible that excitement, WN, and/or stimulant drugs acted in conjunction with one another to produce an overaroused condition. This interaction may have acted to suppress the scores of the boys in Conditions II, III, and IV. That the children experienced a high level of excitement can only be supported by this investigator's observations. In general, the boys expressed great enthusiasm for the study and for WN. It should be noted that within a few days of the beginning of the study, a large number of permission slips were returned. Some classmates of those selected for the study requested that they, too, be allowed to participate. A number of girls expressed negative feelings about the fact that only boys were allowed to participate in the study. In short, it seemed to be some sort of a status symbol to be included in the investigation. Furthermore, the boys frequently expressed disappointment when they heard NN. One of the children insisted, "I hear it, I hear it," when he was hearing NN. A boy in Condition I persistently and excitedly described a "thump, thump, thump" whenever the earphones were on his head. It is probable that he was hearing his own heart beat. Drugs or excitement could have affected the study.

It is also interesting to note that restlessness and fidgeting seemed to be a problem during the 2-minute intervals only if the child had been assigned to a NN condition. Again and again, the observation was made that the hearing of WN seemed to be correlated with a decreased level of physical activity.

The difficulty in obtaining large numbers of subjects for the study may have been another reason statistical significance was not obtained. Berlyne et al. (1965), Berlyne et al. (1966), McLean (1969), Uehling and Sprinkle (1968), Baumeister and Kistler (1975) and Archer and Margolin (1970) were able to analyze their data using 850, 124, 158, 99, 72, and 44 degrees of freedom, respectively. For example, McLean was able to obtain statistical significance with a difference of .5 between the WN and NN groups on a 2-minute interval test and a difference of only .125 between the WN and NN groups on a 24-hour interval test. There would seem to be a decided advantage to working with 158 degrees of freedom. It is also probable that McLean was working with criterion measures and subjects that produced very little variance.

The difficulty in obtaining a large population of hyperactive subjects from a single environment cannot be overemphasized. This investigator found that small, special-education schools were frequently willing to participate in the research project, but could usually produce no more than four or five children who met the criteria of the study. If these small schools had been utilized as a source of subjects, the investigator would have been forced to move from school to school in order to obtain an adequate number of children for the study. Differences in background noise, lighting, room decorations, distances between classrooms and experimental rooms, attitudes of teachers and directors toward the study, etc., could have confounded the results of the study. This investigator also found that some pediatricians were willing to refer children to participate in the research project. These pediatricians, who specialized in the treatment of hyperactive children, seemed to have a tendency to medicate the children under their care. Utilization of these children as subjects might have resulted in a population of children who were already experiencing a CNS arouser. Public schools, on the other hand, were extraordinarily sensitive when it came to the idea of a research project. The main problem appeared to be a reluctance to ask parents for the release of confidential information. Although the school involved in this study was extremely cooperative and helpful, it was only after this investigator agreed to eliminate the requirements for information regarding intelligence, reading ability, listening ability, recall ability, learning ability, and whether the children were taking CNS stimulant medication, that the proposal for research was accepted by the school.

The auxiliary analyses which were conducted did not test the hypotheses which were designed to guide this investigation. However, a few intercorrelations and lack of intercorrelations were worth noting.

The fact that WN threshold level and age were found to be significantly and positively related in the 36-subject analysis suggested that these children exhibited a significant hearing loss as age increased.

The results of the procedures which yielded correlation coefficients between the four variables and the four criterion measures involved in the study did not support the notion that hyperactivity and a recall deficit were related. There was neither a significant relationship nor a trend toward a relationship between the degree of hyperactivity and performances on Occasions 1, 2, 3, or 4 in either the Condition-I analysis or the 36-subject analysis.

The Condition-I analysis also failed to support the idea that age and recall ability were significantly related. The 36-subject analysis, however, did yield significant and positive correlations between age and performance on Occasions 1 and 4. Interestingly, there was no significant correlation between age and long-term recall performance on the silently read paragraphs half test. Furthermore, the Condition-I analysis suggested that there was a trend toward a negative correlation between age and performance on Occasion 2. These results are not consistent with those reported by Baumeister and Kistler (1975). Those authors observed that, in their study, older children exhibited better long-term recall than younger when visually presented serial, free-recall or paired-associate learning tasks were involved. One possible explanation of this apparent discrepancy in findings is that some hyperactive children do not exhibit an expected increase in visual long-term recall as they grow older.

It may be that the Shedd School program (Appendix A) is effective because it presents an instruction method which combines auditory acquisition methods (instructions, questions, and responses are shouted by tutors, teachers, and students) with an auditory arouser (background noise). Although the results of the analyses of the auditorily presented task, the tape-recorded paragraphs half tests, were not statistically significant, the results of the analysis of the data obtained on Occasion 3 were in the directions predicted by hypotheses 1, 2, 3, 4, and 5. The results of the analysis of the data obtained on Occasion 4 were in the directions predicted by hypotheses 6, 8, and 10. If, indeed, some hyperactive children do not exhibit an expected increase in visual long-term recall as they grow older, then it may be that auditory acquisition methods are more effective than visual acquisition methods for some hyperactive children. In other words, some children may exhibit better long-term recall if they hear material than if they read material.

This interpretation is made with caution since it could be that the boys in the study were more aware of what was expected of them for the tape-recorded paragraphs task and tests than they were for the silently read paragraphs task and tests. The tape-recorded task consistently followed the silently read paragraphs task. This awareness might have resulted in making Occasions 3 and 4 an intentional acquisition problem and making Occasions 1 and 2 an incidental acquisition problem. However, the boys were warned on Occasion 1 that they would be asked more questions about the reading task at a 24-hour interval. Therefore, it is also possible that the predicted directionality of eight of the ten hypotheses, when an auditory task was presented, was the result of an auditory acquisition task being combined with an auditory arouser, as seems to be the case in the Shedd School program.

In conclusion, it seems clear that WN failed to facilitate acquisition and recall for the hyperactive boys in the study. Two questions remain: First, why did WN improve long-term recall in the Baumeister and Kistler (1975) experiments which involved normal children, but fail to facilitate long-term performance in the present study which involved hyperactive boys? Second, why are the people involved with the Shedd School convinced that deliberately sought background noise results in successful learning experiences for learning-disabled and hyperactive children? These are intriguing questions that cannot be answered in this paper.

Implications

The implications of this research are limited. The large variability within noise-condition groups, however, did suggest that the subjects in the study were from a heterogeneous population. It might prove fruitful to attempt to select a more homogeneous population in regard to age, intelligence, reading ability, listening ability, recall ability, and/or acquisition ability. This suggestion is easily made, but may prove extremely difficult to implement.

It might be profitable for future researchers to attempt to obtain larger numbers of subjects for additional research. Again, this suggestion is offered, but practical advice on how to do so cannot be given.

The recommendation is made that additional research with WN and hyperactive children be undertaken using different criterion measures. It is possible that more traditional serial, free-recall and paired-associate learning tasks and tests are more reliable and more sensitive to quantitative research than the tasks and tests which were developed for this investigation. These traditional tasks and tests may also produce less variance, even among hyperactive children. It may be that a non-traditional acquisition task might be utilized, but in this case it is suggested that both the task and WN be presented over a longer period of time. In other words, it is possible that one application or two applications of WN were not enough to be reflected quantitatively on the tests designed for this study. WN might be found to be an effective aid to acquisition and recall if it were presented on numerous occasions over a long period of time.

It would be interesting to discover whether hyperactive children are different from normal children in their response to WN. Was the failure to find that WN facilitated recall due to the methodological problems discussed above, or is there a difference between normal and hyperactive children. Some suggestion that there is a difference between the two groups is offered by the study by Satterfield et al. (1973). Satterfield et al. compared EEGs of MBD children with normal children and found that the MBD group had lower auditory-evoked cortical responses than control children. Perhaps hyperactive children are more resistant to arousal than normal children. The recommendation is made that additional research be undertaken which compares normal and hyperactive children in their reaction to WN.

Some researchers may be able to determine whether their hyperactive subjects are taking medication. If the experimental group could be limited to drug-free children, then it would be clear that drugs were not a source of arousal. In order to prevent the experimenter from becoming a source of excitement or arousal, it might be possible to have school nurses or other school employees, who are familiar figures to the children, administer the tests. If outside investigators are used, it might be best to administer a few pre-tests that are similar to the actual tests. This might accustom the children to the test situation and eliminate some of the excitement that may have affected this study.

One of the questions that has risen regards the recall ability of hyperactive subjects. Do hyperactive boys have better long-term recall of auditorily presented material than of visually presented material? An answer to this question might lead to the development of more effective teaching methods for these children.

The most promising avenue of research suggested by this research and the Shedd School program would be to combine an auditory acquisition method, such as a tape-recorded paragraphs task, with an auditory arouser, such as WN. If the methodological problems discussed above could be solved, then it may be that WN could be shown to be an effective aid to acquisition and recall for some hyperactive children.

The high incidence of hyperactivity and the poor prognosis for children who suffer from hyperactivity associated with a learning disability makes it essential that research in this area be continued. There may be ways, other than the use of stimulant medication, to help these children. More successful efforts to find such alternatives await future research effort.

APPENDIX A

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Specific Reading and Learning Difficulties

Association of Roanoke

PHONE (703) ~~342-3620~~ 989-3739
P. O. Box 8273
Roanoke, Virginia 24014

March 15, 1977

Mrs. N. Jean Arbuckle
11224 Bellmont Drive
Fairfax, Virginia 22030

Dear Mrs. Arbuckle,

Thank you for your letter and for the outline of your dissertation plan. We would be delighted to work with you, but I do not believe our students would be suitable for your data.

Dr. Shedd completed experimental work while at the Alabama School of Medicine, Spain Rehabilitation Center, in the area of the introduction of white noise to normals and to diagnosed specific learning disabilitied students. Because of the results obtained, our programs operate as they do.

Tutoring, classes, operate in open situations with background noise deliberately sought. Therefore, our students have all had this approach. They are not separated, isolated when they work. Interestingly, we were the first to do this and now others are coming to the same conclusions.

Our students have all had a full diagnostic battery including IQ, visual, auditory discrimination, left-right, the Rorschach and other testings. They are also drug free.

From what I could gather from your proposal you would need students who had not had our type of remedial approach in order to have more selective data.

We wish you well and would be most interested to hear of your results. If you do not agree with my conclusions, do let me know.

Sincerely,

Mrs E A Hawthorne

Mrs. E.A. Hawthorne
Director

APPENDIX B

LETTER TO PARENTS

Dear Parents:

The following is a brief description of a research project which may result in a simple method of improving learning and recall for some children.

The study involves "white noise" which has been described as a random sound compounded of all frequencies of vibration in equal amounts. The noise resembles the sound of a waterfall, or perhaps it is best described as a hissing sound. Research has shown that white noise used on college students has been effective in improving learning and recall. This study will be investigating whether 2-minute intervals on the noise will be a learning aid to younger children.

The study is very simple and involves only a few minutes a day for four days for each child in the study. On the first day, each child will be reading a short, very easy, Dick-and-Jane type of story. The child can take all the time he needs to read the story. After he is finished, the investigator will ask the child to orally answer a few questions about the story. After a 24-hour interval, the child will again be asked questions about the silently-read story. On the third day, each child will hear a very short and simple tape-recorded story. After he listens to the story, he will be asked to orally answer a few questions about the tape-recorded story. On the fourth day, each child will again be asked questions about the tape-recorded story.

Each child's teacher will be asked to fill out a brief rating scale which describes the child's behavior at school. No child's name will be used in the dissertation which will result from the study.

If you have any questions or concerns which have not been answered by this brief description of the study, please feel completely free to call the investigator who will be conducting the research project, Mrs. N. Jean Arbuckle, Ph.D. Candidate, University of Maryland, 591-4077.

Please check the appropriate statement below:

____ I give my consent for ____________________ to participate.

____ I do not give my consent.

____ I would like to have a summary report of the results.

Comments: ____

____

____

Signature of parent or guardian _________________________

Please return this letter in the enclosed envelope.

Sincerely,

____
Principal

APPENDIX C

CONNERS' TEACHER'S QUESTIONNAIRE

Listed below are descriptive terms of behavior. Place a check mark in the column which best describes this child. ANSWER ALL ITEMS.

Observation	Not at all	Just a little	Pretty much	Very much
CLASSROOM BEHAVIOR				
1. Constantly fidgeting				
2. Hums and makes other odd noises				
3. Demands must be met immediately-easily frustrated				
4. Coordination poor				
5. Restless or overactive				
6. Excitable, impulsive				
7. Inattentive, easily distracted				
8. Fails to finish things he starts-short attention span				
9. Overly sensitive				
10. Overly serious or sad				
11. Daydreams				
12. Sullen or sulky				
13. Cries often and easily				
14. Disturbs other children				
15. Quarrelsome				
16. Mood changes quickly and drastically				
17. Acts "smart"				
18. Destructive				
19. Steals				
20. Lies				
21. Temper outbursts, explosive and unpredictable behavior				
GROUP PARTICIPATION				
22. Isolates himself from other children				
23. Appears to be unaccepted by others				
24. Appears to be easily led				
25. No sense of fair play				
26. Appears to lack leadership				
27. Does not get along with opposite sex				
28. Does not get along with same sex				
29. Teases other children or interferes with their activities				
ATTITUDE TOWARD AUTHORITY				
30. Submissive				
31. Defiant				
32. Impudent				
33. Shy				
34. Fearful				
35. Excessive demands for teacher's attention				
36. Stubborn				
37. Overly anxious to please				
38. Uncooperative				
39. Attendance problem				

APPENDIX D

biocoustics inc ELECTRONICS FOR AUDIOLOGY,
SPEECH PATHOLOGY AND THE BEHAVIORAL SCIENCES

Mrs. Jean Arbuckle

White Noise Generator, Beltone Model NB-102

Maximum white noise output is 124.7 dB SPL re .0002 microbar. Unit was calibrated in dB output SPL using a pair of TDH-39 headphones with MX-41 cushions. Calibration was done in a 6 cc coupler through a Bruel & Kjaer Model 4144 Microphone into a Bruel & Kjaer Model 2203 Sound Level Meter.

The output switching arrangement of the noise generator was modified to allow the presentation of timed bursts of white noise at SPL levels calibrated in 5 dB increments and presented to both ears simultaneously at equal level. An interrupter switch was added to allow for quick presentation and release of the stimulus white noise.

12316 WILKINS AVENUE • ROCKVILLE, MD. 20852

(301) 881-2211

APPENDIX E

SILENTLY READ PARAGRAPHS TASK, QUESTIONS, AND ANSWERS

Don was 7 years old. He had 6 sisters. Mother liked to bake Tac for the kids. Don liked to play a game called Mel after school.

The family decided to mover to Bam. Father sold Zag to make money.

The family got on a bus to move to their new home. Don lost his belt on the bus. Mother lost her hat on the bus. Father lost his coat on the bus. Don's oldest sister lost a button on the bus.

The family took oranges with them to eat on the bus. Don found a peach on one of the seats of the bus. A nice lady gave Don a banana to eat. The man in the seat behind Don gave him a pear.

The family moved into a new house. The girl next door was named Mary. The boy next door was named Jack. Mary liked to catch fish in the lake. Jack liked to play in the sand.

The new house had 5 bathrooms. It had 3 TV sets. It had 2 bedrooms. It had 4 telephones.

Their new car was white. The new house was blue. The dryer was green. Don's room was brown.

Don liked his new house very much. He was glad that the family had moved.

___ 1. How old was Don?
Acceptable: 7

___ 2. What did Mother like to bake for the kids?
Acceptable: Tac
Question: Any pronunciation that sounds close to Tac. E should ask child to spell the name of what Mother liked to bake. Score correct if Tac is spelled correctly.

____ 3. What did Father sell to make money?
Acceptable: Zag
Question: Any pronunciation that sounds close to Zag. E should ask child to spell the word. Score correct if Zag is spelled correctly.

____ 4. What did Mother lose on the trip on the bus?
Acceptable: Hat

____ 5. What did Father lose on the trip on the bus?
Acceptable: Coat
Jacket

____ 6. What did the family take with them to eat on the trip on the bus?
Acceptable: Oranges

____ 7. What did the nice lady on the bus give to Don to eat?
Acceptable: Banana

____ 8. What was the name of the girl next door to the new house?
Acceptable: Mary

____ 9. What did the girl next door like to do?
Acceptable: Fish

____10. How many bedrooms did the new house have?
Acceptable: 2

____11. How many bathrooms did the new house have?
Acceptable: 5

____12. What color was their new car?
Acceptable: White

____13. What color was the new dryer?
Acceptable: Green

____14. How many sisters did Don have?
Acceptable: 6

____15. What was the name of the game that Don liked to play after school?
Acceptable: Mel
Question: Any pronunciation that sounds close to Mel. E should ask child to spell the name of the game. Score correct if Mel is spelled correctly.

____16. What was the name of the place to which the family decided to move?

Acceptable: Bam

Question: Any pronunciation what sounds close to Bam. E should ask child to spell the name of the place. Score correct if Bam is spelled correctly.

____17. What did Don's oldest sister lose on the trip on the bus?

Acceptable: Button
Button off a coat
Button off a hat

____18. What did Don lose on the trip on the bus?

Acceptable: Belt

____19. What did the man in the seat behind Don give *him to eat?*

Acceptable: Pear

____20. What did Don find to eat on one of the seats of the bus?

Acceptable: Peach

____21. What was the name of the boy next door to the new house?

Acceptable: Jack

____22. What did the boy next door like to do?

Acceptable: Play in the sand
Not Acceptable: Play in the mud

____23. How many TV sets did the new house have?

Acceptable: 3

____24. How many telephones did the new house have?

Acceptable: 4

____25. What color was their new house?

Acceptable: Blue

____26. What color was Don's room?[1]

Acceptable: Brown

[1]There are 26 items on the silently read paragraphs test and only 16 items on the tape-recorded paragraphs test. Experience during the pilot studies that were conducted prior to the beginning of the study suggested that the normal subjects in the pilot studies could recall more visually presented items than auditorily presented items. In order to leave room for "improvement" and room for "forgetting" on each half test, it was necessary to construct tests that were not equal in their number of items.

APPENDIX F

TAPE-RECORDED PARAGRAPHS TASK, QUESTIONS, AND ANSWERS

David lost his shoe. Mother said, "You cannot watch TV until you find that shoe!"

David looked under the piano. He found an apple under the piano. David looked under the sofa. He found a screwdriver under the sofa. David looked under Mother's bed. He found a newspaper under Mother's bed. David looked under the table. He found a book under the table.

Finally, David decided to hunt for the lost shoe outside. He saw some girls playing. The first girl was running backwards. The second girl was standing on her head. The third girl was skipping rope. The fourth girl was playing hopscotch.

David looked for his shoe in a purple truck. It was not there. He looked for his shoe in a pink jeep. It was not there. He looked for his shoe in a yellow station wagon. It was not there. He looked for his shoe in an orange bus. It was not there.

David found 5 cats. But no shoe. He found 6 dogs. But no shoe. He found 3 rabbits. But no shoe. He found 2 turtles. But he could not find his shoe.

David felt very bad. His favorite TV show was about to start. He walked back to the house and sat down on the sofa. What do you think he saw under the TV set?

____ 1. What did David find under the piano?
Acceptable: An apple
An old apple

____ 2. What did David find under Mother's bed?
Acceptable: A newspaper
A paper

____ 3. What was the first girl doing when David saw her?
Acceptable: Walking backwards
Running backwards

____ 4. What was the third girl doing when David saw her?
Acceptable: Skipping rope
Jumping rope

____ 5. What color was the truck?
Acceptable: Purple

____ 6. What color was the station wagon?
Acceptable: Yellow

____ 7. How many cats did David find?
Acceptable: 5

____ 8. How many rabbits did David find?
Acceptable: 3

____ 9. What did David find under the sofa?
Acceptable: A screwdriver

____10. What did David find under the table?
Acceptable: A book

____11. What was the second girl doing when David saw her?
Acceptable: Standing on her head
Standing upside down

____12. What was the fourth girl doing when David saw her?
Acceptable: Playing hopscotch

____13. What color was the jeep?
Acceptable: Pink

____14. What color was the bus?
Acceptable: Orange

____15. How many dogs did David find?
Acceptable: 6

____16. How many turtles did David find?
Acceptable: 2

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