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ABSTRACT

In order to assess the effects of environmental stimulation on the perceptual thresholds of high active and low active mentally retarded persons, 36 male and female residents from a state institution (mean IQ 56 and 60 for high and low groups, respectively) were observed under three conditions of environmental stimulation: no noise, white noise, and cafeteria noise. Each subject's activity level was recorded for exactly five minutes, on each occasion, by means of an ultrasonic motion detector, and was compiled by an electromagnetic counter. Results showed that the high- and low-active mentally retarded persons did not differ in perceptual threshold measures under the restricted auditory conditions. There were no significant differences between all of the possible comparisons of level of activity with the other dimensions of the study or with any of the associated interactions. An extensive list of references and a detailed review of the literature accompany the study. (RD)

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by

William Glasgow Lucker, Ph.D.

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by

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Bachelor of Arts

Texas Western College

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THE EFFECTS OF ENVIRONMENTAL STIMULATION ON THE PERCEPTUAL THRESHOLDS OF HIGH-ACTIVE AND LOW-ACTIVE MENTALLY RETARDED PERSONS

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The effects of environmental stimulation on measures of perceptual threshold of mentally retarded persons were investigated. Eighteen high-active and 18 low-active institutionalized retardates were required to identify pictures of four common objects presented at different tachistoscopic speeds. Each person was shown the pictures of common objects in conjunction with cafeteria noise, Gaussian noise, and no noise. Measures of the perceptual thresholds for the recognition of these pictures were obtained by the methods of ascending and descending limits. All subjects received all conditions of environmental stimulation in counterbalanced orders.

The statistical analysis of the threshold measures indicated that high-active and low-active mentally retarded persons did not behave differently when under different types of stimulation. Cafeteria noise, when presented initially only, had a disruptive effect on measures of perceptual threshold. When cafeteria noise was presented in other than the initial administration, it was found not to have the disruptive effect. Gaussian noise and no noise, whether

initially or subsequently presented, did not have the disruptive effect on measures of perceptual threshold.

The theoretical positions of Strauss and his colleagues (Kephart & Lehtinen), Gellner, and Zaporozhets present different explanations for hyperkinetic behavior and mental retardation. The results of this investigation found no support for the theoretical position of Strauss and his colleagues and minimal support for the theoretical positions of Gellner and Zaporozhets. An approach toward a more adequate theory for the effects of stimulation was suggested.

Introduction

Attentional factors have often been cited to account for learning deficits found in two broad categories of children, the mentally retarded and children who display exceptionally high levels of motor activity. Many very active children have, in common with the retarded, an inability to learn as well as their age peers in certain areas of academic achievement. This latter group of children has been variously termed "minimally brain damaged," "hyperactive," "hyperkinetic," "psychoneurologically disordered," "organically impaired," "birth damaged," "chronic brain syndrome," and "Strauss syndrome" (Dunn, 1968).

A number of theoretical positions have attempted to explain the relationships found among activity level, attentional factors, and learning deficits. Cromwell, Baumeister, and Hawkins (1963) and Cromwell (1963) have reviewed seven such positions. Of these seven positions, three heuristically important, though largely rational, theories appear to offer alternative explanations for the relationship between poor academic achievement and activity level. Each of these theories, Strauss, Lehtinen, and Kephart (Strauss & Kephart, 1955; Strauss & Lehtinen, 1947), Gellner (1959), and Zaporozhets (1957, 1960, 1969), accounts for high levels of activity from different perspectives, and each theory implies different remedial approaches. Strauss and his colleagues see the hyperactive child as one who is exceptionally sensitive to environmental stimulation. In a normal environment this "hypervigilant organism--one whose reactibility is beyond his control--can only meet the situation with persistent indirected response (Strauss & Lehtinen, 1947, p. 129)." For these authors, brain injury is seen as a causal factor, while de-emphasis of environmental stimulation is seen as both an educational and management approach to the problem.

Gellner (1959), on the other hand, views hyperactivity as the indication of an inability to "appreciate emotionally" and respond "meaningfully" to visual and auditory stimulation. In order to overcome his deficits, the child must compensate through the kinesthetic, tactual, and proprioceptive modes of stimulation. She believes that in both mental retardation and hyperactivity, the midbrain structure, specifically the superior and inferior colliculi of the tectum, is dysfunctional.

Zaporozhets (1957, 1960, 1969), a Russian psychologist, describes a developmental, reorganizational growth process in which the child first must come into contact with his environment through motor-touch associations. These motor-touch associations form the basis for later visual associations, which, in turn, form the basis for verbal associations. Neurological impairment, or, more recently, lack of appropriate training, would then demand that the child continue to depend upon motor-touch associations or "external operations" in order to react with his environment.

Enhanced visual and auditory stimulation, therefore, is seen as definitely debilitating by Strauss and his colleagues, while such increases in stimulation may be seen as enhancing by Gellner and Zaporozhets. Conceivably, the same educational and remedial approaches used by Strauss and his colleagues would be the obverse of the educational and remedial approaches used by Gellner and Zaporozhets. From their theoretical positions, these latter authors would seem to emphasize more auditory and visual stimulation to overcome the child's need to rely on the kinesthetic and tactual modes of learning.

Neurophysiological research concerned with the correlates of hyperactivity and attentional deficits is equivocal, at best. Klinkerfuss, Lange, Weinberg, and O'Leary (1965) found slowed electrical activity as the outstanding feature of the hyperkinetic encephalogram, whether children between the ages of 4 years and 16 years had known neurological diseases or normal neurological examinations. These authors found further that the incidence of this slowed electrical activity did not increase or decrease as a function of age among children who presented hyperkinesis as their common symptomatology.

Hernandez-Peon (1965), also using electroencephalographic (EEG) tracings as his inferential basis, concluded that mentally retarded children had deficient corticoreticular mechanisms involved in the triggering and the maintenance of attention. He suggested the corticofugal projections arising in the frontal lobes and descending into the reticular system as most importantly involved in attention. Specifically, from his work with infrahuman organisms, he has seen the possibility of overcoming these deficits by direct chemical stimulation of the brain.

Laufer, Denhoff, and Solomons (1957), using the photo-Metrazol technique of Gastaut (Gastaut, 1950; Gastaut & Hunter, 1950), stated that the "hyperkinetic syndrome is a very specific entity (p. 48)." Contrary to Hernandez-Peon, Laufer et al. described the hyperkinetic child with his associated attentional deficits as an individual "unusually sensitive to stimuli flooding in from both peripheral receptors and viscera (p. 46)."

Empirical support for both the enhancing effects of stimulation and the "flooding" concept of Strauss and his colleagues and Laufer et al. can be found. Furster (1958) implanted electrodes in the mesencephalon of monkeys and found that they performed significantly better in a tachistoscopic task while receiving a weak electric shock. Cohen, Taft, Mahadeviah, and Birch (1967), on the other hand, found that children with behavior problems and suspected intellectual retardation were unable to control "overflow" movements to the "other hand" while given a series of tasks to perform with one hand. These authors found further that even when informed of such movements, these children continued to be unable to inhibit such "overflow" movements. Finally, Stevens, Boydstun, Dykman, Peters, and Sinton (1967), using a series of tasks requiring a functional and intact nervous system, compared children diagnosed as minimal brain dysfunction (MBD) with normal children matched on age, sex, and socioeconomic status. MBD children were inferior to normals on all tasks, and the authors concluded that disorders of attention were particularly implicated in the inferior performance of MBD children. Stevens et al. (1967) stated that "these children could attend for just so long and no longer (p. 284-285)."

A number of researchers have investigated the effects of environmental stimulation on the behavior and task performances of a wide range of subjects. In most experiments, environmental stimulation enhanced task performance or reduced undesirable behavior, while in the remaining studies such stimulation usually did not have the disruptive consequences that would be predicted from the theoretical position of Strauss and his associates.

Investigating the effects of stimulation upon activity level, Gardner, Cromwell, and Foshee (1959) found that both organic and cultural-familial retardates were less active under enhanced visual stimulation than when under reduced visual stimulation. Both high- and low-active retardates, previously assessed on activity level, were less active under enhanced visual stimulation. A specific finding of interest was the fact that high-active subjects showed a significantly greater reduction of activity while under enhanced visual stimulation than did low-active subjects.

Spradlin, Cromwell, and Foshee (1959) also investigated the effects of stimulation upon activity level, but used enhanced auditory stimulation rather than visual stimulation. These investigators found no significant differences in activity level either between organic and cultural-familial retardates or between high-active and low-active retardates, when under enhanced auditory stimulation as compared with a period of relative silence. Thus, in that study, no support was given to the position that either organic retardates or high-active retardates are deleteriously affected by increased auditory stimulation.

Concerning the relationship between activity level and task performance, a single study was found which indicated that high-active retardates performed less adequately than low-active retardates (Sprague & Toppe, 1966). On the other hand, Foshee (1958) found no difference between high- and low-active retardates on a simple and complex task when differences in IQ between the two groups were equated statistically. Cromwell, Palk, and Foshee (1961) did not find activity level to be correlated with the acquisition of a classically conditioned eyeblink response.

The research on performance level and stimulation indicates an enhancing effect of stimulation in most studies. Berlyne, Borsa, Hamacher, and Koenig (1966) found that white noise presented at 70 dB enhanced the learning performance of female undergraduate students in a paired-associates task. Massey and Insalaco (1969) found that white noise presented at 95 dB enhanced the performance of retarded persons in a two-choice discrimination problem. Cruse (1961) found that brain-injured mentally retarded children did not perform more poorly than cultural-familial mentally retarded children on a reaction time test in a room strewn with toys and with balloons hanging from the ceiling and kept in constant motion by means of an electrical fan. There was no significant difference in performance by both groups between the objects-present condition and the objects-absent condition. Dugas and Baumeister (1968) found that visual stimulation (a display of rhythmically moving lines of light in various colors ascending and descending at various speeds) actually improved retardate performance in a match-to-sample task, both in terms of total correct responses and in terms of latency scores. In two experiments, Girardeau and Ellis (1964) found no difference in the performances of normal and retarded subjects either on a serial-order or paired-associates verbal task as a function of noise present or noise absent. Ellis, Hawkins, Pryer, and Jones (1963) found that a distracting-mirror-present condition enhanced the performance of normal public school children on an oddity task, while it did not hinder the performance of age-matched mentally retarded subjects on the same task.

In a study using culturally advantaged children, Turner (1969) found that the performance of children who received 70 dB of typing noise while learning a two-choice discrimination problem was superior to the performance of children who solved the same problem without noise. In order to assess the generality of the facilitating effect of auditory stimulation, Turner presented a third group of children with the same task while listening to children's songs. The performance of this third group of children was superior to that of the group that had learned the task with no extraneous auditory stimulation.

Stereotyped behavior among the retarded has often been considered self-stimulation type movement (Berkson & Davenport, 1962; Berkson & Mason, 1963; Davenport & Berkson, 1963; Guess, 1966; Kaufman & Levitt, 1965a, 1965b; Levitt & Kaufman, 1965). Germane to the present review, however, is the effects of differing environmental stimulation upon the prevalence of such behavior. Davenport and Berkson (1963) found the amount of stereotyped behavior to be significantly higher for mentally retarded persons when no toys were present than when toys were provided. In one group, these authors also found that stereotyped behavior was significantly higher when the least preferred toy was present, as compared to the frequency of stereotyped behavior when the most preferred toy was present. Berkson and Mason (1963) found that stereotyped behavior in profoundly retarded persons increased significantly when in a novel and restricted environment, and was significantly lower on a playground with approximately 50 other persons. In 83 mentally retarded subjects, Kaufman and Levitt (1965b) found amount of body rocking and head rolling to be significantly higher as a function of time of day, just prior to lunch and in the middle of the afternoon when ward personnel changed shifts and patient-staff interaction was minimal. Finally, Levitt and Kaufman (1965) presented retardates who displayed either high or low body-rocking movements, no noise, low white noise (70 dB), medium white noise (85 dB), and high white noise (110 dB) in an observation room. Rocking behavior for girls in the high-rocking group systematically decreased with increasing amounts of noise. Unfortunately, no such effect was found for the boys in the high-rocking group.

The research cited thus far has concerned itself primarily with the effects of stimulation, in general, upon the behavior of various groups. The studies have been concerned primarily with the presence or absence of stimulation in a given task, and have not considered directly either the prolonged effects of stimulation or specifically the effects of stimulation for different age groups. Such concerns, to the present author at least, represent the increasing sophistication to be found in an area of research when succeeding information enlarges upon or more specifically delineates previously acquired research findings. Turner (in press) postulates a dual role for enhanced visual and auditory stimulation. Specifically, he suggests that auditory and visual stimulation may have an enhancing effect on "older" individuals, whereas it may have a debilitating effect on "younger" individuals. Turner randomly assigned 90 subjects of average intelligence and of three ages (5½ years, 6½ years, and 7½ years) to one of three conditions of stimulation (mirror present, noise present, and control). All subjects were required to learn an oddity task. Though there were no significant overall main effects, except for trial blocks, a trend analysis using the age-by-conditions sum of squares indicated that the number of correct responses of 5½-year-old subjects on an oddity task in the mirror condition was significantly lower than for control subjects of that age, while the performance of 7½-year-old children under the mirror condition was significantly superior to the performance of control subjects of that age.

Belmont and Ellis (1968) have proposed a dual theory of stimulation. These authors have posited that, whereas stimulation may have an enhancing effect upon performance when a person is unfamiliar with the testing situation, stimulation may also have a debilitating effect upon performance once the person has become familiar with a given situation. In support of this position, Belmont and Ellis conducted a series of six experiments, the last two of which are of interest here.
The fifth experiment consisted of presenting 20 retardates a different 10-pair discrimination problem daily for 5 consecutive days. The discrimination problem consisted of two "meaningless" line drawings at the bottom of a screen, while stimulation consisted of "meaningful" pictures of animals and scenes which filled the remainder of the screen. Results of the experiment indicated a significant groups-by-days effect; i.e., on Day 1, the control group performed less efficiently than the "stimulated" group, but by Day 5 the control group performed best. The last experiment consisted of 16 subjects matched on Day 5 performance. Subjects were randomly assigned either to a stimulation or nonstimulation group, and a new problem with new "meaningful" stimulation was presented to the appropriate group. Control group performance was found to be significantly superior on the two-choice discrimination task, as compared with the group receiving "meaningful" pictures as added stimulation.

Ample empirical support has been presented for the efficacy of stimulation in the enhancement of task performance to bring into serious question the theoretical position which holds to the simplistic view that hyperactivity is the result of too much stimulation in the environment of a "hypervigilant" organism. On the other hand, evidence is also cited (Belmont & Ellis, 1968; Turner, in press) for the obverse simplistic view that all stimulation under all sets of conditions leads to the enhancement of task performance.

The purpose of the present study was to investigate the relationships among activity level, stimulation, and attention. Specifically, its purpose was to investigate the effects of activity levels and levels of sensory stimulation upon the perceptual thresholds of mentally retarded persons. It is the author's position that perceptual threshold is dependent upon attention and that attention is dependent upon environmental stimulation. Perceptual threshold, therefore, can be used as a particularly sensitive measure to assess any shifts in attention as a function of environmental change.

The literature, though somewhat equivocal, suggests that environmental stimulation, both in the auditory and in the visual modes, can act as a suppressor of motor activity in human organisms. This effect is more dramatic with relatively high-active human subjects than it is for relatively lower-active human subjects. The literature indicates, furthermore, that there is no decrement in performance on a task either by relatively higher-active or relatively lower-active persons due to enhanced environmental stimulation; rather, the usual finding is one of increased effectiveness in performance. The purpose of the present study was to clarify these indications.

Two groups of mentally retarded persons were given the task of recognizing pictures of common objects. High-active and low-active subjects were required to identify these pictures presented tachistoscopically at various exposure times. Each person performed this task under three different conditions: pictures presented with no noise (NN), pictures presented with white noise (WN), and pictures presented with cafeteria (real) noise (CN). The expectations were as follows:

1. High-active and low-active retarded subjects will have different perceptual threshold measures under restricted auditory conditions; specifically, high-active subjects will have lower perceptual sensitivity (higher perceptual thresholds) than will low-active subjects.

2. High-active retarded subjects will have greater perceptual sensitivity (lower perceptual thresholds) under enhanced auditory conditions, regardless of the type of auditory stimulation, than they did under conditions of less auditory stimulation.

3. The effects of either type of enhanced auditory stimulation should not differ from the effects of the remaining type of enhanced auditory stimulation; i.e., there was no reason for making differential predictions about the effects of white noise vs. cafeteria noise.

Method

Subjects

Thirty-six male and female residents from a state institution for the mentally retarded were chosen as subjects. These subjects were selected from an initial pool of 72 residents who had clinically normal hearing and vision. They ranged in CA from 14 to 39 years and were free from severe personality disorders, according to institutional records. Characteristics of the subjects are reported in Table 1.

Table 1

Means and Standard Deviations (SD) of Chronological Ages (CA), Intelligence Quotients (IQ), and Activity Level Scores of Subject Groups

Activity Level	CA		IQ		Activity Scores	
	Mean	SD	Mean	SD	Mean	SD
High	18.39	5.00	56.00	13.72	760.72	95.15
Low	20.61	4.19	60.72	14.23	146.56	104.32

<u>Measurement of Activity Levels</u>

Initially, all 72 subjects were assessed on activity level. In four recording sessions, two in the morning and two in the afternoon, of at least two different days, each subject was seated in a testing cubicle. The cubicle was bare except for a shelf immediately to the left of the chair on which was placed three comic books. The subject was told that the comic books were there for him to view if he so desired. Each subject's activity level was recorded for exactly 5 minutes, on each occasion, by means of an ultrasonic motion detector. The subject's activity level for each occasion was summed by an electromagnetic counter. The time interval for recording activity was controlled by an automatic timer. The four movement scores for each subject were summed, and a mean activity score was obtained. Morning and afternoon activity scores for each subject were summed, and a correlation coefficient of .79 was obtained between these two subtotals.

All subjects were ranked in terms of total mean activity, and the 18 most active and 18 least active subjects, representing the upper and lower quartiles of the distribution of activity level, were selected as the subjects for this study.

The cubicle in which the activity level was assessed measured 5 x 5½ x 8 feet in height. The transmitting (one) and receiving (two) transducers were suspended from the ceiling approximately in the vicinity of the chair in which the subject was seated. When in operation, the apparatus was sensitive enough to emit a pulse for any movement that exceeded a 4-inch movement of one hand in the remote corner of the cubicle; thus, all movements by a subject (e.g., head jerk, leg thrust, etc.) were recorded by means of the counter without any type of restraints upon the subject. Sound level within the cubicle was 40,000 Hz, thus well above the audible range of all subjects.

Apparatus

Activity level was assessed by means of an ultrasonic motion detector (Alton Electronics Company, 1968). This piece of equipment consisted of a high-frequency transmitter which generated a 40,000-Hz sinusoidal electric wave that was converted into sound energy by a resonant ceramic transducer. Two identical resonant ceramic transducers connected to the receiving portion of the system picked up the sound waves and converted them into electric signals. When the transducers are placed in a room, portions of the sound waves emitted from the transmitting transducer travel directly to the receiving transducer, while others are reflected from the walls and objects within the room. By adjusting the sensitivity of the detector, the out-of-phase waves will cancel each other, while the in-phase waves will reinforce each other; thus, the receiving transducers receive sound stimuli, which is then converted into an electrical signal of consistent amplitude. Should an object within the room move, however, the sum of all the phase relations changes, resulting in a change in the amplitude of the received sound wave. This change in the sum of all phase relations is proportional to both the size and velocity of movement within the room, causing the unit to produce rectangular output pulses whose rate and duration correspond to the velocity and size of the movement. The electrical signals were used in the present study to operate an impulse recorder which indicated the sum of a given subject's activity for a 5-minute session.

A standard tachistoscope was used to assess the perceptual threshold of the subjects. Presentation times from approximately 4/1,000 of a second through 1 second were made available through the use of a BRS electric timer and pulse generator. The BRS timer, accurate to 1/1,000 of a second, was used to control the onset and offset of the electric lamp within the tachistoscope.

Subjects viewed pictures of four different common objects (umbrella, knife, hose, and pin) through the tachistoscope. Photographs of these objects were taken from the Verbal Meaning subtest of the revised (1962) Primary Mental Abilities (PMA) test, and were presented to the subjects in a randomized 4x4 Latin Square sequence. All stimuli were chosen carefully to be of approximately the same height and width, thus necessitating the discrimination of detail for identification.

Subjects wore matched earphones (Telephonics, model TDH-39) throughout the experimental procedure. They were presented with three conditions of stimulation: no noise, Gaussian (white) noise, and cafeteria noise. Gaussian noise was previously recorded on Scotch magnetic tape from a random noise generator (Type 1390-A, General Radio Company, Cambridge, Massachusetts). Cafeteria noise presented to the subjects represented a recording from a tape loop played on an Ampex Model 601 recorder (Redwood City, California) which simultaneously recorded the stimuli on Scotch magnetic tape. The original cafeteria noise was obtained from a recording made in the Peabody College cafeteria in which voices were heard, and sounds of chairs scraping and dishes rattling could be discriminated. The recording of these stimuli was distorted by clipping the recorded wave form. This procedure masked any recognizable and distinctive sounds which were ultimately presented to the subjects.

Both Gaussian and cafeteria noise were presented to the subjects from a Wollensak magnetic tape recorder (T-1500) at 80 dB re 0.0002 dynes/cm^2 intensity, as indicated by a Brüel and Kjoer (Type 2203) sound-level meter utilizing a Brüel and Kjoer (Type 4152) artificial ear.

Procedure

From the original pool of 72 subjects, the 18 most active and 18 least active subjects were selected for the present study. The study required the assessment of each subject's perceptual threshold under three conditions of environmental stimulation: no noise, white noise, and cafeteria noise. Subjects from each activity level were randomly assigned to one of the six possible orders of stimulation, with the limitation that each order of stimulation appear equally often in the high-active and low-active groups; thus, all subjects received all three conditions of environmental stimulation, and there were three subjects in each activity level who received one of the possible six orders of stimulation.

Perceptual thresholds of each subject under the three conditions of environmental stimulation were assessed, using a modified procedure of the method of ascending and descending limits (Guilford, 1954). Under each condition the subject was presented four pictures of common objects (pin, hose, umbrella, and knife) at various exposure times, using a tachistoscope. Pictures of the same four objects were taped to the table immediately beneath and in front of the tachistoscope. After each stimulus presentation the subject was required merely to point to the picture he saw. All four pictures were presented at a single exposure time, and the subject was regarded as having successfully perceived the stimulus at the particular exposure time if he had been able to identify three of the four pictures presented correctly.

The four pictures, in a different order, were then presented to the subject at a second exposure time. When the subject failed to identify three of the four pictures correctly, the exposure time was increased by 1 millisecond (in the method of descending limits), and the subject was again presented the four pictures in a different order; i.e., failing to reach criterion, pictures were re-presented at the next higher millisecond speed again. In the method of ascending limits, when the subject actually did reach criterion, the exposure time was reduced by 1 millisecond, and the pictures re-presented, but in a different order. Failing to reach criterion, the speed of presentation was again raised 1 millisecond and the series presented again. Thus, each subject was required to reach criterion at one presentation speed twice before the speed was recorded as his perceptual threshold.

In each stimulus condition 16 perceptual thresholds for each subject were obtained using, alternately, the methods of ascending and descending limits. Such a procedure was employed in an attempt to overcome the variable performance of the mentally retarded and to obtain more stable measures of each subject's threshold under the particular conditions of extraneous stimulation.

Immediately prior to assessing the perceptual thresholds of the subjects, each subject was pretrained on the task, first without earphones and then with earphones. Subjects were presented the four pictures at speeds of approximately 1 second and asked to identify each of the pictures they saw. During this pretraining period, verbal responses were discouraged and pointing responses encouraged. The series of four pictures was presented at least three times to each subject, and more times if required. After successful performance in which the subject was able to identify all four pictures correctly without earphones, each subject was requested to wear the set of earphones and was again asked to identify the pictures presented to him by pointing to their counterparts taped to the table. Instructions were given to the subject via a microphone through the earphones he was wearing. After pretraining, each subject was removed from the testing chamber for 5 minutes before actual testing was begun.

During all conditions of testing subjects wore earphones, and any directions, if necessary, were given to them through a microphone attachment to the tape recorder. After the 5-minute rest interval succeeding pretraining, a subject was returned to the testing cubicle, and his threshold for that particular condition of stimulation assessed. After completing 16 assessments of threshold, the subject was removed from the testing chamber for 10 minutes and then returned for a second assessment of threshold under a different condition of stimulation. The threshold for the third condition of stimulation was assessed in exactly the same manner.

Results

The 16 threshold measurements obtained for each subject under each condition were summed, and a mean threshold response computed for each subject under each condition of stimulation; thus, for each subject three thresholds were obtained: one under the no-noise condition, one under the white-noise condition, and one under the cafeteria-noise condition. Each of these thresholds represented the mean of eight assessments of threshold using the method of ascending limits, and eight assessments of threshold using the method of descending limits. The standard deviation for each subject under each condition was also computed using Sheppard's correction (Guilford, 1954), and the standard error of the mean is reported (in Appendix B) as the estimate of a given subject's variability under each of the three conditions.

The three mean threshold responses for all subjects under each condition were compared in a three-factor design with repeated measures on one dimension (Lindquist, 1953, Type III design). Specifically, high-active and low-active retardates received one of six possible orders of stimulation while threshold measurements were obtained, and all subjects received all types of stimulation: no noise, white noise, and cafeteria noise, i.e., a 2x6x3 matrix. The orders of stimulation are presented in Table 2.

Table 2

Experimental Conditions in Determining

Threshold Responses for Subjects

Order	Sequence of Stimulus Presentation		
	First	Second	Third
1	NN	WN	CN
2	WN	CN	NN
3	CN	NN	WN
4	NN	CN	WN
5	WN	NN	CN
6	CN	WN	NN

Note.--NN indicates no noise; WN indicates white noise; CN indicates cafeteria noise.

The mixed-effects analysis of variance yielded data indicating no main effects for activity level, order of stimulation, or types of stimulation, as shown in Table 3. The analysis did yield a significant ($p<.05$) interaction, the order by type of stimulation condition; i.e., perceptual thresholds for subjects' recognizing common objects under three types of stimulation varied differently as a function of the order in which the different types of stimulation were presented. See Table 4. A graphic representation of this interaction is presented in Figure 1.

Table 3

Means and Standard Deviations (SD) of Perceptual Threshold Determinations, in Milliseconds of Exposure Time, for the High-Active and Low-Active Groups under Three Stimulation Conditions

Activity Level	Stimulus Condition	Mean	SD
	No Noise	13.57	4.48
High	White Noise	14.37	5.20
	Cafeteria Noise	16.74	11.14
	No Noise	16.31	8.44
Low	White Noise	19.89	7.54
	Cafeteria Noise	19.04	12.95

The simple effects for the significant order by type of stimulation interaction were obtained after collapsing over activity levels because there was no significant main effect for activity nor a significant interaction involving activity. Duncan's new multiple range test (Edwards, 1964) was used to compare the 18 cell means with each other. Each cell thus represented six subjects at one level of stimulation, in one order. As there were six orders of stimulation, each with three types of stimulation, two groups of six subjects each

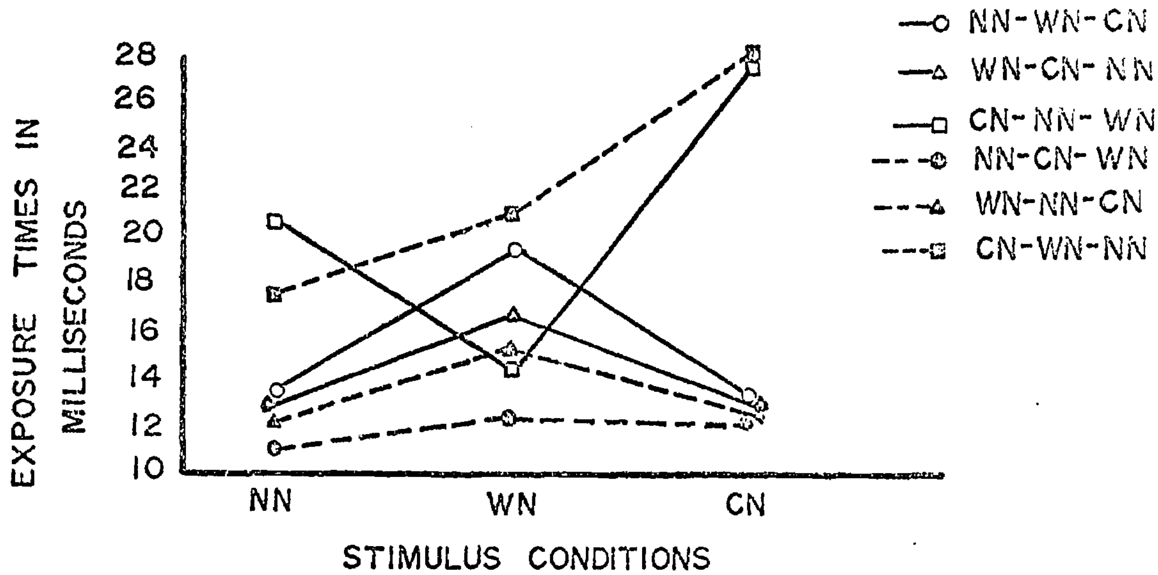
Table 4

Analysis of Variance Summary Table: Mean Perceptual Thresholds as a Function of Activity Levels, Stimulation Conditions, and Orders of Presentation

Source	*df*	Mean Square	*F*
Between Subjects	35		
B (Activity)	1	274.56	1.39
C (Order)	5	282.42	1.43
B x C	5	29.65	.15
Error (between)	24	197.28	
Within Subjects	72		
A (NN, WN, CN)	2	79.24	2.20
A x B	2	12.47	.35
A x C	10	82.45	2.29*
A x B x C	10	25.94	.72
Error (within)	48	35.95	
Total	107		

Note.--NN indicates no noise; WN indicates white noise; CN indicates cafeteria noise.
*$p<.05$.

received each type of stimulation initially, secondly, or finally, but only one group of six subjects received any one of the six possible combinations of the three types of stimulation. These comparisons are shown in Table 5.



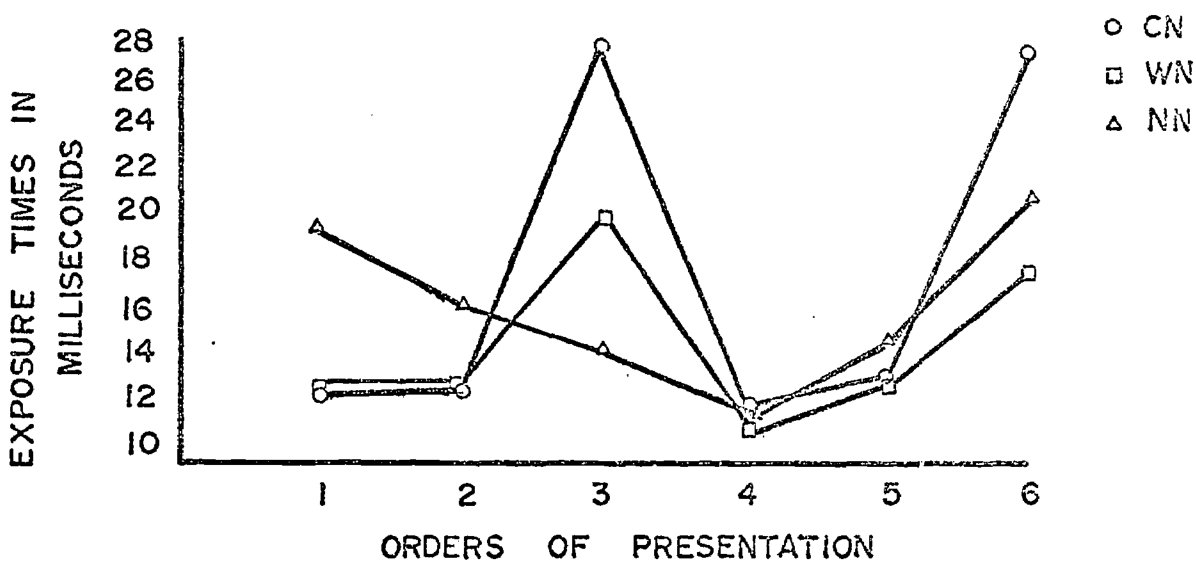


Figure 1. Mean Exposure Times as a Function of Stimulus Conditions and Orders of Presentation.

Table 5

Duncan's New Multiple Range Test of Least Significant

Differences: Cell Mean Comparisons

	Order:	4	4	4	1	2	2	5	5	1
	Stimulus:	NN	CN	WN	NN	CN	NN	CN	NN	CN
	Means:	11.23	12.61	12.68	13.06	13.27	13.32	13.46	13.55	13.65
11.23			1.38	1.45	1.83	2.04	2.09	2.23	2.32	2.42
12.61				.07	.45	.66	.71	.85	.94	1.04
12.68					.38	.59	.64	.78	.87	.97
13.06						.21	.26	.40	.49	.59
13.27							.05	.19	.28	.38
13.32								.14	.23	.33
13.46									.09	.19
13.55										.10
13.65										
14.38										
15.43										
16.58										
17.95										
19.63										
20.51										
21.07										
27.17										
27.22										

Table 5 (continued)

Order:	3	5	2	6	1	3	6	6	3		
Stimulus:	WN	WN	WN	NN	WN	NN	WN	CN	CN		
Means:	14.38	15.43	16.58	17.95	19.63	20.51	21.07	27.17	27.22	Range[a]	
11.23	3.15	4.20	5.35	6.27	8.40	9.28	9.84	15.94*	15.99*	10.92	R2
12.61	1.77	2.82	3.97	5.34	7.02	7.90	8.46	14.56*	14.61*	11.50	3
12.68	1.70	2.75	3.90	5.27	6.95	7.83	8.39	14.49*	14.54*	11.85	4
13.06	1.32	2.37	3.52	4.89	6.57	7.45	8.01	14.11*	14.16*	12.12	5
13.27	1.11	2.16	3.31	4.68	6.36	7.24	7.80	13.90*	13.95*	12.35	6
13.32	1.06	2.11	3.26	4.63	6.31	7.19	7.75	13.85*	13.90*	12.51	7
13.46	.92	1.97	3.12	4.49	6.17	7.05	7.61	13.71*	13.76*	12.66	8
13.55	.83	1.88	3.03	4.40	6.08	6.96	7.52	13.62*	13.67*	12.78	9
13.65	.73	1.78	2.93	4.30	5.98	6.86	7.42	13.52*	13.57*	12.85	10
14.38		1.05	2.23	3.57	5.25	6.13	6.69	12.79*	12.84*	12.93	11
15.43			1.15	2.52	4.20	5.08	5.64	11.74	11.79	13.01	12
16.58				1.37	3.05	3.93	4.49	10.59	10.64	13.08	13
17.95					1.68	2.56	3.12	9.22	9.27	13.16	14
19.63						.88	1.44	7.54	7.59	13.20	15
20.51							.56	6.66	6.71	13.24	16
21.07								6.10	6.15	13.28	17
27.17									.05	13.32	18
27.22											

*$p < .05$.

[a]Shortest significant range; $p < .05$, $df = 60$.

The results of all possible comparisons of cell means indicated the following:

1. Mean threshold measures for subjects initially receiving cafeteria noise were significantly higher than mean threshold measures for subjects who initially received no noise.

2. Mean threshold measures for subjects who initially received white noise did not differ significantly from mean threshold measures of subjects who initially received no noise, and did not differ significantly from threshold measures of subjects who initially received cafeteria noise. Thus, cafeteria noise, when initially presented, had the highest disruptive effect upon threshold measures; no noise, initially presented, had the least disruptive effect upon threshold measures; mean threshold responses for subjects initially receiving white noise fell between the two previously mentioned means.

3. Mean threshold measures for subjects who received cafeteria noise in other than an initial presentation were significantly lower when compared with mean threshold measures of subjects who received cafeteria noise initially. Further, threshold measures for subjects receiving subsequent cafeteria noise did not differ significantly from threshold measures for subjects who received no noise in their initial presentation.

4. Mean threshold measures of subjects who received white noise as their initial presentation did not differ significantly from threshold measures of subjects who received subsequent white noise, and threshold measures of subjects who received subsequent white noise did not differ significantly from threshold measures of subjects who received either initial or subsequent no noise.

5. Threshold measures of subjects receiving no noise did not differ significantly from threshold measures of subjects receiving no noise in a subsequent presentation and, also, did not differ significantly from threshold measures of subjects receiving either initial or subsequent white noise, or of subjects who received subsequent cafeteria noise.

Discussion

The expectations of the present study were not realized. High-active and low-active mentally retarded persons did not differ in perceptual threshold measures under the restricted auditory conditions. Furthermore, there were no significant differences between all of the possible comparisons of level of activity with the other dimensions of this study and all their associated interactions. High-active subjects did not have greater perceptual sensitivity under enhanced auditory conditions when threshold measures were compared with measures obtained under restricted conditions. With the exception of initially presented cafeteria noise, there was no significant difference in perceptual sensitivity under restricted auditory stimulation when compared with enhanced auditory stimulation for both groups. The effects of different types of enhanced auditory stimulation did indeed differ significantly from each other when initial presentations of white noise and cafeteria noise were compared with initial presentations of no noise. Initial threshold measures obtained under cafeteria noise significantly differed from measures obtained under no noise, but initial threshold measures obtained using white noise did not differ significantly from initial threshold measures obtained using no noise.

The effect of stimulation upon the behavior of hyperactive children and high-active mentally retarded children has, perhaps, been too simply drawn. For Strauss and his colleagues (Strauss & Kephart, 1955; Strauss & Lehtinen, 1947), the hyperactive child is seen as a hypervigilant organism, unusually sensitive to environmental stimulation. For Gellner (1959) and Zaporozhets (1957, 1960, 1969), the hyperactive child is seen as a person who, because of a dysfunctional nervous system or because of lack of previous learning, is unable to react to auditory and visual stimuli as his peers do. The possibility that environmental stimuli of different physical characteristics, but within the same modality of perception, may have different behavioral consequences is not adequately considered by these three theorists.

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If task performance becomes more effective or behavior less active in the presence of stimulation, the results are interpreted as offering no support for the notions of Strauss and his colleagues, and, by inference, support for the notions of Gellner and Zaporozhets. If the contrary condition should obtain, then such results would be interpreted in the contrary fashion as well.

The present study demonstrated that different types of stimulation within a given perceptual modality have different effects upon behavior. Although threshold measures obtained under white-noise stimulation were found to be statistically no different from threshold measures obtained when subjects were presented with a no-noise condition, threshold measures obtained under cafeteria noise were found to be significantly different from threshold measures obtained under the no-noise condition. The present study demonstrated further that the administration of a stimulus which had an initially disruptive effect upon behavior did not have such an effect if presented later in the series. For example, threshold measures obtained initially while under cafeteria noise were significantly different from threshold measures obtained under cafeteria noise which was subsequently presented, and only threshold measures of cafeteria noise initially presented differed from measures obtained under the no-noise condition. Thus, not only did some types of stimulation have no deleterious effects upon performance (in this case, white noise), but also the same type of stimulation which originally did have a deleterious effect upon performance no longer had such an effect.

Any view of environmental stimulation that attempts to account for human performance and activity level in terms of the presence or absence of stimulation in general, or in terms of the characteristics of the stimuli under consideration alone, is inadequate and cannot account for the findings in the present study. Only a relativistic view of stimulation appears to the present author to be adequate to account for the findings of the research previously cited and for the findings of the present study. Parameters for such a relativistic view of stimulation appear to include not only the physical characteristics of the stimulation itself, but also the prior experience of the organism and, perhaps, the specific task under consideration. Such a view of stimulation ultimately may prove useful in explaining the effects of stimulation upon the behavior and task performances of the two groups of children who have so long concerned researchers, the hyperkinetic and the mentally retarded.

Turner (in press) reported evidence to support the position that the effects of a particular type of stimulus are different for children of different ages. Belmont and Ellis (1968) reported evidence to support the position that the effects of the same stimulus are different when subjects were in a familiar testing situation than when subjects were in an unfamiliar testing situation. These efforts appear to offer promise for the view of stimulation suggested in the present study. Turner (in press) chose to manipulate the age dimension, which such a new view on stimulation seems certain to require. Belmont and Ellis (1968) ignored age but found that time spent in the task had a significant effect on whether "meaningful" pictures enhanced or disrupted performance.

Studies which have been concerned only with the effects of presence or absence of stimulation on task performance or activity level have been necessary to indicate that the effect of stimulation is not a simple problem. After that need has been indicated (and it has, amply so), the usefulness of such studies decreases dramatically. Specifically, the present author suggests that the time for studies that merely present a general type of stimulation as the variable in an experiment is past, and the time is present for studies that systematically vary the physical characteristics of the stimulus while at the same time systematically taking into account the prior experience of the organism, both in terms of his past exposure to stimulation under study and the different duration times it is presented, as well as other factors (e.g., age, intelligence, motivation). Researchers in this area should no longer attempt to support through their research efforts simple positions on a question which has been amply demonstrated to be quite complex by the studies to date.

An adequate theory which attempts to explain the effects of stimulation upon the behavior of hyperkinetic and mentally retarded persons must explicitly take into account at least the following variables: the age of the person; the physical characteristics of the stimulus itself, as well as the duration of presentation; the past experiences of the subject, which should include not only his familiarity with the specific task but also his familiarity with the specific stimulus presented. The contribution of the present study to such a theory of stimulation has been to demonstrate specifically the different effects of a given stimulus on the performance of a specific task, and to emphasize the importance of sequential relationships in the presentation of different qualities of stimulation. A particular quality of stimulation may have quite different effects on performance, depending upon its sequential relationship to other types of stimulation in the organism's recent experience. Without consideration for the interactive effects of the physical characteristics of the stimulus, its duration, and the past sequential experiences of the person, support for any or all three theoretical positions (Strauss, Gellner, & Zaporozhets) may be found in isolated studies; thus, such studies appear to be of limited utility.

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APPENDIXES

APPENDIX A

REVIEW OF THE LITERATURE

REVIEW OF THE LITERATURE

The intention in the present study was to investigate the relationships between changes in the environment and activity level, as well as the effects of changes in the environment and activity level upon task performance. Relevant literature involves the various theoretical models related to activity level, experimental studies investigating the relationship between environmental stimulation and activity level, and also studies of human behavior indicating the effects of environmental manipulation and motor activity upon the performance of certain clearly defined tasks. Specifically, though not exclusively, the present study was intended to add to the growing body of literature concerned with retarded children and the large group of children who have been called, variously, "minimally brain damaged," "hyperactive," "Strauss syndrome," or "psychoneurologically disordered" (Dunn, 1968), and who frequently display exceptionally high motor activity as one of their major behavioral signs, as well as a common inability to learn as efficiently as their peers in a normal classroom setting. Ultimately, of course, it is hoped that through the use of knowledge gained by studies of this type, new and improved techniques of teaching can be developed which may at least lessen the learning deficits found in children who have been defined as either hyperactive or retarded or both.

Definitional Problems of Activity and Hyperactivity

Activity, per se, is a hypothetical construct, and, as the term is usually used, it refers to "processes or entities that are not directly observed . . . a 'something' which has a host of causal properties (McCorquodale & Meehl, 1948, pp. 103-105)." For excellent reviews and suggestions concerning the "host of causal properties" see Baumeister, Hawkins, and Cromwell (1964) for the relationship between activity and need states of the organism, as well as a critical evaluation of such concepts; Hunt (1963), Miller, Galanter, and Pribram (1960) and Pribram (1967) for the relationship between activity and incongruity; Kagan, Rosman, Day, Albert, and Phillips (1964) for informational processing aspects of the environment and children's attitudes; and Berlyne (1967) for relationships between activity and arousal level.

Definitions of activity are dependent upon the methods used in arriving at this construct, and these methods have been variable both across studies and among investigators. As Cromwell, Baumeister, and Hawkins (1963) have indicated, the problem of precise definition is most difficult.

> If activity were defined in terms of position in space, the large or heavy subject and the small or light one would yield the same amount of activity in shifting from one point to another. On the other hand, if activity level were defined in terms of energy or work output, the large, heavy subject has displayed more activity in this unit shift of position. Moreover, if one defines activity level in terms of energy output, oxygen, or

> caloric consumption, or electrical activity in efferent nerves, the shift of position in space may have only gross inferential value. Finally, if activity were to be defined in terms of achievement or end product, the measurement would exclude irrelevant motion (pp. 632-633).

The authors (Cromwell et al., 1963), therefore, have concluded that activity is merely a generic term and that no integrated set of laws will be formulated that will usefully convey everything which has been included in activity.

Definitional problems of activity are not only difficult to overcome but are also compounded when one is faced with children who have been variously labeled "hyperactive," "hyperkinetic," "brain damaged," "perceptually impaired," "Strauss syndrome," "psychoneurologically disordered," etc. (Dunn, 1968), with the major presenting behavior of "overactivity" and a common inability to learn as well as peers. In a more phenomenalistic vein, these children have been described as children with short attention span, restlessness and overactivity, poor judgment and impulsive action, poor perceptual and conceptual abilities, defective memory, poor muscular coordination (Burks, 1960); hyperactive and easily distracted, having a short attention span, emotionally labile, easily frustrated, impulsive (Menkes, Rowe, & Menkes, 1967); hyperactivity, short attention span, distractibility, impulsivity, lack of inhibition and control (Schrayer, Lindy, Harrison, McDermotte, & Wilson, 1966); "with hyperactivity as the most striking item (p. 38)," short attention span, poor powers of concentration, unable to tolerate any delay in the gratification of their needs and demands, irritable, explosive, and with low frustration tolerance (Laufer, Denhoff, & Solomons, 1957); unpredictable performance, explosiveness with wide fluctuations, and exaggerated response to external stimuli (Klinkerfuss, Lange, Weinberg, & O'Leary, 1965); and as children who talk incessantly, constantly interrupting the class with irrelevant remarks and bothering other children by knocking things off their desks, hiding their pencils, and hitting them on the head (Dunn, 1968).

The difficulties in this area of research are compounded even further by variabilities of opinions in the literature as to whether children with the various labels of psychomotor dysfunction do, in fact, differ with regard to activity level. McConnell, Cromwell, Bialer, and Son (1964), using a triple blind technique, had 57 retarded children (CAs 6-2 to 15-1; mean CA=11-9) rated by four ward attendants using a 10-item Child Rating Scale made up of terms most frequently used in describing the syndrome of hyperkinesis. Three independent ballistographic measurements, once during each week, were also obtained for these same subjects. Each subject, used as his own control, was then submitted to a 3-week period of drug treatment, which had no statistical effect either on the ballistographic measurements or on the behavioral ratings by ward attendants. Ballistographic measurements were reliable when compared with repeated administrations of the same instrument (r=.81 and r=.86, respectively, after 1 week). These two methods of assessing activity level, however, were not significantly related to each other (.20 being the average correlation between all ballistographic measures and all rating scale measures). These authors concluded that: "It seems clear that what is ordinarily described as hyperkinesis involves much more than body movement. It is often a social term which calls for a definition based on the acceptability of certain behaviors in specific situations (p. 650)."

McFarland, Peacock, and Watson (1966) assessed the activity levels of retarded and nonretarded children using an ultrasonic apparatus which emitted sounds into a room above the auditory thresholds of subjects. When movement within the room occurred, the sum total of all sounds and echoes within the room would change, activating an impulse counter. Thirty retarded children, 10 with the diagnosis of mongolism, 10 with the diagnosis of familial mental retardation, and 10 with the diagnosis of prenatally acquired organic brain damage, were compared with 10 children of normal intelligence. The authors found that the three groups of retarded children did not differ significantly from each other in terms of total activity level, but that the children in the normal group were significantly more active than were those in the three retarded groups. These authors concluded that, though 9 of the 30 retarded children were rated hyperactive and none of the normals were so rated by their parents, such ratings may be more in terms of the social nature of activity than in terms of some objective assessment.

Buddenhagen and Sickler (1969) reported a 48-hour sample of activity by a 13-year-old mongoloid girl who had been institutionalized since the age of 5 years. The child, Bonnie Jean, had been consistently labeled "hyperactive" by professional personnel, but an analysis of the behavioral record which was accumulated over a 5-day period indicated that "in this particular case, the label of hyperactivity served as a euphemism, describing behaviors which might more properly have been regarded as annoying and encumbering to attending personnel (p. 580)." These authors emphasized the need to identify the parameters of the specific behavioral responses of individuals that, when taken together, elicit the label of hyperactivity.

Zuk (1962) has suggested from his observations that the high level of distractibility frequently seen with retarded children is not due to the inability of the child to pay attention but due to the child's overattention to moving stimuli; thus, the seemingly random activity so frequently reported is actually activity maintained to keep in focus the moving stimuli within the environment of the child. Zuk distinguishes between two levels or types of distractibility:

those behaviors found in individuals believed to have a mental age of between 12 and 18 months in which the whole body is engaged in various movements, and those behaviors found in individuals between the mental ages of 18 and 24 months in which the behavior seen is more "segmented"; i.e., these children tend to explore their surroundings "more with fingers than hands, more with hands than arms and shoulders," while the rest of the body remains relatively inactive. Kulka, Fry, and Goldstein (1960) put forward an hypothesis that there exists a kinesthetic drive or need, separate and distinct from other drives. Their orientation stems primarily from the psychoanalytic position, and by the term kinesthetic they mean all incoming stimulus modalities. These authors postulated that it is through motility that there is a discharge or release of tension which has occurred. When this hypermotility occurs in older children, it represents a regression or fixation at an earlier level of development. Schaffer (1966), on the other hand, suggested that activity level is probably a constitutional factor that is relatively independent of maternal and environmental influences.

Primarily concerned with the various suggestions in the literature that the hyperactive child may not be more active than normal children, but merely that his behavior is less socially acceptable, Tizard (1968) undertook two studies (classroom studies I and II) in which she systematically assessed the activity level of severely retarded children with nurses' ratings, behavioral checklist ratings, and by an objective photoelectric device. Furthermore, she assessed these children under two types of conditions: in a social situation which consisted of classroom behavior, and in an experimental room. Because her studies bear so crucially on the definitional problem of hyperactivity, they will be reported in detail.

Forty-six children between the ages of 8 and 10 years living in a residential hospital for severely subnormal children were rated in terms of their activity by two teachers and two ward nurses. The raters were given a description of overactivity--"A very overactive, restless child who is hardly ever still; he is always jumping up and down and running around (p. 541)"--and asked to indicate the degree to which such a description applied to each child (did not apply, applied somewhat, certainly applied). Ten children were considered "very overactive" by all four raters, though 18 had been considered "very overactive" by one or the other of the teachers and 16, by one or the other of the ward nurses. Nine of the 10 children considered "very overactive" by all four raters became the experimental group. The control group was made up of 11 children who were judged "not overactive" by two or more of the raters and "somewhat overactive" by the remainder of the raters. All but three control group subjects had only estimated IQ scores of approximately 20, while the three control group children had assessed Stanford-Binet IQ scores of 30, 34, and 39, respectively.

The author and her assistant then undertook an objective, observational analysis of both experimental and control group children on 5 consecutive mornings for 2-hour periods of time. The children were observed in a social setting, classroom or ward for two children who had been excluded from school, for a period of 5 weeks. The initial period was spent in adapting the children to the presence of the observers. Teachers were told that the study was concerned with all of the children in class in order not to influence their behavior toward either control or experimental subjects. Children were observed in groups of six, some of whom were neither control nor experimental subjects. Each child was observed in alphabetical turn for 1 minute. During the four 15-second intervals the observer recorded whether one of eight possible behavioral events occurred or did not occur; thus, during the 2-hour period each child in the study was observed for approximately 10 minutes. Over the period of 5 days there were over 200 assessments of the child's activity.

All subjects, one at a time, were then taken to a 12-foot by 8-foot room and tested for activity for 5-minute periods on 4 consecutive days. On 2 of the 4 days there was only a chair in the room, and on 2 of the days toys were included. An assistant, with whom the children were acquainted, was also seated in the room on all 4 days, but she paid no attention to the particular child and was present only to insure against the child's becoming exceedingly frightened in a totally new situation. Overall movement was assessed by means of photoelectric cells placed about the room which activated an impulse counter whenever the light beam was broken by the child. An observer, standing behind a one-way vision screen, recorded the type of activity in which the child engaged.

From the study in which the activity level of previously assessed overactive children were compared to previously assessed not overactive children in a social situation, Tizard found that the overactive group did indeed differ in terms of overactivity from the not overactive group when assessed by an objective behavioral checklist. Even when the three "high" IQ controls (30-39 on Stanford-Binet) were not considered, the "very overactive" group differed significantly from the "not overactive" group in favor of the former ($t=3.37$, $p<.01$). The type of activity displayed was markedly stereotyped in behavior, and as a group the children were not more aggressive than the control group; rather, they made significantly fewer friendly approaches ($t=2.18$, $p<.05$) and received significantly fewer approaches from others ($t=2.17$, $p<.05$). Tizard described these findings as a "tendency toward social isolism" that was displayed by this group even though they were totally more active than their controls.

From the study in the laboratory setting, Tizard found that when two subjects' scores were not considered (one usually overactive boy who stood motionless by the door over the 4 days while in the small experimental room, and one control subject who ran continuously about the room for one entire 5-minute period), there was again a significant difference in overall movement between the previously assessed overactive and not overactive groups in favor of the overactive groups ($p<.001$). The activity level on this occasion was assessed by photoelectric cells alone. She also found a significant correlation between overall movement scores as assessed by means of the photoelectric cells and classroom observation scores assessed by the checklist technique ($r=.62$, $p<.01$). Finally, though stimulus variation (toys vs. no toys) had no significant effect on total movement scores, when activities were classified into categories (using toys, exploring the environment, sitting or standing, apparently aimless locomotion, and rocking or head banging), there was a difference in terms of kinds of activity for both groups. The introduction of toys caused a "major redirection of activity in both groups (Tizard, 1968, p. 550)." Activities judged to be aimless locomotion and self-stimulating, e.g., rocking, head banging, and thumb sucking, were greatly reduced for both groups.

Tizard has demonstrated that children judged hyperkinetic by others did indeed differ significantly in terms of movement when assessed by a behavior checklist, as well as when assessed by more "objective" photoelectric devices. Furthermore, she has demonstrated that this excess of activity occurs not only in a social setting, but under a restricted laboratory environment as well. Finally, though statistical evidence is lacking, different environmental stimuli seem capable of eliciting qualitatively different behavior, though there may be no decrement in the overall activity level of the child.

Theoretical Rationale

Cromwell, Baumeister, and Hawkins (1963) and Cromwell (1963) have reviewed seven theoretical positions with regard to activity level. Of these seven positions there are three important, though largely rational, theories which attempt to account for the high activity levels found in children with learning deficits. Each of these three theories--Strauss, Lehtinen, and Kephart (Strauss & Kephart, 1955; Strauss & Lehtinen, 1947), Gellner (1959), and Zaporozhets (1957, 1960, 1969)--attempt to account for high behavioral activity from different perspectives, and thus may be heuristically valuable in the formulation of a more comprehensive theory of learning.

Strauss, Lehtinen, and Kephart hold that:

> The brain-damaged organism, as we know, is abnormally responsive to the stimuli of his environment, reacting

> unselectively, passively, and without conscious intent. When such a hypervigilant organism--one whose reactibility is beyond his control--is placed in a situation of constant and widespread stimulation, he can only meet the situation with persistent undirected response (Strauss & Lehtinen, 1947, p. 129).

For these authors, essentially, there is a cycle from the time the organism is stimulated until the time he makes an overt response. The organism receives environmental stimulation via his sense organs, organizes the stimuli into a meaningful pattern, considers the pattern in terms of his own individual needs, chooses an appropriate behavior in response to the stimuli, and finally acts out the behavior through the skeletal muscles. For any person who is neurologically impaired, however, there is a disruption of this normal sequence of events, and the energy which is normally allotted to each stage is not totally utilized; thus, when the final overt response does occur, the excessive energy makes the overt behavioral response explosive in nature. Others interpret this explosive way of behaving as hyperactive and highly distractible.

A direct prediction from the Strauss, Lehtinen, and Kephart theory is that increasing environmental stimulation increases the activity level and the distractibility of the brain-injured child. Strauss's whole educational and management approach has been to reduce environmental stimulation. Strauss and his colleagues recommend an undistracting school environment with pupils screened off from each other, facing the wall, and taught by a teacher whose dress is plain and who is free from all ornaments.

Gellner (1959), on the other hand, has suggested that the highly active person is highly active not because he is receiving too much environmental stimulation, but because he cannot react "meaningfully" and "appreciatively" to visual and auditory stimuli. Gellner believes that the midbrain, specifically the superior and inferior colliculi of the tectum, is dysfunctional in mental retardation. Furthermore, she believes that four classifications of behavioral impairments can be made: visual motor defect, auditory motor defect, visual autonomic defect, and auditory autonomic defect. It is these last two classifications, visual autonomic and auditory autonomic, that are directly germane to the present investigation. As Cromwell et al. (1963) have pointed out, the inability to "appreciate emotionally" or to respond "meaningfully" to visual and auditory stimuli suggests that a child will compensate by getting as much kinesthetic, tactual, and proprioceptive stimulus input as possible. The possible prediction from Gellner's position, then, would include the possibility that increased environmental stimulation, whether it be visual or auditory, should, in part, overcome the organism's inability to "appreciate emotionally" or respond "meaningfully" to such stimuli, and thus decrease the need for compensation in terms of kinesthetic, tactual, or proprioceptive modes. Such a position, of course, is diametrically opposed to the prediction made from the position of Strauss and his colleagues.

Finally, Zaporozhets (1957, 1960, 1969), a Russian psychologist, has described a developmental, reorganizational process in the growth of a child. For Zaporozhets's position, Cromwell et al. (1963) have indicated that at a very early age the child displays much motor activity, which forms the basis of the motor-touch associations the child has with his environment. As the child grows older, visual associations develop, using the former motor-touch associations as their base. At this stage a child no longer has to come into direct contact with the objects in order to respond to them. Finally, a transition is made so that word associations, as well as sensory associations, also develop. In more recent work, Zaporozhets (1969) has not only implied his original position, but has emphasized the need for training in the various sense modalities of the child in order that higher mental function may occur. He posits that Western psychologists have erred in their belief that basic sensory abilities exist from birth and that, in fact, Soviet preschool educational theory "regards sensory development as the development of new processes and abilities that a child does not have at birth but which he acquires under the influence of an active program of instruction (p. 89)." Originally, in the normal child, the organism is equipped only with some of the prerequisites for sensory development, but training and experience are necessary to develop "distinctively human" sensory abilities. This training and experience is usually acquired only haphazardly and incidentally by most children, particularly those from the West where the need for such an approach is not recognized; yet, it is only after the mastery of these earlier stages of sensory and perceptual development has been completed that fundamentally new reorganizations can occur to allow for the higher mental processes to develop. He states: "The development of mental processes begins with certain external operations that an individual performs with objects. Subsequently, given certain conditions, this process acquires an orienting, cognitive function which, once it has undergone a series of changes and becomes contracted, is ultimately converted into an internal operation, one that takes place on the plain of ideas (Zaporozhets, 1969, p. 116)." Again, as Cromwell et al. (1963) have asked, what could one expect to occur either due to neurological impairment or (in Zaporozhets's later formulation) lack of adequate training? The child would continue to depend upon motor-touch associations or "external operations" in order to react to external stimuli. Thus, at an earlier age the type of behavior engaged in by the child would appear quite normal, while this same behavior, i.e., motor-touch behavior or "external operations" upon stimuli in the environment, would be interpreted as hyperactive or distractible at a later age when the child is compared to his peers.

In summary, with Zaporozhets's position as with Gellner's position, and opposed to the Strauss, Lehtinen, and Kephart position, high behavioral activity levels are not explained in terms of too much environmental stimulation, but rather as an inability to utilize properly certain modes of stimulation. Conceivably, then, by increasing environmental stimulation one could expect a decrease in the activity of highly active individuals. One might also expect better task performance and more efficient learning to occur under the conditions of enhanced environmental stimulation and the obverse to obtain under the very conditions laid down by Strauss and his associates as the recommended school environment.

Review of Relevant Research

The primary emphasis of this review of research is in terms of the effects of environmental change on the activity level and task performance of mentally retarded, hyperactive children. Because the various theoretical positions reviewed posit neurological dysfunction as causal in hyperactive individuals, research indicating the plausibility of such a position is included. Studies on activity level and environmental stimulation, studies on the effects of environmental stimulation and task performance, and studies on the effects of differing environments on stereotyped behavior are included in the remainder of the review.

Physiological Correlates of Hyperactivity

Klinkerfuss, Lange, Weinberg, and O'Leary (1965) attempted to establish at least some commonalities among the heterogeneous group of children who present excessive undirected motor behavior as their major symptom. These authors began their study by examining the records of 782 children referred to the "Hyperactive Clinic" of St. Louis Children's Hospital in 1963 and 1964. All children presented at least some of the usual criteria of the hyperkinetic syndrome and were examined by a pediatrician, a neurologist, and often a psychiatrist. From the results of these examinations, 277 children were excluded because they displayed symptoms of psychosis, severe neurosis, marked mental deficiency, recent head trauma, or acute encephalitis. Eighty-seven children were excluded because they were less than 4 years old, and the authors did not wish to have their study confounded by the possibility that hyperkinesis might be considered to be "normal" in 2- and 3-year-old children. Finally, 65 children were excluded on the basis of either unsatisfactory electroencephalographic (EEG) tracings or the absence of them. The final population, 353 children, was divided into two groups: the first group consisted of those children (N=60) with hyperkinesis and a known neurological disease (e.g., birth injuries, convulsions, etc.) or definite neurological signs (e.g., aphasia, hemiparesis, etc.); the second group (N=293) consisted of those children diagnosed with hyperkinesis alone, having no known neurological diseases and with normal neurological examinations.

Waking EEGs were obtained for all children from bipolar recordings of needle electrodes placed over the frontal, temporal, vertex, and occipital areas. All EEG recordings were examined by two of the authors, independent of each other, with only the age of the child available. The information from these tracings was in terms of the presence or absence of occipital frequency abnormalities or focal abnormalities. Dysrhythmias and paroxysmal sequences were classified as mild, moderate, or severe; thus, EEG tracings were analyzed for fast, slow, paroxysmal, and focal features.

Results of the final tabulation by two independent interpreters indicated that 92 percent of the hyperkinetic children with known neurological diseases and normal neurological examinations had either borderline or abnormal EEG tracings; however, 53 percent of the first group had severely disordered tracings, while only 30 percent of the second group had the same type of tracings. Thus, there was no statistical difference (χ^2 test) between the two groups when both borderline and abnormal EEG tracings were considered, but a statistically significant difference in favor of those children with hyperkinesis and known neurological disease did occur when only severely disordered tracings were compared.

In both groups, significantly more tracings showed slow activity than was true for paroxysmal or focal abnormalities.

The authors concluded that slowed activity is the outstanding feature of the hyperkinetic EEG (first group, 43 percent marked or moderate and 48 percent mild; second group, 23 percent marked or moderate and 61 percent mild slowing). Though abnormally slow frequencies have been attributed previously to delayed maturation, brain damage, and genetic determination, in the present study using children between the ages of 4 years and 16 years, the percentage of incidence did not increase or decrease as a function of age among children who had hyperkinesis as their common symptomatology.

Using electrographic recordings, Hernandez-Peon (1966) reported on a series of studies using normal and mentally retarded subjects with regard to attention. He and his colleagues, using electrodes implanted in the optic radiations, found that in normal subjects potentials evoked by flashes of light were reduced when subjects were engaged in conversation, asked to solve arithmetic problems, or remember some past event; thus, Hernandez-Peon concluded that subcortical sensory inhibition appears to be a pervasive phenomenon accompanying all varieties of attention. Using a photoelectronic technique which averages a given number of evoked responses, thereby bringing out a specific response from random background activity, Hernandez-Peon and Aguilar-Figueroa (cited in Hernandez-Peon, 1966) were able to obtain the same result from evoked potentials from the scalp without penetrating the brain. In this last case, the stimuli consisted of single rectangular pulses applied to the skin of the forearm of normal subjects, and the recording electrodes were located on the contralateral side of the head over the perirolandic area. These investigators found somatic-evoked potentials either reduced or abolished when subjects were engaged in conversation or were asked to solve an arithmetic problem. When tactile stimulation was regularly continued over a period of time, the evoked potentials progressively diminished. Using mentally retarded subjects, however, the investigators found that maximal reduction or enhancement of evoked potentials to tactile stimuli (when extremely simple directions were given directing the subject's attention either away from or toward the stimulus) occurred with a latency of approximately 40 seconds. They found further that these evoked potentials, though exceedingly small at first, progressively increased in magnitude, rather than decreased, when the tactile stimulation was regularly and monotonously continued. This led Hernandez-Peon to conclude that mentally retarded subjects seemed to have "unimpaired subcortical inhibitory and facilitory mechanisms for sensory filtering but deficient corticoreticular mechanisms involved in triggering and maintenance of attention (1966, p. 192)."

Drawing from lobotomy studies and his own work with chemical crystals implanted directly into the brains of animals, Hernandez-Peon postulated that corticofugal projections arising in the frontal lobes and descending into the reticular system are most importantly involved in attention; thus, he concluded that "adequate activation of these corticoreticular projections should induce a state of sustained attention upon objects otherwise incapable of attracting attention for prolonged periods (1966, p. 192)," and that chemical stimulation may eventually be found to provide a method of improvement in the control of attention among mentally retarded subjects.

At least inferential support for Hernandez-Peon's concept of increased stimulation for improvement in attending processes can be found in the work of Furster (1958). Using monkeys, Furster trained the animals to discriminate between a pair of objects by placing food under one of the objects. He then implanted electrodes in the brains of these animals, at the level of the mesencephalon, through which electric current could be induced. Specifically, this area was histologically verified as being the rostral part of the brain stem activating system, mostly composed of the reticular formation of the midbrain tegmentum. Using a tachistoscopic apparatus that exposed the pairs of objects for only short periods of time, Furster found that stimulation consistently increased the animals' efficiency at discrimination as indicated by both higher percentages of correct responses and shorter reaction times. Each animal was used as his own control. Furster found that both "perceptual and motor processes" involved in tachistoscopic discrimination were facilitated by stimulation of the reticular activating system with weak electric stimulation. Stimulation through the same electrodes using intensities higher than thresholds for visible motor effects (i.e., greater than approximately 100 to 300 μa, 300 cps biphasic square wave) were found not to improve but to disrupt performance in terms of correct responses and length of reaction time at all exposure durations.

Using a different approach, Laufer, Denhoff, and Solomons (1957) have attempted to show that the physiological correlates of hyperactivity are to be found in terms of dysfunction of the diencephalon of the forebrain. These authors have postulated that the "hyperkinetic syndrome is a very specific entity (p. 48)," and that hyperactivity is the most striking behavioral sign of this entity. Their research is based upon the work of Gastaut (Gastaut, 1950; Gastaut & Hunter, 1950), who developed a method for studying subcortical brain structures, including the diencephalon and specifically the thalamus. The method is termed the photo-Metrazol technique, and, essentially, Gastaut has demonstrated that a certain, specifiable amount of Metrazol (in terms of milligrams of Metrazol per kilogram of body weight) consistently evokes a myoclonic jerk of the forearms of the individual as well as an EEG spike wave burst when the individual is exposed to the flickering of a stroboscope light within a specified frequency range. Gastaut (1950) and Gastaut and Hunter (1950) also presented evidence to the effect that the amount of Metrazol required to produce these effects in both animals and humans was less when either damage or dysfunction of the diencephalon was present. Stated in another fashion, Gastaut (1950) and Gastaut and Hunter (1950) have indicated that thresholds of the amount of Metrazol, in terms of milligrams per kilogram of body weight, required to produce the myoclonic forearm jerk and EEG spike wave burst when exposed to a flickering light, could be obtained. If thresholds of the amount of Metrazol are lower than expected, damage or dysfunction of the diencephalon can be inferred reliably.

Laufer et al. (1957) selected 50 subjects between the ages of 5 and 12 years from a population in a psychiatric hospital. Thirty-two subjects presented the clinical syndrome of hyperkinetic impulse disorders (i.e., were hyperactive), only 11 of whom had a clear medical history of factors capable of causing brain damage. The remaining subjects (N=18) did not present the clinical syndrome of hyperkinetic impulse disorder and also did not present a medical history of possible factors from which brain damage could be inferred.

Photo-Metrazol thresholds for the two groups were compared and found to be statistically different (t=3.43, p<.01).

The mean photo-Metrazol threshold for the hyperkinetic group was found to be 4.54 mg/kg, while the mean for the nonhyperkinetic group was found to be 6.3 mg/kg. Laufer et al. concluded that, regardless of whether a medical history contains clear-cut evidence of any agent causing injury to the control nervous system, children presenting the clinical diagnosis of hyperkinetic impulse disorder, as a group, will have significantly lower photo-Metrazol thresholds than children of comparable age without the syndrome; hence, diencephalon dysfunction or damage may be inferred.

Using 13 of the original hyperkinetic children, the authors further found that whether the child was administered racemic amphetamine or d-amphetamine, their photo-Metrazol threshold was significantly raised (t=5.38, p<.001) from a mean of 4.8 mg/kg to 6.7 mg/kg while on amphetamine.

Cautioning that neurophysiological research concerning the relations between the diencephalon and cortex is far from clear, Laufer, Denhoff, and Solomons (1957) posited the concept that "stimuli, constantly coming in from sensory and visceral receptors, pass through the diencephalon on the way to cortical areas and that the diencephalon serves to pattern, route and give valence to these stimuli (p. 45)." The authors postulated that: "Injury to or dysfunction of the diencephalon would alter resistance at synapses. This would allow incoming impulses to spread out of the visual pathways and irradiate large cortical areas (p. 45)." Further, they added, "Underlying the hyperkinetic syndrome is dysfunction of the diencephalon which by a mechanism as described could make the individual unusually sensitive to stimuli flooding in from both peripheral receptors and viscera (p. 46)." The relationship between this view of hyperactivity and the position of Strauss and his colleagues is obvious.

An interesting piece of research lending support to the concepts of "irradiation" and "flooding" comes from the work of Cohen, Taft, Mahadeviah, and Birch (1967). These investigators identified two groups of children: 205 normal children between the ages of 6 and 12 years attending regular classes in public school; 124 children between the ages of 6 and 16 years who had been referred to the Developmental Evaluation Clinic of the Albert Einstein College of Medicine for diagnostic evaluation because of behavioral problems, physical disabilities, suspected intellectual retardation, and disorders of communication. All clinical children had received a battery of psychological, neurological, and medical tests.

Both groups of children were given a series of five tasks to perform with one hand, e.g., opposition and separation of thumb and index finger, squeezing and relaxing a rubber toy. Movement in the opposite extremity was visually assessed and rated on a 3-point scale. After the tasks had been applied to both hands, each child was made aware of these "overflow" movements, and three of the tasks were repeated with the child instructed to attempt to inhibit such movements.

The results indicated that the amount of "overflow" activity systematically decreased with age, and by age 9 was markedly less, if present, in normal children. So, too, the ability to inhibit the "overflow" movement in the opposite extremity increases with age until by age 9 "overflow" activity is almost totally controlled. There is almost total ability to insulate action from this age forward in normal children. The clinical group, on the other hand, did not demonstrate this marked decrement of "overflow" movement, whether or not they were made aware of such movement; rather, this group reflected gradual diminution of "overflow" movement over age, through 16 years.

When only the clinical group was considered, the "overflow" movement and the inability to inhibit such "overflow" was particularly present in mentally subnormal children with clinical evidence of central nervous system damage also present, but to a lesser degree for mentally subnormal children with no clinical evidence of central nervous system damage. Both groups had more "overflow" movement and demonstrated less ability to control such movement than their normal age peers.

Specifically using a series of laboratory tasks requiring a functional and intact central nervous system, Stevens, Boydstun, Dykman, Peters, and Sinton (1967) matched 26 children of approximately average intelligence but diagnosed minimal brain dysfunction (MBD) with 26 normal children on age, sex, and socioeconomic status. All children diagnosed MBD had specific learning disabilities and/or were difficult to manage at home or school. The most frequent clinical complaints were poor reading and hyperkinesis.

All children performed: (a) an auditory discrimination task (tones presented at 60 dB between 600 and 800 Hz); (b) a motor coordination task (Whipple Tapping Board); (c) a motor impulsivity task (Subject was seated in front of an arc containing a central light to which the subject would respond by releasing a depressed telegraph key. The arc also contained six other lights subtending visual angles of 8, 16, and 24 degrees which would flash intermittently.); (d) a task in which increasingly more complex directions were given (Twenty plastic tokens of two sizes, two shapes, and five colors were presented to the child. The child was then requested, for example, to "pick up the green circle," but later, "except for the green one, touch the circles.").

The author found significant differences in favor of the normals on all tasks. These results suggested to the authors that although children diagnosed MBD do indeed represent a heterogeneous group, the fact that on the average the MBDs performed more poorly on all tasks than did normal children, insult or genetic variation of the central nervous system is suggested. Specifically, however, these authors emphasized the role of the central nervous system in terms of attentional processes. They stated: "It is our feeling, however, that disorders of attention (i.e., attentional impersistence and lack of attentional focus) were particularly implicated in the inferior performance of MBDs. These children could attend for just so long and no longer (Stevens et al., 1967, pp. 284-285)."

The review of research on the physiological correlates of hyperactivity and learning deficiencies seems to divide itself into two positions. The first is specifically stated by Laufer et al. (1957), who have seen hyperactivity as related to dysfunction of, or injury to, the diencephalon, causing the individual to be particularly sensitive to stimuli in the environment. Support for such a position is found in the study of "overflow movement" by Cohen et al. (1967). The electroencephalographic studies of Klinkerfuss et al. (1965) and of Hernandez-Peon (1966) and his colleagues present another picture. Klinkerfuss et al. found "slowed electrical activity" as the outstanding feature of the hyperkinetic electroencephalogram. Hernandez-Peon found long latencies for enhancement and reduction of evoked potentials as a function of instructions given to mentally retarded subjects, and slowly increasing potentials when stimuli were monotonously continued. Implied from the research of Klinkerfuss et al., and specifically stated from Hernandez-Peon's research, is the need for neurological activation or stimulation. Specifically, Hernandez-Peon suggests chemical activation or stimulation for the control of attentional processes in the retarded.

Diagnosed MBD children have been found to perform less efficiently on a series of laboratory tasks than do normal children matched with them on age, sex, and socioeconomic status. This inferior performance seems most especially related to attentional processes (Stevens et al., 1967). Finally, the study by Furster (1958), using monkeys, indicated that electrical stimulation of certain parts of the brain does, in fact, improve perceptual and motor performances of organisms.

Thus, both the physiological research and theoretical positions can be viewed in terms of two opposing camps, with some members from each group suggesting that stimulus hypersensitivity is responsible for hyperactivity and learning deficits found in large groups of children, while other members of each group suggest that more stimulation is required to overcome the deficits exhibited by these same individuals.

Activity Level, Environmental Stimulation, and Behavioral Change

Theoretical and neurophysiological literature is divided on the effects of stimulation on the activity level and task performance of children who have been labeled either hyperactive or mentally retarded, or both, but who have in common high levels of activity and deficiencies in learning when compared with their age peers. The intention of the present portion of this review is to present research pertinent to the effects of stimulation, and the lack of it, upon the activity level and task performance of human subjects. Stimulation, however, is defined in terms of environmental conditions immediately surrounding the subject, not in terms of electrochemical events occurring within the skin of any given subject. Specifically, this review presents literature concerned with the effects of differing environments on stereotyped behavior (certainly a component of activity level) of mentally retarded persons, the effects of stimulation upon activity level, and the effects of stimulation upon task performance.

Stereotyped behavior and stimulation. The high prevalence of stereotyped behavior among institutionalized mentally retarded persons is commonly observed by individuals who are familiar with institutions. Berkson and Davenport (1962) have found that two-thirds of a randomly selected sample of mentally deficient males engaged in various stereotyped movements and postures. Kaufman and Levitt (1965b) found evidence that 69 percent of the sample of partially or completely ambulant mentally defective children between the ages of 2 and 19 years engaged in some stereotyped behavior. Specifically, these authors found that 57 percent of their subjects engaged in waving of the hand before the eyes, 63 percent engaged in head rolling, and 69 percent engaged in body rocking in one or more periods, using a time sampling technique.

The role, or functional purpose, such behaviors have in the life of mentally retarded persons is still not clear. Berkson and Davenport (1962) reported that Gesell and Amatruda (1941) suggested that stereotyped movements represent "fixations of normal patterns which normal children manifest but outgrow." Berkson and Davenport (1962) studied a group of 71 mentally defective males from six cottages between the ages of 11 months and 54 years. Nine subjects of this group were blind (i.e., had less than travel vision). Two experimenters recorded the behavior of each subject during a 100-second period both in the morning and in the afternoon. Each period was divided into 10 10-second intervals, and behavior, if present, was checked on a 48-item checklist. All behavior was analyzed in terms of three categories: self-manipulations (e.g., suck, bite, hug--clasp one's self); manipulations of the environment (e.g., exploit object, touch); stereotyped behaviors. The authors found stereotyped movements significantly correlated with self-manipulation (r=.46, p<.05), and both kinds of behavior were negatively correlated with manipulations of the environment (r=-.24 and -.45, respectively).

From these results the authors put forth the view that stereotyped behavior is self-stimulatory in character. Further support for this view comes from the fact that when the 9 blind subjects were matched for CA and IQ with sighted subjects, the blind subjects had significantly more incidences of stereotyped behavior (t=3.70, p<.001) but showed no statistical difference in the frequency of self-manipulatory behavior. The authors interpret their results in the following fashion: "It is as if, deprived of a primary mode of stimulation, the blind provided themselves with stimulation by performing stereotyped movements (Berkson & Davenport, 1962, p. 852)."

Support for such a position on the role of stereotyped behavior can be found in the research by Kaufman and Levitt (1965a). They observed 83 partially or fully ambulant mental defectives for four sessions (two in the morning and two in the afternoon), consisting of 25 consecutive 15-second intervals. These subjects were observed in groups of four, and the prevalence of three types of stereotyped behavior (body rocking, head rolling, and waving of the hand before the eyes) was noted on checklist. All children were from an institution for the moderately-to-profoundly retarded, were between the ages of 2 years, 11 months, and 19 years, 8 months, and spent "most of their waking hours in the dayroom without organized activities, save for the blare of a television set or phonograph (Kaufman & Levitt, 1965a, p. 204)." Twenty-six variables describing the medical, social, and psychological characteristics were correlated with stereotyped behavior scores and then factor analyzed. Although among the 26 variables only characteristics concerning the modalities of vision and hearing were included, 3 of the 12 independent factors resulting from the analysis are of importance here. Head rolling was found to be related to hearing impairments; hands before the eyes was found to be related to restriction in motility and visual impairment; body rocking was found to be related to patients' receiving tranquilizers and having hearing impairments. Kaufman and Levitt held that sensory deficits, either due to loss or impairment of a sensory modality or due to some environmental restriction, can at least foster the continuation of certain types of behavior, if not actually give rise to them.

Guess (1966) matched eight blind, and ambulant, and eight blind, but nonambulant, severely and profoundly retarded males with eight sighted, and ambulant, and eight sighted, but nonambulant males on age, intellectual level, and length of institutionalization. Each subject was observed for 10 3-minute intervals in the morning and 10 3-minute intervals in the afternoon for a total of 20 observations totaling 1 hour. Subjects' behavior was recorded by the use of Berkson and Davenport's (1962) checklist, and behavior was analyzed as to the degree of presence of three types of behavior: stereotyped, self-manipulations, and manipulations of the environment.

Stereotyped behavior was found to occur significantly more often among the blind than among the sighted subjects. Ambulant subjects engaged in significantly more behavior involving manipulation of the environment than did nonambulant subjects. All other effects were nonsignificant. If both stereotyped behavior and self-manipulation are assumed to be aspects of self-stimulation, then by combining these two types of behavior Guess found that blind subjects have significantly higher self-stimulating scores than sighted subjects, and nonambulant subjects have significantly higher self-stimulating scores than do ambulant subjects. He concluded that because these subjects cannot respond to their environment in more effective ways, and because of their inadequate response repertoires, these subjects engage primarily in primitive, self-stimulatory activities.

Finally, as to the role of stereotyped behavior, Berkson and Mason (1963) have indicated "the fact that self-manipulation tends to change in the same way as stereotyped behaviors gives empirical support to the widely held view that stereotyped movements are a type of self-stimulation (p. 411)." These authors furthermore postulated that it is primarily through the kinesthetic, tactual, and vestibular functions that stimulation is sought. The relationship between this view of the role of stereotyped behavior and the theoretical positions of Zaporozhets and Gellner is immediately apparent.

Germane to the present review, however, is not so much the role of stereotyped behavior in the life of the retarded person, but the effects of differing environments, some more stimulating and others less stimulating, on the frequency of such behavior.

Davenport and Berkson (1963) first rated 24 mentally deficient persons in terms of amount of stereotyped behavior displayed in a 100-second period. The 100-second interval was divided into 10 10-second intervals, and if such behavior appeared during any given 10-second period, it was so noted on a checklist. Subjects were then divided into two groups: the low group (N=10), who showed stereotyped behavior in 3 or fewer of the possible 10 10-second periods; the high group (N=14), who showed stereotyped movements in 6 or more of the 10 periods. Subjects were taken individually to the cottage dining room. Each subject was again observed for a second 100-second period, then presented with four objects, one at a time (rubber ball, doll, plastic ball with marbles, and wood blocks), and his behavior assessed again for 100-second intervals while each toy was present. Subjects were finally rated a seventh time with all objects removed.

Amount of stereotyped behavior for both groups was found to be significantly higher when no objects were present than when objects were present. Subjects in the low-stereotype group engaged in significantly more object exploitations than did subjects in the high group. When the amount of stereotyping for the high-stereotype group was analyzed in terms of most preferred object present and least preferred object present (as determined by object manipulation scores), the authors found significantly less stereotyped behavior with the most preferred object; i.e., not only did objects vs. no objects have an effect on the amount of stereotyped behavior, but the type of stimulus also was found to have an effect. The authors viewed the amount of stereotyped behavior engaged in by a subject as a measure of his particular degree of responsiveness to his environment.

Berkson and Mason (1963) rated two groups of profoundly retarded male patients on four categories of behavior: stereotyped behavior, manipulation of the environment, self-stimulation, and locomotion, in two different combinations of environments. The first group was placed in a cottage dayroom, with other patients present, in a cottage dining room, with a number of objects present, and in an unfamiliar hospital room, with only the observers present. Subjects from the second group were placed in a cottage dayroom, in a cubicle in a house trailer, and in an outdoor playground, with approximately 50 other patients present.

Results of the first experiment indicated that the level of stereotyped behavior and self-manipulation was significantly higher while subjects were in the hospital room than while they were in the dayroom. All other comparisons were nonsignificant. Thus, in the first study, stereotyping increased in a novel and restricted environment in which opportunities for other activities were not present.

Results from the second experiment indicated that stereotyped behavior was significantly less frequent on the playground than in the trailer or dayroom. Self-manipulation was significantly more frequent in the trailer than in either the dayroom or on the playground. Finally, locomotion scores were higher on the playground than in the trailer. All other comparisons yielded nonsignificant differences.

These authors concluded that stereotyped behavior in profoundly retarded persons is related to the situation in which the person finds himself, and that the direction of change in the levels of these different forms of behavior may be determined by the types of environments evoking alternative activities.

Kaufman and Levitt (1965b) assessed the body rocking, head rolling, and waving-of-the-hand-before-the-eye movements of 83 partially or fully ambulant mentally retarded persons as a function of time of day, age, and sex. The authors found significant variations in rates of body rocking and head rolling as a function of time of day. The two peak periods were just before lunch and in the middle of the afternoon. Upon further investigation, the authors found that these were the times when ward personnel changed shifts and patient-staff interaction was at a minimum. At these times of day there was a drastic curtailment of organized activities, and all play objects were removed from the dayroom. In short, there was an increase in stereotyped behavior when there was a decrease in effective environmental stimulation.

Most significant to the present review is the partial finding of Levitt and Kaufman (1965). From a population of 83 institutionalized retarded persons, these authors selected 32 subjects on the basis of rates of body rocking (high vs. low), sex, and age (The older group had a mean age of 177.69 months, while the younger group had a mean age of 65.25 months.). Analyses of variance revealed no significant differences between groups on age and sex variables, and no significant differences within groups on the rate of body rocking.

Subjects, four at a time, were taken to a minimally furnished observation room and submitted to four treatment conditions: no noise, low white noise (70 dB), medium white noise (85 dB), and high white noise (110 dB). Noise was played into the room through four speakers. Each condition was presented on different days. Each session consisted of 10 15-second observation periods at each of the four intensities of sound, with a different rater watching each subject through a one-way vision mirror. The dependent variable was the amount of body rocking in each condition during the observation period.

Results indicated a significant second-order interaction (treatments by groups by sex; $F=2.72$, $p<.05$) that is of primary concern. Rocking behavior for girls in the high-rocking group systematically decreased with increasing amounts of noise, lending more support to the position that the amount of environmental stimulation is inversely related to the amount of stereotyped behavior displayed. Unfortunately, no such effect was found for the boys within the high-rocking group; in fact, the reverse was found. There were no significant differences between boys and girls in the low-rocking group, and both boys and girls tended to increase in rocking behavior as sound level increased. The authors interpreted their results in terms of rocking behavior serving as an adaptive or coping function "to protect against an unstimulating or stressful environment (Levitt & Kaufman, 1965, p. 733)."

Activity level, performance, and stimulation. Activity level, performance, and stimulation, and the relationships among these variables, have been viewed from different perspectives and differentially combined by the many investigators in this area. Some investigators have chosen to examine the effects of activity level alone on task performance, but even within this group there are some investigators who have assessed activity level in various ways, such as while the subjects are engaged in the task itself or either before or after completion of the task. Some investigators have chosen to define performance in terms of an actual learning criterion, while others have defined performance in terms of such variables as reaction time or threshold levels. The same situation obtains for stimulation. This term is used by some investigators to mean an exacerbation of visual or auditory stimuli of a general or specific type, while others are concerned with the degree of "meaningfulness" of such added stimulation. Some investigators have chosen to examine the effects of stimulation on task performance alone, while others have examined the effects of stimulation on activity level alone, and still others have examined the effects of stimulation, activity level, and task performance in a single design. Finally, different investigators have used different subject populations in their research. Some have used retarded individuals, others have discriminated among categories of retarded persons, and still others have used college students. Cromwell et al. (1963) have discussed the problems of measurement for the variables of interest and have emphasized the need for caution in generalizing across studies in this area.

The present review examines pertinent literature in terms of activity level and stimulation, activity level and performance, and finally, performance and stimulation.

Realizing the nascent stage of research in this area, the review is intended to indicate emerging trends rather than finally supporting or rejecting the various theoretical positions previously put forward. It is the author's position that all theories are ultimately heuristic devices by which we come to some understanding of ourselves, of others, and of the world around us. Theories are essentially aids at our disposal in the furtherance of our understanding. They should be judged in terms of their utility in accounting for empirical findings as well as their suggestive implications for future research, not in terms of ultimate "truthfulness" or ultimate "correctness." Such latter views of theories seem only to retard and impede the progress in a given area rather than encourage and impel continuous investigative efforts. The theoretical position of Strauss and his colleagues has more than adequately served the former role of theory for the last 20 years. The orientations of Gellner and Zaporozhets, unfortunately, have not received such attention to date.

Irwin (1930, 1941) was among the earliest investigators who specifically studied the effects of stimulation upon activity level. He found that if infants were exposed either to periods of continuous illumination or to periods of continuous auditory stimulation, they showed a decrease in activity over that observed when no specific visual or auditory stimulation was present. Irwin further found that when the infants were subjected to both illumination and auditory stimulation simultaneously, there was an even greater reduction of stabilimetric activity; thus, the effects of stimulation in these two modes appeared to be additive.

Gardner, Cromwell, and Foshee (1959) investigated the effects of distal visual stimulation on four groups of retarded subjects. They used organic retardates matched on chronological age and mental age with familial retardates for two of their groups, and high-active retardates vs. low-active retardates for their remaining groups. Subjects in the high-active and low-active groups represented the upper and lower quartiles of 101 retardates previously assessed for activity level by a ballistograph platform. All subjects were given a 5-minute period under reduced visual stimulation (partially surrounded by a black screen) and a 5-minute period under enhanced visual stimulation (partially surrounded by a screen on which there were multicolored Christmas tree lights, toys, trinkets, and brightly colored cards). Organic and familial retardates did not differ significantly from each other, although both groups were significantly more active under the reduced visual stimulation condition than under the enhanced visual stimulation condition. Both high- and low-active retardates were also more active under reduced visual stimulation than under increased visual stimulation, but, even more important, high-active subjects showed a significantly greater reduction in activity during increased visual stimulation than did the low-active subjects.

Results of a study that does not conform so well to the simple inverse relationship between activity level and amount of environmental stimulation should be mentioned. Spradlin, Cromwell, and Foshee (1959) investigated the effects of increased auditory stimulation on the same four groups of subjects used by Gardner et al. (1959). All subjects were seated in a sound-insulated booth placed upon a ballistograph platform. Under the silent (reduced stimulation) condition, there was a marked but not complete absence of sound for a 4-minute period of time. Under the increased-auditory-stimulation condition, subjects heard a tape of a human voice recorded at 3 3/8 ips, but played at 7 1/2 ips, also for a 4-minute period. Visual stimulation for both auditory conditions was uniform and consisted of a burlap-covered wall which surrounded each subject. There were no significant differences between organic and familial retardates in either total activity, or in the effects of reduced and increased auditory conditions. The same finding was obtained for the high-active and low-active retarded groups.

Concerned with the relationship between perceptual variables and activity level, Wolfensberger, Miller, Foshee, and Cromwell (1962) identified a high-active and a low-active group from 100 normal high-school students and used Rorschach responses as their dependent measure. All subjects were first tested on a ballistograph for 10 minutes while listening to music and surrounded by a black screen. The 22 most active and 22 least active high-school students became subjects for this experiment. Specifically, these authors were concerned with the relationship between objectively assessed activity level and the concept Erlebnistypus, or experience balance. Rorschach pattern interpretation indicates that individuals whose movement responses to the cards are in excess of the sum of their color responses (M>C) generally tend to be more responsive to thought-process stimuli (are introverted) and, therefore, should have lower activity scores. The reverse should obtain for those individuals whose C>M and are considered to be extratensive. The authors found no significant differences on the ratio of movement to the sum of the color responses between the high-active and low-active groups. They did find a tendency for the low-active group to have a greater variety of and less form-controlled determinants in their responses than did the high-active group. These authors offered an interpretation of their results in terms of perceptual dilation and constriction. The low-active group seemed to have a broader range of perceptual response and may have been better able to organize and attend to stimulus elements in a novel situation, while the high-active group may have been more limited or perceptually constricted in novel situations, and therefore exhibited more motor activity in response to stress or as a need for self-imposed sensory feedback which is not novel.

Foshee (1958) identified 24 high-active and 24 low-active mentally retarded adults from a population of 101 such individuals, all of whom were assessed on a ballistographic device. The high-active and low-active subjects were required to perform a simple and a complex task, in effect a card-sorting task using two or eight geometric figures, respectively. After controlling for intelligence differences between his groups, Foshee found no significant differences between high-active and low-active mentally retarded subjects on either task. As he did find a significant difference between total number of correct responses for the two tasks, the two problems actually did represent an easier and a more difficult task.

Sprague and Toppe (1966), on the other hand, did find differences in the performance of high-active and low-active retarded persons. Thirty trainable mentally retarded children were required to learn a two-choice discrimination task (blue toy car or white toy boat) while seated on a stabilimetric chair. For one-half the subjects one toy was considered correct, while for the remainder of the subjects the other toy was correct. A 12-second delay interval followed a choice made by the subject, after which either an M&M candy was given (for the correct choice) or a doorbell buzzer was sounded (for the incorrect choice). The number of correct responses after 80 trials was the dependent variable, and the scores of the eight most active and eight least active children were compared. The low-active group made significantly more correct responses and improved across trials to a greater degree than the high-active group, though there were no significant differences between the two groups on chronological age or mental age. Previously gathered teacher ratings of activity, using the Child Rating Scale by McConnell, Cromwell, Bialer, and Son (1964), were not significantly correlated to the stabilimetric measure of activity.

Cromwell, Palk, and Foshee (1961) studied the relationship between a range of activity levels and the acquisition of a classically conditioned eyelid response. They randomly selected 61 subjects from an institutional population with Stanford-Binet intelligence scores on file. These subjects ranged in chronological age from 12 years to 58 years and in mental age from 2-5 to 10-2. IQ scores ranged from 15 to 68. Each subject was seated in a ballistographic chair so that activity level and eyelid conditioning could be measured simultaneously. Subjects wore a standard headpiece so that eyelid movements could be recorded by an electropotentiometer. The conditioning procedure was as follows: A 25-millisecond warning buzzer was first sounded, after which a 3-second delay interval occurred. A disc of light was then illuminated for 550 milliseconds. This constituted the conditional stimulus. During the last 50 milliseconds of disc illumination an air puff of .6 pounds/square inch was delivered to the right eye of the subject as the unconditioned stimulus. An intertrial interval of 25 seconds then occurred and the series was repeated. All subjects received 80 conditioning trials.

The data indicated that the acquisition of an eye blink response was not significantly related to activity level, chronological age, or IQ. It was, however, significantly related to mental age. The authors also found that activity as a function of chronological age decreased to and tended to approach an asymptote at approximately 35 years, much later than is supposed in a number of studies on activity level.

Turner (1969) found significant differences in learning by advantaged, high-IQ young children who learned under stimulating conditions. Twenty children with an average CA of 3-9 were paired with 20 children with a mean CA of 4-9 and were randomly assigned to a noise or no-noise condition. All children learned a two-choice discrimination problem consisting of six geometric forms. The noise condition consisted of playing a tape of typing noises at approximately 70 dB into a booth in which the task was given. The no-noise condition represented no special distractions, with an ambient noise level of approximately 40 dB. Both younger and older children in the noise condition did significantly better than did children in the no-noise condition. Children in the noise condition reflected more rapid learning and better maintenance of performance when compared with children in the no-noise condition.

In order to assess the generality of the facilitory effects of stimulation, an additional group of 10 subjects (mean CA 4-3) were given the task to perform while listening to children's songs played into the same booth via the tape recorder. These children, as well, showed enhanced learning performance under this condition of stimulation when the learning scores of this group were compared to the scores of the children in the previous no-noise condition.

Finally, a sample of 13 children having a mean CA of 3-3 were randomly assigned to a noise (typing) or no-noise condition and were given the same discrimination task. In this last experiment, Turner found no significant differences between the performance of the two groups. Turner suggested an age-by-conditions interaction hypothesis to account for these findings; i.e., noise is favorable for "older" children but has no such facilitative effect for "younger" children.

In a second study, Turner (in press) randomly assigned 90 children of three ages (5½, 6½, and 7½ years) to one of three distracting conditions (mirror, noise, and control) while learning an oddity problem. All children were of estimated average intelligence, white, and came from families of lower-middle economic status. Subjects learned the oddity problem in a booth arrangement located on the school stage. Affixed to the front of the booth, and above the learning apparatus, was a one-way vision screen, which, when removed, exposed a mirror that served as the distractor for one condition. The sound condition consisted of the playing of children's songs and stories via tape recordings into the learning booth at approximately 60 dB. The control condition consisted of both mirror-hidden-from-view and sound-absent while the subject was learning the problem. Each subject was shown 60 triads of stimuli (a crescent and parallelogram), and the presentation interval for all triads lasted for only 4 seconds. Number of correct responses was the dependent variable.

The author predicted that each distractor stimulus would have a dual role; i.e., at the lower ages the distractor stimulus would inhibit performance, while at the higher ages it would enhance performance. A trend analysis using the age-by-condition interaction sum of squares was used to test this hypothesis. The noise condition was not in keeping with the author's hypothesis, but the mirror condition, when assessed against the control group performance, did prove to be statistically significant; i.e., the number of correct responses of the 5½-year-old children under the mirror condition was significantly less than the number of correct responses of control group children, while the performance of the 7½-year-old children under the mirror condition was significantly superior to performances of control group children. Differences between 6½-year-old mirror and control group children were nonsignificant. Overall analysis of variance effects for Turner's experiment were nonsignificant, except for a trial blocks effect. This last finding indicates that neither the sound nor the mirror conditions reduced performance.

Berlyne, Borsa, Hamacher, and Koenig (1966) found learning enhanced with the use of white noise when using female undergraduate students. Sixty-four students, in a paired-associates learning task, were given a sequence of 40 items in which a dysyllabic adjective served as the stimulus element and a dysyllabic familiar male first name served as the response element. Each stimulus element appeared for 4 seconds in the aperture of a memory drum, and then for 2 more seconds with the response item. This sequence was followed by a 6-second intertrial interval before the next stimulus/stimulus-response pair was presented. In a counterbalanced design all subjects learned under four conditions of extraneous stimulation: white noise presented at 70 dB, no noise, noise during the intertrial interval, and noise during both stimulus/stimulus-response periods and intertrial interval.

All subjects were tested without white noise 24 hours later. Berlyne et al. (1966) found that recall was significantly better for items that had been associated with white noise during the presentation of stimulus and response terms. Whether white noise was present or absent after the response was made made no significant difference. There were no significant interactions among the various conditions.

Massey and Insalaco (1969) presented a two-choice discrimination problem (red circle and yellow square) to four groups of institutionalized mentally retarded females. Three of the four groups received .5 second of white noise at 95 dB in some combination with M&M candy, while the fourth group received only candy for each correct response. One group received both noise and candy for each correct response; the second group received noise and candy for each correct response and noise alone for each incorrect response; while the third group received candy only for each correct response and noise only for each incorrect response. The three groups receiving white noise, regardless of the particular combination, made significantly fewer errors in learning the two-choice discrimination problem than did the group which received no white noise. There were no significant differences in mean errors among the groups receiving noise, regardless of the particular combination in which it was administered.

Cruse (1961) randomly divided 24 brain-injured mentally retarded and 24 familial mentally retarded children into two groups and tested their reaction time to a stimulus light under two environmental conditions. One-half of each group took the test in a room with the floor strewn with toys and with several balloons hung from the ceiling that were kept in constant motion by means of an electric fan. There was also a mirror placed to the left of these subjects in which they could view themselves whenever they chose. The remainder of each group performed the task surrounded by two black curtains, restricting their view and focusing it upon the stimulus panel. All toys and balloons were also removed. Mean reaction times associated with etiology, experimental condition, and all interactions were statistically nonsignificant. On the premise that the distraction effects would occur only after prolonged or continuous distraction, all subjects received 18 additional reaction time trials on a vigilance task in which the foreperiod interval was varied from 5 to 30 seconds. Again, all comparisons between brain-injured and cultural-familial subjects were statistically nonsignificant; i.e., brain-injured subjects did not exhibit poorer performance under distracting conditions than under nondistracting conditions, nor were the effects of extending the foreperiod of the reaction time task to virtually a vigilance task any more deleterious to brain-injured, mentally retarded subjects than to cultural-familial mentally retarded subjects.

Using college students and institutionalized mentally retarded persons, Dugas and Baumeister (1968) compared difference limen thresholds of intensity to a 1,000-Hz tone under three conditions of extraneous stimulation. Each subject was placed in a chair facing two 100-watt light bulbs, suspended in a corner and 1 foot apart. Difference limens were assessed under three distraction conditions: lights off, lights on, and lights flashing at 1-second intervals. The stimulus presentation was a 2-second standard tone followed by a 2-second comparison tone after 3 seconds of silence. The standard tone was always presented at 40 dB above the particular subject's subjective threshold, and the intensity of the comparison tone was systematically varied using the method of limits. Retarded subjects were found to have significantly greater difference limens to a 1,000-Hz tone than did the comparable age group of normal subjects. Of special interest, however, was the significant distraction-by-order interaction for the retarded group. The authors interpreted this effect in terms of enhanced performance by retarded subjects when distractions were present in at least some orders of presentation.

In an oddity task using institutionalized mentally retarded subjects and normal public school children of comparable MAs, Ellis, Hawkins, Pryer, and Jones (1963) found that a distracting mirror enhanced the performance of normal subjects, while it did not hinder the performance of retarded subjects. These authors matched 144 retarded subjects of MAs

6, 7, and 8 years with 144 normal school children of the same MAs. Each group was further divided so that some subjects in each group performed the oddity task while using objects previously assessed as either high or low in attentional value, and under distracting (a mirror was placed immediately above the response tray) and nondistracting (no mirror) conditions. A marble was placed under the odd member of the three objects presented to act as an incentive. The results indicated that there was no overall significant difference in the number of correct responses between normal children and mentally retarded subjects on this task. A significant groups-by-trials interaction indicated that normal subjects progressed over trials more than did mentally retarded subjects, as did high-MA subjects when compared to low-MA subjects. The significant distraction-by-groups interaction, previously mentioned, indicated that the retardates who had the mirror present did not differ significantly in their performance from retardates who had the mirror absent, but normal subjects who had the mirror present performed significantly better than normals who did not have the mirror present.

In an experiment which, perhaps, even more clearly illustrates the role of stimulation, Baumeister and Ellis (1963), using each subject as his own control, had 10 mentally retarded subjects perform a match-to-sample task under four conditions of delay (0, 25, 45, and 120 seconds) and under two environmental conditions, distraction and nondistraction. The distraction condition consisted of a display of rhythmically moving lines of light in various colors, ascending and descending at various speeds and angles above the display panel. The task required the subjects to recall the form and color of the stimulus element in order to select the appropriate response from four alternative patterns presented to them after the various delay periods. Statistical results indicated a significant effect in favor of the distraction condition, both in terms of mean number of correct responses and in terms of mean latency scores. As the authors stated, "In short, the data presented here suggest that retardates are both more accurate and less hesitant when exposed to the distraction condition (Baumeister & Ellis, 1963, p. 719)."

Two experiments using retardates and normals under distracting sound and nondistracting conditions were conducted by Girardeau and Ellis (1964). These investigators presented a group of normal subjects and a group of retarded subjects a 20-item serial word list, with half of each group learning the list while a tape recording of normal environmental sounds (e.g., dog barking, conversations occurring, automobile and train noises present) was played at 60 dB. The remainder of the subjects learned the list under relatively quiet conditions. Subjects from each group, furthermore, were given the word items under either a 3-second or 9-second interitem interval. In their second experiment, the authors, using a different sample of normal and retarded subjects, presented the same 20-item list in a paired-associates task under the same experimental conditions. Statistical results indicated no significant differences in the acquisition of a 20-item word list, either serially presented or presented as a paired-associates task, as a function of noise present or noise absent. Sounds which had been judged previously as distracting did not alter the performance of either retarded or normal subjects, even though these sounds were presented at intensity levels higher than those usually encountered in the free environment.

In one of the most systematic series of experiments reviewed, Belmont and Ellis (1968), using retarded and normal subjects, manipulated not only the presence or absence of extraneous stimuli along a continuum of presentation intervals, but also varied the "meaningfulness" characteristic of extraneous stimuli. Their results indicated the changing role of extraneous stimulation (ES). The authors conducted a series of six experiments, using responses to two-choice discrimination problems as the dependent variable. Though statistical evidence was lacking, the first four experiments of the series suggested that extraneous stimuli (in this case, bright lights) seemed to have had a facilitatory effect upon learning in retardates and a debilitating effect upon learning in normals. It is with Experiments 5 and 6 that the authors made their unique contribution. Experiment 5 consisted of presenting 20 retardates, who had successfully passed a pretest problem, one 10-pair discrimination problem daily for 5 consecutive days. The discrimination problem consisted of two "meaningless" line drawings projected on the lower corners of a screen. The extraneous stimulus condition consisted of color pictures showing scenes of animals, the World's Fair, the Near East, etc. that filled the screen. Each subject received one problem for each of five ES conditions: no ES and ES appearing either 1, 3, 6, or 9 seconds after each response for a period of 2 seconds. Results indicated no significant effect for ES condition, but a significant groups and days effect; thus, on Day 1 the control group performed less efficiently than the ES group, but by Day 5 the control group performed best. The authors inferred that whereas ES may have a facilitatory effect, after practice it may actually disrupt learning.

Experiment 6 was conducted using 16 subjects matched for previous Day 5 performance. Subjects were randomly assigned to either a control group (no ES) or an ES group and were given a 12-pair test problem comprising new stimuli and, for the ES group, a new set of ES slides, presented for 2 seconds after a response interval of 1 second. Control group performance on the new problem was significantly better than ES group performance, supporting the finding from Experiment 5; i.e., ES (in this case, meaningful pictures) may perform a dual role, depending upon the subject's familiarity in a testing situation.

Cromwell and Foshee (1960) investigated the effects of visual stimulation, activity level, and task performance using two groups of retarded persons--23 organics and 23 familials. Subjects were matched on CA and MA and were given a two-category card-sorting task while seated on a ballistographic chair. Each subject was given an opportunity to sort as many cards as he was able in two 4-minute periods, while surrounded by a black screen on three sides or while facing a screen on which were placed pieces of brightly colored cloth, a number of toys and trinkets, and two strings of multicolored Christmas tree lights. There were no significant differences in task performance, either as a function of stimulus level or of the subject classification. Cromwell and Foshee interpreted their results to be in disagreement with the notion that increased stimulation promotes higher activity and interferes with the task performances of brain-injured subjects, the notion postulated by Strauss and his colleagues.

In an explicit test concerning the educational practices of Strauss and his colleagues, Rost and Charles (1967) used two primary and two intermediate classes of brain-injured, hyperactive children, one-half of whom had been specifically diagnosed as brain-injured by a neurologist, but all children displayed the typical Strauss syndrome. One primary and one intermediate class were taught for one entire semester using the "cubicle method." All individual assignments were done in booths of white corrugated plastic at the back of the classroom, this period lasting for at least 1½ hours a day, while for class participation the children sat together. The remaining primary and intermediate classes were taught in the normal fashion. All subjects were tested both at the beginning and end of the semester with the Wide Range Achievement Test (WRAT). The results indicated that although all children made significant gains on subtest scores between the beginning and end of the semester, there was no significant difference between any subtest score of the WRAT when control subjects were compared with subjects taught by the cubicle method.

In a critical review of the 2-year demonstration study by Cruickshank, Bentsen, Retzburgh, and Tannhauser (1961), using a typical Lehtinen-type classroom environment, Dunn (1968) could find "little statistical evidence" to indicate that experimental subjects made greater progress than control subjects. Cruickshank et al. conducted a 2-year demonstration study with 40 subjects, 20 of whom had been diagnosed brain-injured, hyperactive, and aggressive, and 20 of whom had been diagnosed emotionally disturbed. Admitting that more evidence is required, Cruickshank et al. nevertheless recommended continued use of an unstimulating environment and a structured program for hyperactive children.

Environmental stimulation was found to have an enhancing effect on stereotyped behavior (Berkson & Mason, 1963; Davenport & Berkson, 1963; Kaufman & Levitt, 1965a, 1965b; Levitt & Kaufman, 1965), and if not specifically an enhancing effect, certainly not a disruptive effect on task behavior and activity level of normal and mentally retarded persons, whether they were brain-damaged or not (Baumeister & Ellis, 1963; Belmont & Ellis, 1968; Berlyne, Borsa, Hamacher, & Koenig, 1966; Cruse, 1961; Dugas & Baumeister, 1968; Ellis, Hawkins, Pryer, & Jones, 1963; Foshee, 1958; Gardner, Cromwell, & Foshee, 1959; Girardeau & Ellis, 1964; Massey & Insalaco, 1969; Turner, 1969; Turner, in press). The empirical research on environmental stimulation offers no support for the theoretical position of Strauss and his colleagues (Strauss & Kephart, 1955; Strauss & Lehtinen, 1947). Furthermore, when experimental procedures were employed to test directly the educational procedures recommended by Strauss et al. (Cruickshank et al., 1961; Rost & Charles, 1967), the academic performance of brain-injured, hyperactive children was not enhanced in an environment which was free from distracting stimulation; therefore, the continuation of educational procedures recommending restricted-stimulation environments in order to increase the academic performance of hyperkinetic children and high-active mentally retarded children is simply not supported by experimental evidence.

APPENDIX B

RAW DATA

Table 6

Raw Data for High-Active Subjects

Subjects	Order	Conditions: No Noise — Mean Exp. Time (Thresh.)	No Noise — Standard Error of Mean	White Noise — Mean Exp. Time (Thresh.)	White Noise — Standard Error of Mean	Cafeteria Noise — Mean Exp. Time (Thresh.)	Cafeteria Noise — Standard Error of Mean
1	6	25.00	1.00	27.56	.56	33.44	.63
2	5	10.81	.45	11.19	.28	8.94	.21
3	2	12.44	.27	13.75	.32	13.88	.36
4	6	11.25	.22	14.25	.62	12.69	.77
5	1	8.75	.13	9.56	.26	9.19	.10
6	4	9.88	.23	13.44	.46	11.19	.52
7	2	14.69	.20	10.07	.75	15.06	.73
8	3	22.88	.46	12.62	.41	18.75	1.54
9	6	16.94	.52	13.88	.25	20.50	.41
10	1	13.25	1.40	27.00	1.90	8.50	.00
11	5	19.19	.28	18.81	.88	22.88	.21
12	3	13.44	.49	10.81	.46	55.25	1.73
13	5	12.56	.45	12.62	.65	9.88	.23
14	2	11.88	.26	17.56	2.14	16.12	.37
15	3	11.19	.26	13.75	.66	13.00	1.16
16	4	8.94	.11	8.69	.17	11.44	.44
17	1	10.62	.14	10.50	.38	10.31	.25
18	4	10.50	.30	12.56	.52	10.38	.32

Note.--Order 1 = No Noise - White Noise - Cafeteria Noise
Order 2 = White Noise - Cafeteria Noise - No Noise
Order 3 = Cafeteria Noise - No Noise - White Noise
Order 4 = No Noise - Cafeteria Noise - White Noise
Order 5 = White Noise - No Noise - Cafeteria Noise
Order 6 = Cafeteria Noise - White Noise - No Noise

Table 7

Raw Data for Low-Active Subjects

Subjects	Order	Conditions					
		No Noise		White Noise		Cafeteria Noise	
		Mean Exp. Time (Thresh.)	Standard Error of Mean	Mean Exp. Time (Thresh.)	Standard Error of Mean	Mean Exp. Time (Thresh.)	Standard Error of Mean
1	1	22.25	.88	41.56	2.20	24.38	1.08
2	5	12.75	.30	16.44	.89	11.06	.38
3	4	8.94	.21	9.19	.18	8.81	.16
4	1	13.88	.62	15.56	.59	16.50	.76
5	1	9.62	.33	13.62	.96	13.00	1.94
6	6	11.88	.32	13.50	1.01	39.50	2.18
7	2	13.25	.74	21.75	1.07	10.25	.16
8	2	13.62	.32	18.56	.46	10.88	.50
9	6	30.06	.67	43.25	2.00	46.62	1.42
10	2	14.06	.40	17.81	1.02	13.44	.46
11	3	18.19	.58	10.31	.38	8.62	.10
12	3	44.94	.42	30.31	1.42	51.94	.86
13	5	10.19	.30	12.31	.57	11.25	.34
14	3	12.44	.61	8.50	0.00	15.75	.52
15	4	13.56	.77	11.75	.66	10.94	.78
16	5	15.81	1.67	21.19	1.92	16.75	.61
17	4	15.56	.92	20.44	.44	22.88	.76
18	6	12.56	.22	14.00	.28	10.25	.79

Note.--Order 1 = No Noise - White Noise - Cafeteria Noise
Order 2 = White Noise - Cafeteria Noise - No Noise
Order 3 = Cafeteria Noise - No Noise - White Noise
Order 4 = No Noise - Cafeteria Noise - White Noise
Order 5 = White Noise - No Noise - Cafeteria Noise
Order 6 = Cafeteria Noise - White Noise - No Noise

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