Distraction as a Function of Within-Task Stimulation for Hyperactive and Normal Children

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Research indicates that increased distal and especially peripheral environmental stimulation does not distract the hyperactive child but may actually have a facilitative effect on performance. Increased within-task stimulation, however, has been found to be disruptive, but these studies have generally confounded increased stimulation with increased task complexity (by increasing the number of competing cues). The present study sought to assess task performance of hyperactive and normal children with and without within-task color, holding task complexity constant. Using a repeated-measures design, performance was measured on four tasks: two visual-motor drawing tasks, one visual-concentration task, and a combined visual-motor and visual-concentration task. Error analyses indicated generally poorer performance by hyperactives than by normals, and contrary to prediction, on two of the tasks hyperactives performed better without color than with. Hyperactives tended to perform faster than normals on the visual-motor tasks but performed slower than normals on tasks involving visual concentration. Implications of results and related evidence suggest (1) locus of added stimulation may be important in determining effects on performance, and (2) impulsivity or response speed may be unrelated to performance problems of hyperactive children.

Distractibility has been considered the main contributor to learning problems associated with the hyperactive child (Cruickshank 1975). According to Strauss and Lehtinen (1947, p. 130) distractibility is the result of hyperresponsiveness to environmental stimulation. The hyperactive child is considered hypersensitive to environmental stimulation, and he is as likely to attend to irrelevant as to relevant events, thus producing what appears to be random and goalless motor and attentional behaviors. Thus environmental stimulation has been considered the precipitating cause of learning problems for hyperactive children.

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The effects of manipulated environmental stimulation on activity has received systematic review and empirical investigation (Zentall 1975, Zentall 1977, Zentall & Zentall 1976). However, interpreting the effects of increased stimulation on task performance is made difficult because many studies have not directly manipulated stimulation. Some studies have simply inferred that stimulation was changed due to poorer performance on certain tasks by hyperactive children (Kasper, Millichap, Backus, Child, & Schulman 1971). Other studies have held stimulation constant and varied the information provided by stimulation, e.g., fruit colored appropriately (yellow banana) versus inappropriately (purple banana), and then have attributed differences in performance between normal children and hyperactive (or reading disabled children) to distractibility (i.e., attention to inappropriate information) (Campbell, Douglas, & Morgenstern 1971, Alwitt 1966). Still other studies have found better recall of irrelevant information in hyperactive children (Hallahan, Kauffman, & Ball 1973, Mondani & Tutko 1969), the untested implication being that performance (central recall) would improve if the amount of irrelevant information (stimulation) were reduced.

Interpretation is also made difficult because it appears that the effects of increased stimulation may depend on whether the stimulation is part of the task, on the periphery of the task, or in the distal environment. When studies are grouped according to locus of increased stimulation, patterns do emerge.

DISTAL STIMULATION

The bulk of evidence suggests increases in distal environmental stimulation do not disrupt visual task performance. Studies that have used visual distractors with hyperactive retarded children (e.g., Cromwell & Foshee 1960), with hyperactive, normal-IQ populations (e.g., Shores & Haubrich 1969), and with normal-IQ, distractible populations (Somervill, Warnberg, & Bost 1973) have reported nonsignificant effects on performance. Furthermore, studies that have involved combined visual (distal) and auditory distractors with normal-IQ populations (e.g., Zentall & Zentall 1976) have found no evidence that hyperactives perform worse on visual tasks with such distractions.

Thus when subjects are engaged in a visual task, their performance appears to be relatively unaffected by manipulated changes in the distal sensory environment.

PERIPHERAL STIMULATION

Manipulation of visual stimulation on the boundaries of the task (e.g., on the border of the page) has often had stronger effects on visual task performance than has distal stimulation.

Browning (1967) assessing minimal brain dysfunction children exposed to flashing colored lights and Carter and Diaz (1971) assessing learning disabled children exposed to combined high visual and auditory stimulation reported that the distracting condition facilitated performance relative to normal children.

In general, then, task performance is not adversely affected by peripheral “distracting” stimulation; in fact, under certain conditions performance may improve.

WITHIN-TASK STIMULATION

Some research has suggested increasing within-task stimulation for hyperactive children. Cruickshank, Bentzen, Ratzeburg, and Tannhauser (1961) have suggested increasing the size and color of the instructional materials. More recently, Hallahan and Kauffman (1976) have proposed the use of “vivid colors to highlight instructional materials” for hyperactive children, although they admit that “no investigations have been made of Cruickshank’s recommendations of the specific use of teaching materials that are highly stimulating” (pp. 160–162).

Atkinson and Seunath (1973), however, have demonstrated that children with learning
disorders were more distractible than normals when the discriminative stimulus changed position from trial to trial (high stimulation), compared to a condition where it remained in a constant position (low stimulation). But poor scanning strategies or problems with sustained visual attention required by the high stimulation task may have contributed to the difficulty experienced by the learning disabled children with the high stimulation task.

Others have also reported greater performance decrements for hyperactives than for normals (Adams, Hayden, & Canter 1974) and for nonreaders than for readers (Sabatino & Yseldyke 1972) when within-task stimulation was increased by embedding the task figures in a background of competing lines. But adding stimulation of this kind also makes the tasks more difficult, a factor that explains the group differences. Furthermore, in both studies low stimulation tasks were always administered first, confounding added stimulation with time in the experiment (a factor demonstrated to produce greater decrements in the performance of hyperactive children than of normals — Douglas 1974).

Thus in all three reported studies increased stimulation has been confounded with other changes likely to affect task difficulty.

The effects of increased stimulation on performance may be quite different when the stimulation provides relevant noncompeting cues (increasing the discriminability of the task stimuli necessary for a correct response) than when increased stimulation provides competing cues (increasing the discriminability of task stimuli inappropriate to a correct response).

While it is clear that increases in competing, within-task stimulation can produce learning deficits (distraction) for hyperactive, minimal brain damaged, or learning disabled children, there has been no empirical test of educational recommendations to increase noncompeting, within-task stimulation for hyperactives.

The study sought to investigate the relation between amount of noncompeting, within-task color-stimulation and task performance.

METHOD

Subjects
Twenty-five hyperactive children (23 male and 2 female) between the ages of 6 years 2 months and 10 years 10 months were selected from two private day schools for children with learning and behavior problems on the basis of their high scores (24 to 36; \( \bar{X} = 29.5 \)) on the Rating Scale of Hyperkinesis (Davids 1971). Their mean mental ages (derived from IQ scores on the WISC or Binet) and chronological ages were 7 years 10 months and 8 years 8 months, respectively.

Twenty-two normal control children (20 male and 2 female), with a chronological age range similar to that of the hyperactive children (5 years 10 months to 10 years 0 months) were selected from a parochial and a public elementary school on the basis of their low average scores (6 to 18; \( \bar{X} = 10.8 \)) on the Rating Scale. Their mean mental ages (derived from IQ scores on the Primary Mental Abilities Test) and chronological ages were 8 years 3 months and 7 years 11 months, respectively. The differences in mental and chronological ages between hyperactive and normal children were not significant: \( F (1, 44) = 3.90, p < .05 \) and \( F (1, 44) = 1.07, p < .05 \), respectively.

None of the hyperactive children had diagnoses of psychosis or displayed bizarre behavior, although many had referral complaints of accompanying emotional and behavior disorders in addition to learning difficulties. Children undergoing drug therapy or with obvious emotional problems or with sensory or motor impairment were not included.

Experimental Rooms
In each school a small room containing a desk and two chairs was used to carry out the experiment. Routine school sounds could be heard through the walls of each of the experimental rooms.

Tasks
The Developmental Test of Visual Perception (DTVP) eye-hand coordination subtest involved
drawing lines within narrow boundaries (Frostig 1963) on white paper (black and white condition, BW) versus alternating sheets of blue, yellow, and pink paper (color-added condition, CA). The DTVP was selected because there is evidence that it produces poorer performance in normal-IQ, hyperactive children than in normal-IQ controls (Douglas 1974, p. 18).

The second task involved form copying and was taken from the Developmental Test of Visual-Motor Integration (VMI) by Beery and Buktenica (1967). Fifteen forms that could be colored-in were selected (forms 3, 6, 9, 10, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24). The stimulus forms were black outlines of shapes on white paper (BW) or the same shapes filled with color (CA). The colors used were purple, orange, red, yellow, pink, green, brown, and blue. The VMI, a visual motor task (as is the DTVP), was also expected to elicit impulsive responding.

The DTVP and VMI were scored according to the test manuals (Berry & Buktenica 1967, Frostig 1963) by an independent rater, who was unaware of the purpose, conditions, or type of children involved in the study.

The third task consisted of arrays of line-drawn (black) squares arranged in a pattern on a 5" × 8" white card (6 to 10 squares per card). The child was instructed to copy the design using either white cubes (BW) or colored (blue, green, red, yellow, and black) cubes (CA). The third task, referred to as the block design (BD) task,* was designed to be somewhat different from the DTVP and VMI in that it was not a paper and pencil copying task and consisted of complex patterns. Patterns of the BD tasks were scored correct by the experimenter if each block was in its appropriate relative position.

The fourth task involved the rapid naming of a sequence of shapes (RNS) drawn on a large 10" × 15" white card. Five shapes (circle, triangle, square, star, and rectangle) each appeared 10 times on the card (5 rows of 10 shapes) and were randomly ordered with the constraint that each shape had to occur at least once in each row. On the BW card the shapes were line drawn with black ink. In the color-constant condition (CC), the shapes were colored in: triangles red, squares orange, stars blue, rectangles green, and circles yellow. For the random color condition (RC) the five different colors were randomly assigned to the shapes. The same sequence of shapes was used for all three conditions. The RNS task was adapted from tasks used in distraction research (e.g., Alwitt 1966) and has been found to differentiate normal from hyperactive children.

Children were pretested to ensure they could identify the five shapes. They were then instructed to quickly name each shape on the experimental card. Accuracy was scored by an independent rater, blind to conditions and groups, using tape recordings of the experimental sessions. Errors were classified in four ways: (1) Omission errors occurred when the subject skipped one or more shapes. (2) Addition errors involved naming shapes already named. Both omission and addition errors indicated the subject had lost his place by omitting or repeating a whole row, partial row, or single shape and were thought to result from deficits in sustained visual attention. (3) Substitution errors involved giving an incorrect name to a shape. (4) Self-correction errors occurred when a child attempted to correct an error.

All four tasks were administered during a half-hour session with the condition (BW or CA) constant within a session. All children were retested on the other condition one week later at the same time of day in a repeated measures crossover design. Two orders of task presentation (1, 2, 3, 4 and 4, 3, 2, 1) were counterbalanced across conditions and groups. For the RNS task that involved two different CA conditions (RC and CC), both subconditions were given sequentially during the CA session, with the order of presentation counterbalanced across groups.

The two experimenters were randomly assigned one normal and one special school.

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*Copies of the stimulus cards used for the Block Design task can be obtained from Sydney S. Zentall, Department of Special Education, Eastern Kentucky University, Richmond, Ky. 40475.
FIGURE 1. Mean time to complete visual motor integration task (VMI), Developmental Test of Visual Perception (DTVP), block design task (BD), and rapid naming of shapes task (RNS), for hyperactives (H) and normals (N).

FIGURE 2. Mean number of errors for visual motor integration task (VMI), Developmental Test of Visual Perception (DTVP), block design task (BD), and rapid naming of shapes task (RNS), for hyperactives (H) and normals (N).
Subject order was randomly determined within each of these schools. During the first two days of testing in each week one experimenter was testing special children while the other experimenter was testing normals; this order was reversed during the second two days of testing.

RESULTS

Two performance measures of attention (time to complete the task and errors) were recorded for the four tasks. Time scores were transformed (log x) as were error scores (log x + 1) because the raw scores were not normally distributed.

A two-way repeated measures analysis of variance was done on transformed time-error scores. The repeated measure was Condition (black-white vs. color). The nonrepeated measure was Group (hyperactive vs. normal).

Time

The time data are presented in Table I.

**Group effects.** Hyperactives took significantly less time than normals to complete the VMI, $F(1, 45) = 5.39$, $p < .025$, and though statistically unreliable, the direction of the effect was the same for the DTVP, $F(1, 45) = .53$, $p = .471$.
On the other hand, the hyperactive children took significantly more time than the normals to complete the RNS, $F(1, 45) = 7.78, p = .008$ and more time to complete the block design task, though not significantly so, $F(1, 45) = 1.74, p = .194$. The group effects can be seen in Figure 1.

**Condition effects.** The main effect of color on time to complete task did not approach significance for any of the tasks, nor did the interaction between group and condition.

**Errors**

The error data are also presented in Table I.

**Group effects.** Analyses performed on the error data indicated significantly poorer performance by the hyperactive children on the VMI, $F(1, 45) = 8.80, p = .005$; DTVP, $F(1, 45) = 9.63, p = .003$; and the RNS, $F(1, 45) = 9.01, p = .004$; and a similar, though not significant, difference was found on the BD, $F(1, 45) = .80, p = .375$. The group effects can be seen in Figure 2.

In general the hyperactive children made more errors than the normally active children. A more detailed analysis of the types of errors made on the RNS task revealed that the hyperactive children made significantly more omission errors than normals, $F(2, 90) = 4.40, p = .042$. Differences in the same direction were found for substitution errors, $F(2, 90) = 3.30, p = .076$; self-correction errors, $F(2, 90) = 1.30, p = .260$; and addition errors, $F(2, 90) = .91, p = .345$.

**Color effect.** As with time to complete task, the main effect of color on errors did not approach significance for any of the tasks.

**Interaction.** The general tendency on the VMI, DTVP, and BD tasks was for the hyperactive children to be less accurate with color than without color (relative to normals), though the interaction was significant only for the VMI task, $F(1, 45) = 5.05, p = .030$. Apparently, with the VMI task hyperactive children made more errors with color while normal children made more errors without color.

A detailed analysis of the types of errors made on the RNS task indicated a significant interaction only for addition errors, $F(2, 90) = 4.11, p = .020$. With addition errors, as with VMI errors, hyperactives appeared to suffer from the added color (both color constant and random color relative to the black and white condition), whereas normals tended to improve.

It was expected that omission errors would show effects similar to those of addition errors since both should reflect “losing one’s place.” That omission errors did not show the same interaction as addition errors may be attributable to the great variability in the omission error scores within both groups. The range of omission errors was more than twice the range of addition errors for both hyperactive and normal children. If one considers the median number of omission errors (the median is a measure of central tendency less affected by extreme scores), there is some agreement between addition and omission errors. The hyperactive made more errors in the color-constant condition (median = 2.0) than in the black and white condition (median = 1.0), while the normal children showed no differences across conditions (median = 0.0 for all three conditions).

**DISCUSSION**

As expected, hyperactive children generally made more errors than normals across all tasks, results consistent with those previously reported by studies that have used these tasks. In contrast to the consistent error data, the time data showed task-dependent group differences. For two of the tasks (VMI and DTVP) hyperactive children performed faster than normals, an outcome consistent with the view that performance deficits in hyperactive children are due to their fast, “impulsive” responding (cf. Keogh 1971). For the other two tasks (BD and RNS), hyperactives performed slower than normals.

That time differences were not significant for either the BD or the DTVP may have been due to the fact that both involved more direct experimenter control. With these tasks the experimenter intervened after each problem to present the next problem, while with the VMI
and RNS tasks children proceeded through tasks on their own. There is evidence that experimenter intervention may improve the performance of hyperactive children, i.e., individually versus group administered tests (Douglas 1974), thereby reducing the magnitude of time differences for both the BD and DTVP tasks.

Differences between hyperactives' and normals' time scores that depend on type of task have also been reported by Jacobs (1972). She found that on a simple decision-making task (two-choice task), hyperactives took less time and made more errors, whereas on complex decision-making tasks (sorting cards into stacks, involving from four to eight choices), hyperactives took more time and still made more errors. Since it is reasonable to expect that as task complexity (the number of required choices) increases so does the amount of sustained visual attention, it may be difficult to separate the contribution attention and complexity take to the increased time hyperactives take to complete the task. Adding complexity and/or sustained visual attention to a task can be expected to slow task completion for hyperactive children considerably more than for normals, while errors made by hyperactives remain greater.

The time and accuracy data for the VMI and DTVP visual motor tasks suggest the possibility that for tasks such as these there may be a trade off between accuracy and time; impulsive responding may lead to poorer performance. There is evidence that both cognitive training (e.g., strategy rehearsal, Douglas 1976) and increased incentives for slower, more careful performance (Douglas 1974) slowed performance on a visual motor task without decreasing errors, outcomes that suggest accuracy and time scores may, in fact, be independent.

The main purpose of the present study was to assess the possible facilitative effects of added, noncompeting, within-task stimulation (color) on performance. For three of the four tasks, hyperactives tended to differ from normals more when color was present than when color was absent. Though the differences were significant for only the RNS (addition errors) and VMI tasks (more sensitive tasks not involving continual experimenter intervention), it is of interest that the differences were not consistent with findings from previous research with normal-IQ, hyperactive children using distal and peripheral stimulation, and opposite to predictions that the addition of color to instructional materials should facilitate performance of hyperactive children. The detrimental effects of added color are consistent, however, with the effects of added competing within-task stimulation.

We have since supported the above findings using added relevant within-task stimulation (e.g., coloring the words in a spelling learning task) that exacerbated hyperactive children's learning problems and activity levels (Zentall, Zentall, & Booth 1978).

The results of the present study together with findings from prior studies that have manipulated distal and peripheral stimulation suggest that the location of added stimulation may be important in determining its effects on performance. In the case of added distal and peripheral stimulation hyperactive children may have no difficulty distinguishing the added stimulation from the task itself, and thus performance does not suffer; in fact, performance may actually improve. The addition of stimulation to the task may produce increased attention to the task, but it may also embed the task within the added stimulation. This appears to be true regardless of whether the stimulation increases the discriminability of task stimuli that are (1) appropriate to a correct response (noncompeting cues); or (2) inappropriate to a correct response (competing cues). There is evidence that hyperactive children do, in fact, have more difficulty than normal separating embedded figures from ground (Campbell, Douglas, & Morgenstern 1971). Thus it appears that adding stimulation to a task (not adding stimulation in general) contributes to the learning problems of hyperactive children.
ABOUT THE AUTHORS

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21

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