Journal of Consulting and Clinical Psychology
1976, Vol. 44, No. 5, 693–697

# Activity and Task Performance of Hyperactive Children as a Function of Environmental Stimulation

Sydney S. Zentall
*Eastern Kentucky University*

Thomas R. Zentall
*University of Kentucky*

Hyperactive children in a high-stimulation environment were significantly less active and performed an academically related task no worse than when placed in a low-stimulation environment. The results reject the theory that for hyperactive children activity varies directly and performance inversely with amount of environmental stimulation. Understimulation rather than overstimulation apparently precipitates hyperactive behavior.

Prevailing practice in the treatment of hyperactive children recommends the reduction of environmental stimulation to increase task performance and decrease activity (Alabiso, 1972; Cruickshank, Betnzen, Ratzenburg, & Tannhauser, 1961; Haring, 1974, p. 245; Kirk, 1953, 1972, pp. 48–50; Schrager, 1966; Wasserman, Asch, & Snyder, 1972). The recommendation is based on the assumption that hyperactive and distractible behavior are due to an excess of environmental stimulation. The hyperactive child is assumed to be oversensitive to sensory input due to limited filtering capacity. Motor activity is the result of stimulus "overflow," that is, the shunting of stimulus input directly to response output.

That decreased stimulation results in better performance for hyperactive children, while widely believed and practiced, has received little empirical support (Campbell, Douglas, & Morgenstern, 1971; Carter & Diaz, 1971; Rost & Charles, 1967; Scott, 1970) even by its major proponent (Cruickshank et al., 1961). And although most studies that have examined the relation between environmental stimulation and motor activity have involved mentally retarded children, they do not support the above theory either (Forehand & Baumeister, 1970; Gardner, Cromwell, & Foshee, 1959; Reardon & Bell, 1970; Tizard, 1968). Recently it has been suggested that hyperactive children suffer from underarousal rather than overarousal (Rosenthal, 1973; Satterfield & Dawson, 1971).

In the present study an inverse relation was found between level of environmental stimulation and activity, an outcome that supports an underarousal theory of hyperactivity.

## Method

### Subjects

Sixteen children between the ages of 7 and 11 were selected from 88 children enrolled in a private school for children with learning disabilities and emotional disorders on the basis of their high scores (teacher rated) on the Rating Scales for Hyperactivity (Davids, 1971). Connors' Teacher Rating Scales (Connors, 1969) have also been used to rate hyperactivity (e.g., Quinn & Rapoport, 1975), and although Davids' scales have fewer behavioral items, they contain the same major item clusters as Connors' scales, provide more extensive descriptions of each behavioral item than do Connors' scales, and allow for six rather than four behavior levels for each item. The Davids scales have been found to be reliable and clinically valid and are sensitive to drug versus placebo effects (Davids, 1971; Denhoff, Davids, & Hawkins, 1971). The children selected for the present study had scores that ranged from 26 to 36. According to Davids (1971) children are considered hyperactive if they obtained a score of 24 or above.

The children were exposed to two conditions of environmental stimulation while performing two successive tasks.

### Experimental Room

The experimental room (1.7 m × 6.0 m) contained a child's desk/chair combination at one end (about 1.0 m from the wall) and a folding screen at the other end (about 1.5 m from the wall). Behind the screen was an adult's chair where the experimenter

Preparation of the manuscript was supported by National Institute of Mental Health Grant MH 24092 to the second author.

The authors thank the PACE School, Pittsburgh, Pennsylvania, and its director, Eugenia Donatelli, for cooperation with this research.

Requests for reprints should be sent to Sydney S. Zentall, Department of Special Education, Eastern Kentucky University, Richmond, Kentucky 40475.

sat except when instructions were given to the child. In the low-stimulation condition, the white walls and gray floors were bare and illumination was provided by a 75-W lamp in front of the screen and a 25-W lamp above and behind the desk. Continuous white masking noise was played into the room at 45–55 dB (SPL). In the high-stimulation condition, the walls were decorated with 25 brightly colored pictures and posters and four large lettered signs. A transparent Habit Trail cage (16 cm × 17 cm) with five mice was hung from one wall about 2.0 m in front of the desk. The screen was decorated with a brightly colored three-dimensional papier-mâché scene, and a brightly colored carpet was on the floor. Strings of flashing colored Christmas lights were strung from the screen and across the room. Illumination was provided by a 150-W lamp above and behind the desk and a 100-W lamp in front of the screen. Popular rock music (Led Zeppelin's "House of the Holy") was played into the room at 70–80 dB.

### *Procedure*

Each child was exposed to both of the stimulation conditions, such that eight children were exposed to high stimulation first and eight to low stimulation first. Exposure to the second condition followed exposure to the first condition by 48 hours. The children were exposed to each stimulation condition for 20 minutes. During the first 10 minutes, each child was instructed to sit at the desk and wait there until the experimenter returned. This sitting task in which the child is asked to voluntarily inhibit locomotor activity is reportedly difficult for hyperactive children to perform compared with normal children (Pope, 1970). Activity meters (Timex motion recorder No. 32; a modified self-winding calendar wristwatch) strapped to the child's dominant wrist and same-side ankle provided an objective measure of leg and arm movement. After giving instructions the experimenter appeared to leave the room through a door located behind the screen and then quietly observed the child from behind the screen. The experimenter recorded the amount of time the child remained seated.

After 10 minutes had elapsed, the experimenter appeared to reenter the room, checked the reading of the activity meters, and gave the child materials and instructions for the second task. The second task, an academically related performance task, involved locating and circling the letters of the alphabet in sequential order from a large array of letters (Geake, 1970). The child was instructed to go to the next array and repeat the procedure once he had reached the end of the alphabet. The materials consisted of 20 such arrays, a number that no child was able to complete in 10 minutes. The child was instructed to work at the task while the experimenter worked behind the screen. To discourage locomotor activity during the second task, each child was told the experimenter would remain in the room. The number of appropriate letters circled was the measure of performance. As during the first task, wrist and ankle activity were recorded.

## Results and Discussion

Activity and performance scores for both the sitting task and the letter-circling task under conditions of high and low environmental stimulation are presented in Figure 1.

A repeated measures analysis of variance was performed on the data to examine treatment effects (high stimulation vs. low stimulation), day effects (first day tested vs. second day tested), and sequence effects (high stimulation followed by low stimulation vs. low stimulation followed by high stimulation). Since overall activity and performance varied greatly across children (resulting in a correlation between variances and means), logarithmic transformations ($y = \log_{10} x$) were performed on the raw data prior to data analysis. For the sitting task significant treatment effects were found for wrist activity and ankle activity, $F(1, 14) = 23.24$, $p = .001$, and $F(1, 14) = 9.88$, $p = .007$, respectively. Performance scores, however, did not reflect the difference in stimulation conditions as did the activity scores, perhaps due to the high level of performance shown by almost all children, $F(1, 14) = .17$. Only 5 of the 16 children ever stood during the sitting task.

For the letter-circling task, a significant treatment effect was found for wrist activity, $F(1, 14) = 8.96$, $p = .009$, but not for either ankle activity, $F(1, 14) = .95$, or performance, $F(1, 14) = .43$. Overall, the data indicate that relative to a low-stimulation environment a high-stimulation environment results in decreased activity (three of the four measures) and no tendency toward poorer performance.

For none of the measures was the sequence effect significant, though for the sitting task, ankle activity yielded a significant day effect, $F(1, 14) = 11.54$, $p = .004$; and both wrist and task performance measures approached significance, $F(1, 14) = 3.53$, $p = .081$, and $F(1, 14) = 4.15$, $p = .061$, respectively. The day effects reflect a tendency for the children to perform worse (i.e., stand more often and earlier) and to move wrists and ankles more, on the second day than on the first, an outcome that can be interpreted as the decline in novelty of the experimental environment produced by adaptation (Douglas, 1974; Reardon & Bell, 1970). The day effect suggests that a novel environment per se may reduce activity much as does high stimulation. That is, the novelty of initial exposure to the room (or the anxiety associated with the first-day procedure) produced a decrease in activity comparable to that of the manipulated stimulation condition, suggesting that a novel environment can be high in stimulation value.

The fact that manipulated environmental stimulation had little effect on sitting performance may also be attributed to the novelty of both environments. Near ceiling level performance of the sitting task in both conditions suggests that this task was insufficiently sensitive to the effects of stimulation on hyperactive children because the task was not difficult enough. It is possible that differences would have emerged had subjects been exposed to the task for a longer time. Pope's (1970) finding that hyperactive children perform worse on a sitting task than normal children may have been due to the fact that the task was preceded by four other tasks in the same experimental room.

Even though statistical comparison of treatment effects across tasks is questionable, reduced activity with high stimulation during the letter-circling task appeared to be smaller than that for the sitting task, perhaps due to inherent stimulation provided by the letter-circling task. That is, visual stimulation provided by the task and motor feedback from responding may reduce the impact of environmental manipulation. Task-produced stimulation for both conditions may also account for the minimal effect of increased environmental stimulation on performance. If such reasoning is correct, it may account for the failure by others (Campbell et al., 1971; Carter & Diaz, 1971; Rost & Charles, 1967) to find differences in the performance of academically related tasks for hyperactive children when environmental stimulation was manipulated.

The results of the present study indicate the inappropriateness of treating hyperactive children with stimulus-reduced environments and further question the theoretical model, which assumes that oversensitivity to sensory input precipitates hyperactive behavior. The hyperactive child does not appear to be "driven"

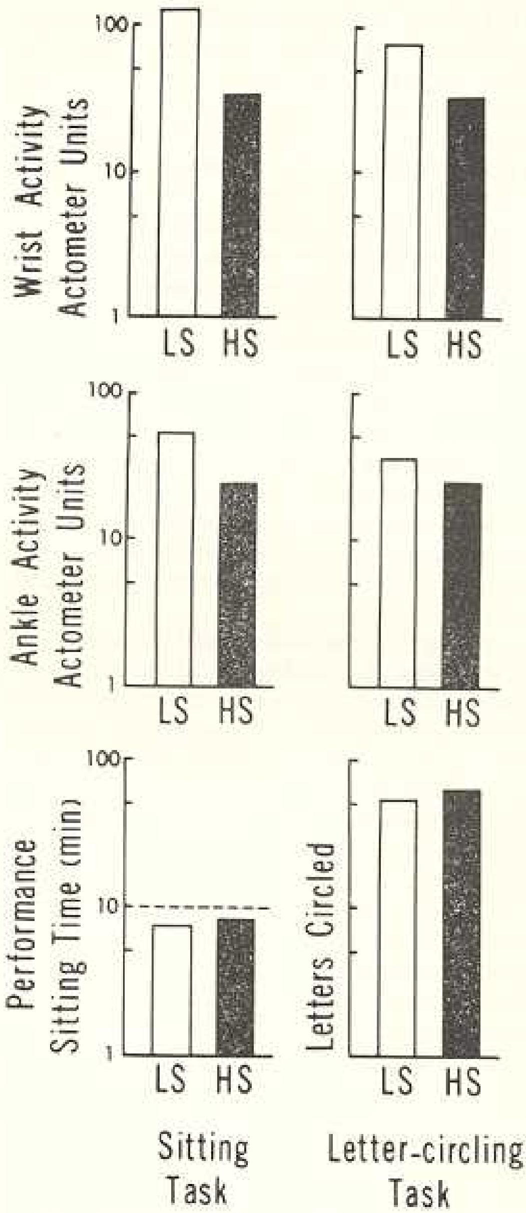


FIGURE 1. Wrist activity, ankle activity, and performance scores (plotted logarithmically) for the sitting task and letter-circling task under conditions of high- (HS) and low-environmental stimulation (LS).

to activity in high-stimulation environments containing "tempting" stimuli; rather, the data suggest that adequate (i.e., high) stimulus input may actually *reduce* certain hyperactive behaviors. Activity for the hyperactive child may function to increase sensory input missing in the environment. Active behavior in normal or hyperactive children may be the visible manifestation of a homeostatic mechanism that attempts to maintain an optimal level of sensory input by supplementing inadequate environmental input with response-produced input. When environmental input is adequate, the hyperactive behavior is not needed to maintain optimal input. It is thus suggested that hyperactive children suffer not from oversensitivity to sensory input but from a kind of sensory blocking or overfiltering, which necessitates a higher level of stimulation to produce the same effect as in normal children.

Support for the theory that hyperactivity is precipitated by inadequate stimulation also comes from studies which have found that stimulant drugs (e.g., amphetamines) produce decreased activity, increased attention, and better performance in many hyperactive children (Freeman, 1966)—effects compatible with those of increased environmental stimulation.

Sensory deprivation studies with normal adults provide an interesting analogy to hyperactive behavior. Prolonged periods of sensory deprivation result in restlessness, disorganization of thought, difficulty in problem solving, and the self-reported inability to concentrate (Scott, Bexton, Heron, & Doane, 1959)—behavioral descriptions typical of hyperactivity (Cromwell, Baumeister, & Hawkins, 1963). The results of sensory deprivation studies suggest the generality of the homeostatic mechanism that may maintain stimulation internally when peripheral stimulation is prevented. When motor activity (characteristic of hyperactive children) is prevented in sensory deprivation studies, subjects often report experiencing hallucinations (Freedman & Greenblatt, 1960) that might be interpreted as internally produced stimulation. Similarly, instructing sensory-deprived subjects to engage in motor activity can greatly reduce impairment produced by sensory deprivation (Zubek, 1963).

The results of the present study and supporting evidence suggest that the present trend in the treatment and education of hyperactive children toward eliminating "distracting" environments may be in error. Instead, the results suggest the importance of maintaining or even increasing environmental stimulation for hyperactive children.

## REFERENCES


Alabiso, F. Inhibitory functions of attention in reducing hyperactive behavior. *American Journal of Mental Deficiency*, 1972, *77*, 259–282.

Campbell, S. B., Douglas, V. I., & Morgenstern, G. Cognitive styles in hyperactive children and the effect of methylphenidate. *Journal of Child Psychology and Psychiatry*, 1971, *12*, 55–67.

Carter, J. L., & Diaz, A. Effects of visual and auditory background on reading test performance. *Exceptional Children*, 1971, *38*, 43–50.

Connors, C. K. A teacher rating scale for use in drug studies with children. *American Journal of Psychiatry*, 1969, *126*, 884–888.

Cromwell, R. L., Baumeister, A., & Hawkins, W. F. Research in activity level. In N. R. Ellis (Ed.), *Handbook of mental deficiency*. New York: McGraw-Hill, 1963.

Cruickshank, W. M., Betnzen, F. A., Ratzenburg, F. H., & Tannhauser, M. T. *A teaching method for brain-injured and hyperactive children: A demonstration pilot study*. Syracuse, N.Y.: Syracuse University Press, 1961.

Davids, A. An objective instrument for assessing hyperkinesis in children. *Journal of Learning Disabilities*, 1971, *4*, 35–37.

Denhoff, E., Davids, A., & Hawkins, R. Effects of dextroamphetamine on hyperkinetic children, a controlled double blind study. *Journal of Learning Disabilities*, 1971, *4*, 491–498.

Douglas, V. I. Sustained attention and impulse control: Implications for the handicapped. In A. Swets & L. L. Elliott (Eds.), *Psychology of the handicapped child*. Washington, D.C.: U.S. Government Printing Office, 1974.

Forehand, R., & Baumeister, A. A. Effects of variations in auditory and visual stimulation on activity levels of severe mental retardates. *American Journal of Mental Deficiency*, 1970, *74*, 470–474.

Freedman, S. J., & Greenblatt, M. Studies in human isolation: I. Perceptual findings. *Armed Forces Medical Journal*, 1960, *11*, 1330–1348.

Freeman, R. D. Drug effects on learning in children: A selective review of the past thirty years. *Journal of Special Education*, 1966, *1*, 17–44.

Gardner, W. I., Cromwell, R. L., & Foshee, J. G. Studies in activity level: II. Effects of distal visual stimulation in organics, familials, hyperactives.

*American Journal of Mental Deficiency*, 1959, *63*, 1028–1033.
Geake, R. R. *Primary tracking: A self-instruction workshop for visual discrimination and perceptual skills in reading*. Ann Arbor, Mich.: Ann Arbor Publishers, 1970.
Haring, N. G. *Behavior of exceptional childen.* Columbus, Ohio: Merrill, 1974.
Kirk, S. P. What is special about special education? The child who is mentally retarded. *Exceptional Children*, 1953, *14*, 138–142.
Kirk, S. P. *Educating exceptional children.* Boston: Houghton Mifflin, 1972.
Pope, L. Motor activity in brain-injured children. *American Journal of Orthopsychiatry*, 1970, *40*, 783–794.
Quinn, P. O., & Rapoport, J. L. One-year follow-up of hyperactive boys treated with inipramine or methylphenidate. *American Journal of Psychiatry*, 1975, *132*, 241–245.
Reardon, D. M., & Bell, G. Effects of sedative and stimulative music on activity levels of severely retarded boys. *American Journal of Mental Deficiency*, 1970, *75*, 156–159.
Rosenthal, J. H. Neurophysiology of minimal cerebral dysfunctions. *Academic Therapy*, 1973, *8*, 291–294.
Rost, K. J., & Charles, D. C. Academic achievement of brain injured and hyperactive children in isolation. *Exceptional Children*, 1967, *34*, 125–126.
Satterfield, J. H., & Dawson, M. E. Electrodermal correlates of hyperactivity in children. *Psychophysiology*, 1971, *8*, 191–197.
Schrager, J. M. The hyperkinetic child: An overview of the issues. *Journal of the Academy of Child Psychiatry*, 1966, *5*, 526–533.
Scott, T. H., Bexton, W. H., Heron, W., & Doane, B. K. Cognitive effects of perceptual isolation. *Canadian Journal of Psychology*, 1959, *13*, 200–209.
Scott, T. J. The use of music to reduce hyperactivity in children. *American Journal of Orthopsychiatry*, 1970, *40*, 677–680.
Tizard, B. E. Experimental studies of over-active imbecile children. *American Journal of Mental Deficiency*, 1968, *72*, 548–553.
Wasserman, E., Asch, H., & Snyder, E. A neglected aspect of learning disabilities. *Journal of Learning Disabilities*, 1972, *5*, 130–135.
Zubek, J. P. Counteracting effects of physical exercises performed during prolonged perceptual deprivation. *Science*, 1963, *142*, 504–506.

(Received June 18, 1975)