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Self-Paced Learning in Children with Attention Deficit Disorder with Hyperactivity

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Attention deficit (ADDH) children self-paced the delivery of response pairs for paired-associate learning at about the rate previously shown to be conducive to relatively good learning in attention deficit. The self-pacing opportunity did not seem either to impair or to enhance the learning performance. On methylphenidate they paced themselves at about the same rate but learned much more. Stimulant therapy does not help by "slowing the child down" but permits more effective memorizing at the same presentation rate.

Though generally inattentive, attention deficit (ADDH) children are known to attend better under some circumstances than under others. Not only do they perform some tasks relatively well (particularly ones of their own choosing), but they will better perform a given task if the circumstances are made "stimulating" (Zentall, 1975) or "salient" (Kinsbourne, 1983). An instance derives from presentation rate in paired-associate learning; the shorter the interval between the presentation of successive pairs for study, the more the ADDH child learns per unit of time (Dalby, Kinsbourne, Swanson, & Sobol, 1977). In contrast, presentation rate does not affect learning by the same children on stimulant medication, or by normal children. The total time hypothesis is obeyed across rates (Dalby et al., 1977). That is, total study

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time determines how much is learned, regardless of how it is divided into trials (Bugelski, 1962).

In Dalby et al. (1977) and in most published studies of learning by ADHD children, the pacing was externally (i.e., experimenter) determined. This study investigated the effect of permitting the children themselves to control the pace of presentation of the stimuli. From our observations of experimenter-paced tasks we noted that subjects appeared impatient during intervals of long duration and often asked the experimenter to proceed to the next item.

Different accounts of ADHD generate opposing expectations for self-paced learning. One view might hold that such children require "structure." Left to their own devices in pacing the learning task, they might exhibit disorganization and learn poorly. Another view might hold that the children comply poorly when task parameters are out of their control. Given control over pacing, their learning scores should improve (Sykes, Douglas, Weiss, & Minde, 1971; Campbell & Werry, 1986). Kinsbourne (1983) drew a parallel between the hyperactive condition and the state of vigilance decrement, observed in normal people when engaged in protracted monotonous activities. Stimulant administration counteracts the vigilance decrement, as does increased signal frequency (Kappauf & Powe, 1959). Self-paced tasks seem exempt from vigilance decrement (Broadbent, 1953). On this basis, self-pacing should result in effectively normal performance (an outcome claimed by Sykes et al., 1971).

If stimulant therapy normalizes learning by ADHD children, then, according to the former view, the benefits of stimulant administration should be particularly great when the task is self-paced. According to the latter view, the medication benefits should be slight. Furthermore, if normal children are a valid model for medicated ADHD children, then for the latter the amount learned should be the same when experimenter- or self-paced (Zacks, 1969).

The mean pace chosen could also be revealing. ADHD children are thought to favor attention-catching aspects of tasks, including fast pace. And indeed, they do relatively better at short than at long presentation rates. It is not known if stimulant therapy minimizes this preference for salient stimuli. If it does, one might expect ADHD children on placebo to select a uniformly rapid presentation rate, but to pace themselves more slowly when normalized on stimulant medication.

The experiment that follows used a method developed for demonstrating characteristics of ADHD and stimulant effects in a controlled laboratory setting taking advantage of the short duration of action of methylphenidate, and the virtually immediate, noncumulative behavioral response, by an acute double-blind drug/placebo paradigm during the different sessions of which alternate forms of the same test procedure are ad-

ministered. The subject's performance under drug and placebo conditions is compared. The method, apart from self-pacing, was identical with that used by Dalby et al. (1977). As noted by Stevenson (1972), paired-associate learning is similar to many situations that children experience in everyday life and is closely related to their success in school and other measures of long-term learning.

METHOD

Subjects

Subjects were 30 children meeting DSM-II criteria (American Psychiatric Association, 1968) for hyperactivity as judged by a pediatric neurologist. They had previously been classified as "favorable responders" to stimulant treatment on the basis of laboratory learning tests (Swanson, Kinsbourne, Roberts, & Zucker, 1978) and had also responded favorably at home and in school. Their mean age was 10.06 years ($SD = 1.57$) with a range of 7 to 12. Twenty-six were male and 4 female. Their mean full scale IQ on the Wechsler Intelligence Scale for Children-Revised was 104.4, $SD = 12.79$ (Verbal = 104.36, Performance = 103.84). The subjects had been taking methylphenidate (Ritalin) for an average of 25.6 months ($SD = 16.2$). All subjects obtained a full scale IQ of at least 80, had no history of cerebral palsy, epilepsy, or brain damage, and had no relevant neurological abnormality.

Materials

Sixteen color slides of animals were used as stimuli. These were divided into two lists of eight, one of which was presented in the morning and one in the afternoon. Experience indicated that this list length was moderately difficult for most of the children used as subjects. A warm-up task of six items preceded actual testing in both sessions. Six orders of each list were compiled by using multiple copies of the stimuli. Blank slides were interpolated after each list order. Slide trays were placed on a Kodak Ektagraphic Carousel Slide Projector, Model B-2. Each list was balanced between sessions with respect to the types of animals.

Procedure

A double-blind crossover design was implemented within a single day. Each child received two gelatin capsules, one containing what was known

to be a clinically effective single dose of methylphenidate for that child (mean 11.8 mg) and the other containing an equal amount of placebo. Individual dosages had been established through clinical titration. The order was counterbalanced between subjects. One capsule was administered at 8:30 a.m. and the other at 12:30 p.m. The short duration of the drug effect makes this acute testing possible. Subjects were tested between 1 and 3 hours after ingestion of a capsule, within the time frame of the drug effect (Swanson et al., 1978).

The paired-associate learning task used in this report has been used in previous studies (Swanson & Kinsbourne, 1976; Swanson et al., 1978; Dalby et al., 1977). Each subject was tested individually and was told that the animals to be shown lived in the Metro Toronto Zoo but were acquired from four other (hypothetical) zoos: the North Zoo, the South Zoo, the East Zoo, and the West Zoo. On the initial presentation of the slides in a given list, the subject was told the name of the animal and its hypothetical location (teaching trial). On the presentations that followed, the subject was required to anticipate the location of the animal before the examiner repeated it 4 seconds after the slide appeared (test trials).

Timing of the presentation rates was controlled by the subject, who had the option of moving to the next slide by use of a hand-held slide advance button any time after the 4-second period of stimulus-alone presentation. Two stop-clocks allowed the experimenter to record presentation rates. A criterion of two correct anticipations of a list or a maximum of 12 trials was set. A randomized presentation of the items in a list constituted a single trial. Interitem intervals were the time until the slides were advanced. Intertrial intervals were also left to the discretion of the subject, but almost invariably they were no less than a minimum of 4 seconds. The learning task dependent variable was the number of errors made. Omissions were scored as errors.

RESULTS

A series of mixed analysis of variance procedures assessed the effects of drug (D)-placebo (P) order (between-subjects factor) and drug (methylphenidate or placebo; within-subjects factor).

The first analysis revealed that fewer mean errors (20.77) occurred in the D condition than in the P condition (31.43), $F(1, 28) = 40.91, p < .001$. No main effect or interaction was caused by drug order.

The second analysis reviewed the mean self-selected presentation rate of the stimuli. No difference was seen between the D state (mean = 4.85 seconds) and the P state (mean = 5.04 seconds). However, there was a sig-

nificant drug by drug order interaction $F(1, 28) = 32.78, p < .001$. In the order PD the subjects *decreased* the stimulus presentation time in the second (D) condition (mean = 4.58 seconds) as compared with the initial (P) condition (mean = 5.16 seconds). No difference was observed in the DP drug order.

Finally, an analysis of completed trials was conducted. Fewer trials were necessary to reach criterion in the D state (9.33) than in the P state (10.33), $F(1, 28) = 6.23, p < .05$. Again an interaction of drug and drug order was observed, $F(1, 28) = 8.97, p < .01$. In the PD order, fewer trials were needed in the D condition (8.13) than in the P condition (10.33). No such differences in the number of trials occurred in the order DP.

DISCUSSION

As expected, the children learned significantly less on placebo than on drug. It is of interest that this was so although colored slides were used as stimuli. Zentall (1986) has reported normalized attention in ADDH children when stimuli were colored. Perhaps this is not so for learning tasks, or perhaps our subjects had more severe attention deficits. The ADDH group paced itself at about one stimulus response pair every 5 seconds, a rate close to the experimenter-imposed rate of a pair every 4 seconds that enabled the best learning for the untreated children in the Dalby et al. (1977) study. This is as expected from a salience or "stimulation level" perspective.

The element of self-pacing exerted little influence over performance. The present group exhibited an error rate of similar magnitude to that of the children in Dalby et al. (1977) when tested at the fast rate. Thus, they neither were handicapped by being deprived of external structure nor benefited by the assumption of personal control. Correspondingly, the stimulant-induced benefit was also similar in degree to that in the Dalby et al. (1977) study. In sum, the self-pacing variable seems not to address core ADDH symptomatology.

Sykes et al. (1971, p. 218) went so far as to suggest that "the child rather than the teacher should determine the pace at which new materials arrive." They inferred this from the finding that hyperactive children exhibited more deficit on an experimenter-paced continuous performance task than on a self-paced serial reaction task. But their design was confounded between pacing and task. The different nature of the two tasks could have been responsible, rather than the different locus of their pacing. In our study, we held the task constant and found no support for their conclusion.

Zacks (1969) found that normal subjects learned no better when self-paced than when externally paced. It appears that normal learners are not

confined to present information when memorizing; they flexibly rehearse previous items while inspecting present ones. This may also apply to ADDH children treated with stimulants. The children paced themselves at much the same rate on drug as on placebo, yet learned much better on drug. The medication seems not to have generated a preference for a slower-moving situation but rather, under comparable pacing conditions, enabled the children to rehearse more flexibly, and perhaps to generate more strategic behavior (cf. Conte, Kinsbourne, Swanson, Zirk, & Samuels, 1986). In contrast, simply giving the children control over the delivery of information for study does not render them able to process in much more effective ways.

As was previously found (Dalby et al., 1977), fast pacing per se mitigates, but does not eliminate, the ADDH child's performance deficit. Complete normalization can be accomplished only if the task is also of intrinsic interest to the child, or if he has an effective incentive for doing it (Kinsbourne, Deutsch, Fiore, & Rosenberger, 1989). For material that is boring or redundant, a fast presentation rate did not help (Schroyer & Zentall, 1986).

We found a drug order effect. Performance in the placebo state was improved if the drug condition preceded rather than followed it. A similar effect was seen in our previous work (Dalby et al., 1977; Swanson et al., 1978). A residual drug effect may have lasted into the afternoon when the drug was administered in the morning.

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