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Contextual Factors in Vigilance Testing of Children with ADHD

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The effect of contextual factors on continuous performance testing was examined by administering a vigilance task to 51 children with ADHD under conditions of examiner presence and absence at different times (i.e., beginning and middle) of an assessment battery. The results showed that the ability to differentiate target stimuli from distractors (d-prime) was related to examiner presence vs. absence, and that response bias (beta), a measure of the subject's carefulness in responding to stimuli, was associated with the time of task administration. The decline in d-prime under conditions of examiner absence was shown to be related more to level of aggression as opposed to level of inattention. Children with ADHD having relatively high levels of aggression demonstrated a significant decline in d-prime scores under conditions of examiner absence, but those with relatively low levels of aggression did not. The results demonstrated the importance of contextual factors on vigilance task performance and suggested a differential impact of contextual variables on children who are inattentive vs. aggressive.

Continuous Performance Tests (CPT) are used frequently in the assessment of attention span and impulse control. The CPT has been shown to differentiate children with hyperactivity from those without it (Sykes, Douglas, & Morgenstern, 1973; Rosenthal & Allen, 1978; Tarnowski, Prinz, & Nay, 1986), but these tasks have failed to consistently distinguish children with ADHD from those having learning, conduct, and emotional disorders (Tarnowski et al., 1986; Nuechterlein, 1983; Aman & Turbott, 1986).

Some evidence indicates that functioning on the CPT is related to performance in the classroom, as measured by direct observation proce-

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dures (Kupietz & Richardson, 1978) and teacher rating scales (Barkley, 1991; Halperin et al., 1988; Klee & Garfinkel, 1983), but this association has not been found consistently (Lovejoy & Rasmussen, 1990). Moreover, the CPT and behavior measures often do not agree when attempts are made to discriminate between children with attention deficit hyperactivity disorder (ADHD) and their non-ADHD peers (Trommer, Hoeppner, Lorber, & Armstrong, 1988; Gordon, Mettelman, & DeNiro, 1989).

Since vigilance testing is conducted in laboratory or clinical settings, questions arise as to the reactivity of children's performance to the artificial circumstances of the laboratory or clinic office (Draeger et al., 1986). Children with ADHD are known to be highly sensitive to contextual variables (Zentall, 1985), such as level of environmental demand (Routh & Schroeder, 1976) and the degree of novelty or unfamiliarity in the surroundings (Barkley, 1977). Performing a relatively novel task, such as the CPT, in an unfamiliar setting with a strange adult present could be expected to optimize the achievement of these children.

One contextual variable that appears to affect vigilance performance is time spent on task. Sykes, Douglas, and Morgenstern (1973) found that hyperactive children showed a decrement in performance on vigilance testing (i.e., omission and commission errors increased) over the duration of the task. A control group of children did not demonstrate a significant change in performance over time. These findings suggest that children with ADHD are particularly vulnerable to the effects of boredom or decreasing levels of environmental stimulation (Zentall, 1985) and have problems modulating levels of central nervous system arousal (Douglas, 1980).

Draeger et al. (1986) demonstrated the importance of another contextual variable, the effect of examiner absence from the room, on CPT performance. They administered a 15-minute vigilance task to children under conditions of examiner presence and absence and found essentially no difference between a group of children with ADHD and normals on this task when the examiner was present. However, children with ADHD were significantly less attentive to target stimuli than the normals when the examiner was not present. The change in response bias (i.e., an index of carefulness of responding) was not significant between present and absent conditions. These findings suggest that the ability to sustain attention is improved by the presence of a supervising adult. The results are consistent with theories linking inattention/impulsivity to deficits in rule-governed behavior (Barkley, 1982).

In the Draeger et al. study, the sample included many children who were aggressive and had conduct problems in addition to meeting criteria for attention deficit disorder with hyperactivity. Research indicates that there is a clear association between ADHD and conduct disorders (Lahey,

Green, & Forehand, 1980; Quay, 1986), but evidence is accumulating to support the presence of distinct symptomatology in children who are hyperactive as opposed to hyperactive and aggressive/conduct disordered (Hinshaw, 1987). Thus it is not clear whether differences between the present and absent conditions could be explained by the coexistence of aggression/conduct problems with ADHD among many of the children in their sample. A competing hypothesis to account for the Draeger et al. results is that children in the sample with high levels of conduct problems attempted to take advantage of the situation created when external cues for control were relaxed by having the examiner leave the room, which significantly affected the group mean.

The main purpose of the present study was to investigate whether continuous performance testing, given under conditions of examiner presence vs. absence and at different times during the course of an assessment battery, relates differentially to measures of various aspects of externalizing behavior. The following hypotheses were examined:

1. Children with ADHD will show a decrement in their sensitivity to target stimuli on a CPT when the examiner is removed from the room.

2. Children with ADHD will show a decline in sensitivity to target stimuli and a more careless response style on a CPT later as opposed to earlier in a testing session.

3. In a sample of children with ADHD, those with higher levels of aggression/conduct problems will show a greater decrement in CPT performance when the examiner leaves the room than those having lower levels of aggression/conduct problems.

METHOD

Subjects

Fifty-one children (43 male), ranging in age from 6-5 to 12-11 and who were referred to the ADHD Program of a regional children's hospital, were studied. Children were diagnosed ADHD if (1) they met DSM IIIR criteria (American Psychiatric Association, 1987), as determined by a team of clinicians associated with the ADHD Program, including a child psychiatrist, clinical child psychologist, and developmental pediatrician, (2) parent ratings on the Hyperactivity factor of the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983), and/or teacher ratings on the Hyperactivity Index of the Conners Teacher Rating Scale-Revised (CTRS-R; Goyette, Conners, & Ulrich, 1978) were greater than one and a half standard deviations above the mean for age and sex, and (3) program clinicians

determined that ADHD symptomatology was not secondary to unremediated learning problems or that ratings on measures of inattention/hyperactivity were not spuriously inflated by ratings on indices of oppositionality/aggression (Abikoff, Courtney, Koplewicz, & Pelham, 1991). Many of the children had coexisting inattention/hyperactivity and oppositionality/aggression. After careful review of assessment findings, cases were discarded if there was doubt regarding whether reports of inattention and hyperactivity might be secondary to oppositional patterns of behavior. Ten cases were excluded because conduct or learning problems could not be ruled out as the major contributor to heightened ratings of inattention and overactivity. All of the children had WISC-R IQs greater than 80.

Measures

Continuous Performance Test. The vigilance task of the Gordon Diagnostic System (Gordon, 1983) was used as the measure of continuous performance. On this task, numbers are presented on a screen one at a time at 1-sec intervals for 9 min, and the child is asked to press a button when a 1–9 combination appears. Several indices are available, most notably Total Correct (i.e., the frequency of responses to 45 target stimuli) and Commissions (i.e., the frequency of responses to non-target stimuli). On another version of the CPT, Omissions (i.e., the complement of Total Correct when both are expressed as proportions) was demonstrated to be related to measures of inattention, and Commissions was shown to be associated with measures of both inattention and impulsivity (Halperin et al., 1988).

Total Correct scores and Commission scores are not independent of each other. For instance, Total Correct can be inflated if the child makes a high number of Commission errors, because random responses might occur at times when target stimuli appear on the screen. To circumvent the problem of interdependence between Total Correct and Commission scores, procedures from signal detection theory (Green & Swets, 1966) have been used frequently to analyze results from the CPT (Beale, Matthew, Oliver, & Corballis, 1987; Draeger et al., 1986; Tarnowski et al., 1986). Signal detection analysis yields a sensitivity index (*d*-prime), which reflects the subject's ability to discriminate target stimuli from distractors, with higher scores indicating greater sensitivity; and an index of response bias (beta), which reflects the degree of certainty required by the subject to respond to stimuli. Higher beta scores are associated with a more cautious approach to responding. The procedure for calculating *d*-prime and beta was reported in Pastore and Scheirer (1974).

Child Behavior Checklist (CBCL). The CBCL was used to obtain parent ratings of externalizing behavior problems. Two of the factors (i.e., Hyperactive and Aggressive) were included in the analyses. Test–retest reliability for these scales exceeds .90, and considerable research supports the concurrent validity of these dimensions (Achenbach & Edelbrock, 1983; Mash & Johnston, 1983; Costello & Edelbrock, 1985). The CBCL has been recommended as both a clinical and research tool for assessing conduct problems (McMahon & Forehand, 1989). The Aggressive scale of the CBCL roughly corresponds to overt manifestations of anti-social behavior, such as argues, attacks people, threatens, and teases peers (Loeber & Schmaling, 1985). The correlation between the Hyperactive and Aggressive factors for the sample in this study was .24.

Conners Teacher Rating Scale-Revised (CTRS-R). The CTRS-R yields three factors: Conduct Problem, Hyperactive, and Inattentive/Passive. Correlations between factors on the CTRS-R and corresponding dimensions from the original CTRS (Conners, 1969) are .92 for Conduct Problem, .87 for Hyperactive, and .82 for Inattentive/Passive (Goyette, Conners, & Ulrich, 1978). Test–retest reliability for each scale exceeds .85 (Edelbrock, Greenbaum, & Conover, 1985). Numerous studies attest to the validity of the original version of this scale (Conners, 1969; Trites, Blouin, Ferguson, & Lynch, 1981; Taylor & Sandberg, 1984). The Conduct Problem Scale assesses overt manifestations of antisocial behavior. The correlation between the Conduct Problem Scale and the Hyperactive factor in the present sample was .59; the correlation between the Conduct Problem Scale and the Inattention/Passive Scale was .43.

Procedure

The CBCL and CTRS-R were sent to the parents via mail after the parents made an initial phone contact with the Program's intake worker. The parents were instructed to complete the CBCL and have the child's teacher fill out the CTRS-R. Subsequently, the parents were asked to mail the materials back to the ADHD Program. In 49 cases, the CBCL was completed, and in 46 cases, the CTRS-R was completed.

Each child was administered the vigilance task on two occasions: the examiner was present during one administration and absent at the other. The order of presentation was counterbalanced. Administration of the tasks occurred in the context of a more comprehensive psychological assessment. The initial administration occurred within the first 10 min of the evaluation, and the second administration began approximately 45 min after completion of the first testing.

Table I. Means and Standard Deviations for Age, IQ, CBCL, and CTRS-R Factors for the Total Sample[a]

Variable	*M*	*SD*
Age	9.1	1.9
WISC-R IQ	107.5	15.2
CBCL hyperactive	70.8	7.4
CBCL aggressive	68.4	10.1
CTRS-R hyperactive	71.1	13.0
CTRS-R inattentive/passive	63.3	8.2
CTRS-R conduct problem	66.2	14.0

[a]Age is reported in years. CBCL and CTRS-R means and standard deviations are in *T*-score form.

RESULTS

Means and standard deviations of the total sample for age and WISC-R IQ, for Hyperactive and Aggressive scores on the CBCL, and for Hyperactive and Conduct Problem scores on the CTRS-R are presented in Table I.

The dependent variables in the analyses were *d*-prime and beta. Correlations between indices derived from signal detection theory and those traditionally used in analyzing vigilance tasks were computed in order to relate the findings of this study with those of other studies. Correlations between *d*-prime scores and corresponding scores on the Total Correct index were extremely high for the present and absent conditions ($r = .95$ for both). Correlations between beta and Commission Errors were −.48 in the examiner present condition and −.76 in the absent condition.

Examiner Absence and Time Effects

A 2 (examiner present vs. absent) by 2 (testing order) repeated measures design was used to examine the effect of examiner absence. Separate analyses were performed to evaluate *d*-prime and beta, because these indices are statistically independent of each other. Means and standard deviations for *d*-prime and beta as a function of examiner presence vs. absence are presented in Table II.

With regard to *d*-prime, there was a significant main effect of examiner condition ($F(1,49) = 22.47, p < .001$), with subjects demonstrating inferior sensitivity to target stimuli in the absent condition. The *d*-prime scores also varied significantly depending on the order of examiner presence ($F(1,49) = 10.91, p < .005$); subjects given the vigilance task first in

Table II. Means and Standard Deviations for *d*-Prime and Beta as a Function of Examiner Condition and Order of Examiner Presence[a]

Order of examiner presence	*d*-prime		Beta	
Examiner present then absent				
Present	.761	(.148)	.743	(.240)
Absent	.699	(.172)	.656	(.307)
Examiner absent then present				
Absent	.820	(.107)	.830	(.151)
Present	.879	(.120)	.720	(.321)

[a]Standard deviations are given in parentheses.

the present condition and then in the absent condition performed more poorly than those given the task in the absent–present sequence. Multiple *t*-tests failed to reveal significant differences in age, IQ, CBCL scores, or CTRS-R scores as a function of order of examiner presence. The interaction of examiner condition and order of examiner presence, that is, the effect of time of task administration, was not significant.

With regard to beta, the main effects of examiner condition and order of examiner presence were not significant, but there was a significant interaction effect, reflecting the impact of administration time ($F(1, 48) = 6.57$, $p < .02$). Higher beta scores were attained when the vigilance task was given earlier in the test battery.

Differential Performance of Clinical Groups Under Conditions of Examiner Presence vs. Absence

Children were divided into relatively high and low levels of hyperactivity and aggression on the basis of a median split of scores on the Hyperactive and Aggressive/Conduct Problem factors of the CBCL and CTRS-R. The median for the CBCL Hyperactive factor was 68 and that for the CBCL Aggressive factor was 69. The median for the CTRS-R Hyperactive factor was 72 and that for the CTRS-R Conduct Problem factor was 65. A median split resulted in four separate clinical groups (i.e., low hyperactive–low aggressive, low hyperactive–high aggressive, high hyperactive–low aggressive, and high hyperactive–high aggressive). Because there was agreement between CBCL groupings and CTRS-R groupings in only 27% of the cases, parent ratings were analyzed separately from teacher ratings. Means and standard deviations on the behavioral measures for each combination of high vs. low levels of hyperactivity and aggression, as determined by CBCL and CTRS-R scores, are given in Table III.

Table III. Means and Standard Deviations on the CBCL and CTRS-R for Each Clinical Group[a]

Clinical group	CBCL hyperactive		CBCL aggressive	
Low hyp–low agg (N = 11)	64.1	(5.3)	57.0	(4.7)
High hyp–low agg (N = 12)	75.9	(6.6)	62.6	(6.0)
Low hyp–high agg (N = 6)	64.0	(4.6)	75.8	(7.5)
High hyp–high (N = 20)	73.4	(5.2)	76.0	(6.0)
	CTRS-R hyperactive		CTRS-R conduct prob	
Low hyp–low agg (N = 13)	58.3	(8.0)	52.2	(6.5)
High hyp–low agg (N = 9)	78.0	(4.7)	57.2	(5.3)
Low hyp–high agg (N = 10)	64.0	(7.4)	71.5	(5.1)
High hyp–high agg (N = 14)	83.5	(8.7)	81.1	(9.8)

[a]Hyp refers to scores on the CBCL Hyperactive scale or CTRS-R Hyperactive scale; Agg refers to scores on the CBCL Aggressive scale or CTRS-R Conduct Problem scale. Subjects were determined to be high vs. low on the Hyperactive and Aggressive scales on the basis of a median split. CBCL and CTRS-R means and standard deviations are given in T-score form. Standard deviations are in parentheses.

A 2 (high vs. low hyperactivity) by 2 (high vs. low aggression/conduct problems) by 2 (examiner present vs. absent) repeated measures design was used to analyze the performance of children with varying levels of hyperactivity and aggression under conditions of examiner presence and absence. When the clinical groups were determined by CBCL scores and d-prime was the dependent variable, there was a significant interaction between level of aggression and examiner condition ($F(1,45) = 5.47$, $p < .05$). Removing the examiner from the room resulted in a significant decrement in d-prime scores only for the relatively aggressive children. The interaction between level of hyperactivity and examiner condition was not significant, nor was the three-way interaction of level of aggression, level of hyperactivity, and examiner condition. Means and standard deviations for d-prime during the present and absent conditions for each clinical group, as determined by CBCL scores, are given in Table IV.

When clinical groupings were determined by Hyperactive and Conduct Problem scores on the CTRS-R and d-prime was the dependent variable, performance under conditions of examiner presence vs. absence did not vary significantly as a function of level of aggression or level of hyperactivity. The three-way interaction of level of hyperactivity, level of aggression, and examiner condition demonstrated a trend toward significance ($p < .10$). Means and standard deviations for d-prime during the present and absent conditions for each combination of high vs. low hyperactivity and aggression, as measured by the CTRS-R, is presented in Table V. The re-

Table IV. Means and Standard Deviations for *d*-Prime According to Examiner Condition and Levels of CBCL Hyperactivity and Aggression[a]

Level of hyperactivity/aggression	Present		Absent	
Low hyp–low agg (N = 11)	.813	(.192)	.771	(.193)
High hyp–low agg (N = 12)	.846	(.131)	.847	(.135)
Low hyp–high agg (N = 6)	.762	(.167)	.703	(.151)
High hyp–high agg (N = 20)	.833	(.121)	.773	(.152)

[a]Hyp refers to scores on the CBCL Hyperactive scale; Agg refers to scores on the CBCL Aggressive scale. Standard deviations are given in parentheses.

sults suggest a trend toward a decrement in *d*-prime scores under conditions of examiner absence for children with relatively high scores on the Hyperactive factor and/or Conduct Problems factor of the CTRS-R. The only group that clearly failed to show a decrement in *d*-prime scores upon removal of the examiner from the room was the one with relatively low scores on the Hyperactive and Conduct Problems factors.

The data were re-analyzed using the Inattentive/Passive factor of the CTRS-R instead of the Hyperactive factor. The median for the Inattentive/Passive factor was 64. Children in the high inattention group (N = 24) had a mean of 69.4 and a standard deviation of 5.4; children in the low inattention group (N = 22) had a mean of 56.6 and a standard deviation of 4.6. Performance under conditions of examiner presence vs. absence did not vary as a function of ratings on the Inattentive/Passive factor or on the interaction of ratings on the Inattentive/Passive factor and Conduct Problems factors. Means and standard deviations during the present and absent conditions for each combination of high vs. low inattention and aggression, as measured by the CTRS-R, are presented in Table VI. The results showed a trend toward a decrement in *d*-prime scores under conditions of examiner absence for children with relatively high scores on the Conduct Problems factor. There was essentially no difference in *d*-prime

Table V. Means and Standard Deviations for *d*-prime According to Examiner Condition and Levels of CTRS-R Hyperactivity and Conduct Problems[a]

Level of hyperactiviyt/aggression	Present		Absent	
Low hyp–low agg (N = 13)	.849	(.148)	.839	(.134)
High hyp–low agg (N = 9)	.731	(.153)	.651	(.168)
Low hyp–high agg (N = 10)	.880	(.107)	.795	(.165)
High hyp–high agg (N = 14)	.829	(.158)	.769	(.118)

[a]Hyp refers to scores on the CTRS-R Hyperactive scale; Agg refers to scores on the CTRS-R Conduct Problem scale. Standard deviations are given in parentheses.

Table VI. Means and Standard Deviations for *d*-prime According to Examiner Condition and Levels of CTRS-R Inattention/Passivity and Conduct Problems[a]

Level of inattention/aggression	Present		Absent	
Low ina–low agg (N = 14)	.791	(.174)	.747	(.184)
High ina–low agg (N = 8)	.818	(.135)	.789	(.148)
Low ina–high agg (N = 8)	.852	(.132)	.775	(.159)
High ina–high agg (N = 16)	.850	(.147)	.782	(.136)

[a]Ina refers to scores on the Inattention/Passive factor of the CTRS-R; Agg refers to scores on the CTRS-R Conduct Problem factor. Standard deviations are given in parentheses.

scores between present and absent conditions for children with high vs. low levels of inattention, as rated on the CTRS-R.

With beta as the dependent variable, there was not a significant difference between present and absent conditions as a function of level of inattention/hyperactivity or level of aggression, either when groups were determined by CBCL or CTRS-R scores. Similarly, beta scores attained early vs. late in the session did not vary as a function of level of inattention/hyperactivity or aggression.

DISCUSSION

The results confirmed that the vigilance task performance of children with ADHD is significantly reactive to context. In this study, a group of children with ADHD generally performed more poorly on vigilance testing when the examiner was not present and when the vigilance task was readministered later in the assessment. However, the two indices derived from vigilance testing were sensitive to different contextual dimensions. The ability to differentiate target stimuli from distractors (i.e., *d*-prime scores) varied with examiner presence vs. absence; response bias (i.e., beta scores) varied according to time of task administration.

These findings suggested that for children with ADHD sensitivity to target stimuli is highly reactive to the presence of adult supervision, with poorer attentiveness being associated with adult absence. In contrast, carelessness of response style appears linked to the degree of familiarity with the setting, examiner, and task, with increasing carelessness being associated with a greater degree of familiarity.

The first hypothesis was confirmed. In a heterogeneous group of children with ADHD, sensitivity to target stimuli declines when the examiner leaves the room. However, differences in reactivity to examiner absence emerged for subgroups of children.

Aggressive children, in general, were more likely to demonstrate a decrement in performance under conditions of examiner absence than children who were relatively non-aggressive. Thus, the third hypothesis was tentatively confirmed, but the effects of examiner absence on aggressive children was more marked when aggression was assessed by parents as opposed to teachers. Children with higher levels of aggression, as determined by parents' ratings, demonstrated a significant difference in *d*-prime scores between conditions of examiner presence and absence, but those with lower levels of aggression did not. There was no difference in *d*-prime scores between present and absent conditions for children with either high or low scores on the CBCL Hyperactive factor. The pattern of results was somewhat more complex when vigilance performance was related to teacher ratings. Children with high ratings on either the Hyperactive or Conduct Problems factors of the CTRS-R demonstrated a trend toward a decrement in *d*-prime scores when the examiner was removed from the room, but those with lower levels of hyperactivity and conduct problems did not. There was essentially no difference in *d*-prime scores between present and absent conditions for children with either high or low scores on the Inattentive/Passive factor of the CTRS-R.

The different pattern of results that emerged from parents vs. teachers appears related in part to variations in what each scale measures. The Hyperactive factor of the CBCL measures a heterogeneous set of behaviors, including inattention, immaturity, learning problems, and hyperactivity. On the other hand, the CTRS-R factors assess a more homogeneous set of behaviors. The Hyperactive factor of the CTRS-R assesses hyperactivity and impulsivity, and the Inattentive/Passive factor assesses inattention and, to some extent, social passivity. Children with a high degree of hyperactivity and impulsivity, but not necessarily a high degree of inattention, responded similarly to those who were aggressive. Both the hyperactive and aggressive groups appear more likely to take advantage of the situation created when the level of adult supervision is relaxed by having the examiner leave the room. This finding is not surprising given the moderate to high correlation (i.e., .59) between the Hyperactive and Conduct Problem factors of the CTRS-R in this sample. In contrast, children with ADHD who demonstrate a high level of inattention, immaturity, and learning problems, but not necessarily a high level of hyperactivity, may be no more vulnerable to the effects of reducing external cues for control than those with low levels of inattention. The findings highlight the similarity between disorders in rule governed behavior, that is hyperactivity and aggression (Barkley, 1982; Lahey, Green, & Forehand, 1980), and the dissimilarities between hyperactivity and inattention (King & Young, 1982; Lahey, Shaughency, Hynd, Carlson, & Nieves, 1987).

The relatively small sample sizes of most of the clinical groupings render these conclusions to be rather tentative. The ecological validity of measures of vigilance task performance derived under conditions of examiner presence vs. absence needs to be further investigated using larger sample sizes as well as multiple measures of inattention, hyperactivity, and conduct problems, including direct observation methods as well as parent and teacher ratings.

The results partially confirmed the second hypothesis. Subjects showed a decline in carefulness of responding, but not sensitivity to target stimuli, between early and later task administrations.

In this study attentiveness to target stimuli (i.e., *d*-prime) did not decline between early and later task administrations within an extended battery of tests. In contrast, both Sykes et al. (1973) and Halperin, Sharma, Greenblatt, and Schwartz (1991) found a significant increment in omission errors, which are very highly correlated with *d*-prime scores, over time during the course of a single vigilance testing. (In this study *d*-prime scores did not change significantly over the course of a single testing, but there was a trend in the expected direction.) Considered together, the results suggest that, at least for children with ADHD, the ability to sustain attention declines over the course of vigilance testing, but is rejuvenated after a period where the child is allowed to shift attention to other activities.

The results further indicated that for children with ADHD, performance on a CPT becomes more careless over time. In this study, there was essentially no decline in beta scores over time during the course of a single vigilance testing, but there was a significant decrement in beta scores between early and later task administrations. Responding to a series of task demands over the course of an extended testing battery appears to result in a more careless response to continuous performance tasks. Research is needed to investigate further time effects on vigilance testing and the conditions that promote a revival vs. a decline of children's ability to attend and to respond carefully to CPTs.

It should be noted that the findings of this study were obtained using one version of the continuous performance test, that is, the Gordon Vigilance Task. Longer versions of the CPT, using auditory as opposed to visual methods of stimulus presentation and a longer interstimulus interval, might produce different patterns of results (Halperin et al., 1991; Draeger et al., 1986).

In conclusion, the findings raise additional questions regarding the stability and ecological validity of vigilance tasks (Barkley, 1991). The results suggest that assessing children on vigilance tasks with the examiner absent or when the testing occurs later in the course of an assessment battery may produce a different pattern of findings than those generated under

standard conditions or when testing takes place earlier in the session. Also, children with ADHD having relatively high levels of aggression/conduct problems appear to be particularly vulnerable to the effects of reducing the degree of adult supervision during continuous performance tasks. Further research is needed to clarify the significance of vigilance testing under these different conditions and the relationship of vigilance performance under various conditions to children's functioning in naturalistic contexts.

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REFERENCES

Abikoff, H., Courtney, M., Koplewicz, H. S., & Pelham, W. E. (1991). The Influence of Halo Effects on Teachers' Ratings of Behavior Problems. Paper presented at the Annual Meeting of the Society for Research in Child and Adolescent Psychopathology, Zandvoort, Holland.

Achenbach, T. M., & Edelbrock, C. S. (1983). *Manual for Child Behavior Checklist and Revised Child Behavior Profile*. Burlington: University of Vermont: Department of Psychiatry.

Aman, M. G., & Turbott, S. H. (1986). Incidental learning, distraction, and sustained attention in hyperactive and control subjects. *Journal of Abnormal Child Psychology, 14*, 441-455.

American Psychiatric Association (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, D.C.: Author.

Barkley, R. A. (1977). The effects of methylphenidate on various measures of activity and attention in hyperkinetic children. *Journal of Abnormal Child Psychology, 5*, 351-369.

Barkley, R. A. (1982). Guidelines for defining hyperactivity in children: Attention deficit disorder with hyperactivity. In B. B. Lahey & A. E. Kazdin (Eds.), *Advances in clinical child psychology* (Vol. 5, pp. 137-180). New York: Plenum Press.

Barkley, R. A. (1991). The ecological validity of laboratory and analogue assessment methods of ADHD symptoms. *Journal of Abnormal Child Psychology, 19*, 149-178.

Beale, I. L., Matthew, P. J., Oliver, S., & Corballis, M. C. (1987). Performance of disabled and normal readers on the continuous performance test. *Journal of Abnormal Child Psychology, 15*, 229-238.

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

Costello, E. J., & Edelbrock, C. S. (1985). Detection of psychiatric disorders in pediatric primary care: A preliminary report. *Journal of the American Academy of Child and Adolescent Psychiatry, 24*, 771-774.

Douglas, V. I. (1980). Higher mental processes in hyperactive children: Implications for training. In R. Knights & D. Bakker (Eds.), *Treatment of hyperactive and learning disordered children* (pp. 65-92). Baltimore: University Park Press.

Draeger, S., Prior, M., & Sanson, A. (1986). Visual and auditory attention performance in hyperactive children: Competence or compliance. *Journal of Abnormal Child Psychology, 14*, 411-424.

Edelbrock, C. S., Greenbaum, R., & Conover, N. C. (1985). Reliability and concurrent relations between the teacher version of the Child Behavior Profile and the Conners Revised Teacher Rating Scale. *Journal of Abnormal Child Psychology, 13*, 295-303.

Gordon, M. (1983). *The Gordon Diagnostic System*. DeWitt, NY: Gordon Systems.

Gordon, M., Mettelman, B. B., & DiNiro, D. (1989). Are Continuous Performance Tests Valid in the Diagnosis of ADHD/Hyperactivity? Paper presented at the 97th Annual Convention of the American Psychological Association, New Orleans.

Goyette, C. H., Conners, C. K., & Ulrich, R. F. (1978). Normative data on Revised Conners Parent and Teacher Rating Scales. *Journal of Abnormal Child Psychology, 6*, 221-236.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics*. New York: Wiley.

Halperin, J. M., Wolf, L. E., Pascualvaca, D. M., Newcorn, J., Healey, J. M., O'Brien, J. D., Morganstein, A., & Young, G. (1988). Differential assessment of attention and impulsivity in children. *Journal of the American Academy of Child and Adolescent Psychiatry, 27*, 326-329.

Halperin, J. M., Sharma, V., Greenblatt, E., & Schwartz, S. T. (1991). Assessment of the continuous performance test. *Psychological Assessment: A Journal of Consulting and Clinical Psychology, 3*, 603-608.

Hinshaw, S. P. (1987). On the distinction between attentional deficits/hyperactivity and conduct problems/aggression in child psychopathology. *Psychological Bulletin, 101*, 443-463.

King, C., & Young, R. (1982). Attentional deficits with and without hyperactivity: Teacher and peer perceptions. *Journal of Abnormal Child Psychology, 10*, 483-496.

Klee, S. H., & Garfinkel, B. D. (1983). A computerized continuous performance task: A new measure of attention. *Journal of Abnormal Child Psychology, 11*, 487-496.

Kupietz, S. S., & Richardson, E. (1978). Children's vigilance performance and inattentiveness in the classroom. *Journal of Child Psychology and Psychiatry, 19*, 145-154.

Lahey, B. D., Green, K. D., & Forehand, R. (1980). On the independence of rating hyperactivity, conduct problems, and attention deficits in children: A multiple aggression analysis. *Journal of Consulting and Clinical Psychology, 48*, 566-574.

Lahey, B. B., Shaughency, E., Hynd, G., Carlson, C., & Nieves, N. (1987). Attention deficit disorder with and without hyperactivity: A comparison of behavioral characteristics of clinic-referred children. *Journal of the American Academy of Child and Adolescent Psychiatry, 26*, 718-723.

Loeber, R., & Schmaling, K. B. (1985). Empirical evidence for overt and covert patterns of antisocial conduct problems. *Journal of Abnormal Child Psychology, 13*, 337-352.

Lovejoy, M. C., & Rasmussen, N. H. (1990). The validity of vigilance tasks in differential diagnosis of children referred for attention and learning problems. *Journal of Abnormal Child Psychology, 18*, 671-681.

Mash, E. J., & Johnston, C. (1983). Parental perceptions of child behavior problems, parenting self-esteem, and mothers' reported stress in younger and older hyperactive and normal children. *Journal of Consulting and Clinical Psychology, 51*, 68-99.

McMahon, R. J., & Forehand, R. (1989). Conduct disorder. In E. J. Mash & R. A. Barkley (Eds.), *Treatment of childhood disorders* (pp. 73-132). New York: Guilford.

Nuechterlein, K. H. (1983). Signal detection in vigilance tasks and behavioral attributes among offspring of schizophrenic mothers and among hyperactive children. *Journal of Abnormal Psychology, 92*, 4-28.

Pastore, R. E., & Scheirer, C. J. (1974). Signal detection theory: Considerations for general application. *Psychological Bulletin, 81*, 945-958.

Quay, H. C. (1986). Conduct disorders. In H. C. Quay & J. S. Werry (Eds.), *Psychopathological disorders of childhood* (3rd ed., pp. 35-72). New York: Wiley.

Rosenthal, R. H., & Allen, T. W. (1978). An examination of attention, arousal, and learning dysfunctions of hyperkinetic children. *Psychological Bulletin, 85*, 689-715.

Routh, D. K., & Schroeder, C. S. (1976). Standardized playroom measures as indices of hyperactivity. *Journal of Abnormal Child Psychology, 4*, 199-207.

Sykes, D. H., Douglas, V. I., & Morgenstern, G. (1973). Sustained attention in hyperactive children. *Journal of Child Psychology and Psychiatry, 14,* 213-220.

Tarnowski, K. J., Prinz, R. J., & Nay, S. M. (1986). Comparative analysis of attentional deficits in hyperactive and learning disabled children. *Journal of Abnormal Psychology, 95,* 341-345.

Taylor, E. A., & Sandberg, S. (1984). Hyperactive behavior in English school children: A questionnaire survey. *Journal of Abnormal Child Psychology, 12,* 143-156.

Trites, R. L., Blouin, A. G., Ferguson, H. B., & Lynch, G. W. (1981). The Conners Teacher Rating Scale: An epidemiological inter-rater reliability and follow-up investigation. In K. Gadow & J. Loney (Eds.), *Psychosocial aspects of drug treatment for hyperactivity.* Boulder, CO: Westview Press.

Trommer, B. L., Hoeppner, J. B., Lorber, R., & Armstrong, K. (1988). Pitfalls in the use of a continuous performance test as a diagnostic tool in attention deficit disorder. *Developmental and Behavioral Pediatrics, 9,* 339-345.

Zentall, S. S. (1985). A context for hyperactivity. In K. D. Gadow & I. Bialer (Eds.), *Advances in learning and behavioral disabilities* (Vol. 4, pp. 273-343). Greenwich, CT: JAI Press.