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Attentional and Intellectual Deficits in Unmedicated Behavior-Disordered Adolescent Inpatients

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The authors examined the hypothesis that impairments in attention and verbal intelligence are associated with seriously maladaptive social behavior in behavior-disordered, hospitalized adolescents. Twenty-five unmedicated inpatients with disruptive behavior disorder diagnoses were rated during a one-month period for frequency of severe disruptive episodes, or "critical incidents" (CI); these included assaults, behavior resulting in the use of restraints, etc. All subjects independently received intelligence testing and continuous performance testing (CPT). Based on CI scores, subjects were divided into a high-CI group (CI > 5; N = 9) and a low-CI group (CI < 4; N = 16). On the CPT, the high-CI group showed more impairment in perceptual sensitivity (d'); this group also had lower verbal IQ scores. (Both findings were significant at the $p < .05$ level.) The latter result was largely due to differences in Comprehension subtest scores. These results support the hypothesis, and may have implications for the treatment of behavior-disordered adolescents.

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INTRODUCTION

The role of cognitive impairment in the genesis of behavioral disturbance in children and adolescents has been the subject of numerous recent studies. One line of research has examined the association between cognitive impairment, juvenile delinquency, and subsequent adult antisocial behavior—focusing either on specific neuropsychological functions, such as attention and concentration, memory, verbal and reading abilities, and visuospatial-motor integration (Lewis *et al.*, 1989; Moffitt and Silva, 1988b, 1988c) or on general intelligence (Hodgins, 1992; Moffitt and Silva, 1988a). Another approach has been to examine the prominence of cognitive impairment in children with externalizing diagnoses, or disruptive behavior disorders (Szatmari *et al.*, 1990). Some see etiologic links in these findings. For example, Moffitt (1990) suggests that verbal ability can protect against the risk of delinquency associated with attention-deficit hyperactivity disorder (ADHD). Others regard language deficits as mediating between physical abuse and aggressive behavior (Burke *et al.*, 1989; Tarter *et al.*, 1984). We sought to extend this line of work to a clinical population of adolescents by examining the association between seriously dysfunctional social behavior in behavior-disordered adolescent inpatients and two aspects of cognition—intelligence and attention.

Intelligence testing is fairly standard. Attention, however, has been defined and measured in various ways. Most commonly, sustained attention has been measured by tasks derived from the continuous performance test (CPT) described by Rosvold *et al.* (1956). This visual vigilance task was originally developed to measure deficits in sustained attention or alertness in brain-damaged subjects. The task involves monitoring a continuous series of single letters or numbers that are presented briefly, one at a time, with a relatively short, fixed interstimulus interval. The subject is told to respond by pressing a button whenever a predesignated target stimulus (e.g., the numeral *5*) appears in a random stimulus series. More complex versions of the CPT may require a relatively high momentary processing load through the use of perceptually degraded stimuli (Nuechterlein *et al.*, 1983), or may use sequential targets (Rutschmann *et al.*, 1977). These methods have been used to demonstrate attentional deficits in a variety of psychopathological groups—including children at risk for schizophrenia (Cornblatt and Erlenmeyer-Kimling, 1985; Nuechterlein, 1983; Rutschmann *et al.*, 1977, 1986), children exposed to hypoxic conditions perinatally (O'Dougherty *et al.*, 1984), learning disabled children (Beale *et al.*, 1987; Swanson, 1981), hyperactive children (Nuechterlein, 1983; O'Dougherty *et al.*, 1984; Sykes *et al.*, 1971, 1973), and children with conduct disorder (Klee and Garfinkel, 1983).

Several investigators using the CPT to study clinical populations have described the advantages of utilizing indices derived from signal detection theory instead of the traditional raw scores—that is, the percentage of targets correctly responded to, or hit rate, and the percentage of stimuli incorrectly responded to, or false alarm rate (Beale *et al.*, 1987; Nuechterlein, 1983; O'Dougherty *et al.*, 1984). These signal detection theory indices transform the raw scores into a dimension of discrimination capacity, or perceptual sensitivity (d'), and an independent dimension of response bias, or decision criterion (ß). The former index reflects the subject's ability to distinguish signal from nonsignal (or noise) stimuli, while the latter reflects the amount of perceptual evidence that the subject requires in order to respond to a stimulus as a signal. Therefore, a low d' score indicates difficulty in discriminating signal from noise stimuli, while a low ß score indicates an impulsive pattern of response. Since errors of omission (reflected in a low hit rate) can result from either a low d' or a high ß, and since errors of commission (false alarms) can result from either a low d' or a low ß, the signal detection theory indices can reveal more about the underlying perceptual processes by considering both types of error in evaluating performance.

The hypothesis for the present study was that impulsive, socially maladaptive behavior would be associated with deficits in information processing and in verbal (language) capacities. We sought to examine the relationship between maladaptive behavior, on the one hand—and perceptual sensitivity, decision criterion, verbal IQ, and performance IQ, on the other.

METHOD

Subjects

Subjects were recruited from an adolescent inpatient program at the Yale Psychiatric Institute that specialized in the care of treatment-refractory patients. The majority of such cases were diagnosed as having disruptive behavior disorders. At the time of the study, lengths of stay on this unit ranged between a few months and well over a year. Early during the hospitalization, patients were routinely observed for a period of at least several weeks without psychotropic medications; laboratory assessments of attention and other information processing capacities were performed during this medication-free period. Within the first two months, patients received a thorough psychiatric evaluation, a diagnostic assessment, and complete psychological testing (including either a WAIS or a WISC-R). Diagnoses were based on DSM-III-R criteria (American Psychiatric Association,

1987), and upon team discussions involving at least two advanced trainees and two authors who were faculty members assigned to the unit. In making these diagnoses, clinical staff had access to all evaluation materials, as well as to any records from prior treatments. The diagnosis of ADHD was confirmed through the use of a developmental symptom checklist for parents, based upon DSM-III-R criteria. Inclusion criteria specified that the patient have at least one DSM-III-R disruptive behavior disorder diagnosis, have no psychotic disorder diagnosis, have completed a medication-free assessment on the CPT, and have undergone psychological examination. Twenty-five subjects met these criteria.

The sample included 13 males and 12 females, ranging in age from 13 to 18 years. Two subjects were African American, one was Native American, and the remainder were Caucasian. The average number of prior psychiatric hospitalizations for this sample was 1.9. Diagnostically, 22 met DSM-III-R criteria for conduct disorder, while two met criteria for oppositional defiant disorder. In addition, 17 were diagnosed as having ADHD. Five of the subjects had the comorbid diagnosis of major depression; 20 were dysthymic; none was bipolar. Ten subjects met criteria for at least one substance use disorder. Twenty-three subjects met DSM-III-R criteria for borderline personality disorder. None met criteria for a pervasive developmental disorder or was mentally retarded.

Procedure

The CPT procedure included both a standard and a degraded version; the test was computer generated, using a program developed by Nuechterlein. An IBM XT computer was utilized. Subjects sat such that their eyes were 1.0 m from a Taxan 720 screen. Arabic numerals were presented in succession for intervals of 40 ms, with an interstimulus interval of 1.00 s. Subjects were instructed to press a button each time a zero appeared. Each version of the CPT consisted of three blocks of 160 stimuli, for a total of 480 stimuli. Of these, 25% were targets. Prior to each version of the test, subjects were given a practice trial of 160 stimuli, so that they could become familiar with the procedure. Subjects who were judged to be preoccupied or uncooperative were rescheduled for another day. Visual acuity screening was performed prior to the testing, in order to ensure that no subjects had acuity deficits that might artificially impair performance. The complete testing procedure lasted about 30 min. The indices d' and ß were calculated from the degraded CPT total hit rate and total false alarm rate scores (Hochhaus, 1972).

The psychological examination of the subjects included either a WAIS or WISC-R. Subtest, verbal IQ, and performance IQ scores were used in the data analysis. In addition, Witkin triad factor scores were calculated for each subject (Witkin *et al.*, 1962/1974). Here, a Verbal-Comprehension factor is the average of the Comprehension, Information, and Vocabulary subtest scores; an Attention-Concentration factor is the average of the Digit Span, Digit Symbol, and Arithmetic scores; and a Perceptual-Organization factor is the average of the Block Design, Object Assembly, and Picture Completion scores.

In order to quantify seriously dysfunctional social behavior in the hospital, *critical incidents* were counted for a 30-day period immediately preceding each subject's CPT evaluation. These behavioral events were felt to represent dysfunctional social behavior within the hospital setting. They included any instance in which clinical staff were called emergently to manage an agitated patient (often referred to as a "code"), any instance in which physical restraints were necessitated, any instance that necessitated the use of locked seclusion, an assault of another person, an episode of self-injury, significant vandalism, significant sexual acting-out, drug use, suspension from the hospital school, and elopement from the hospital. The number of critical incidents (*CI*) were tallied for each subject on a weekly basis, using the hospital charts and the staff communication logs; consensus was reached between two of the authors who worked on the treatment unit at the time of the study. These incidents were all objective events and were well documented in the hospital records. Because *CI* was ascertained for the month prior to the CPT assessment, the individuals rating *CI* were blind to these test results.

RESULTS

Statistical analysis revealed no significant correlation between age and either d' or ß. Table I shows correlation coefficients for the variables of interest. Of note, *CI* had a significant negative correlation with verbal IQ—as well as a negative correlation with d' that approached significance ($p = .07$, two tailed). There was no significant correlation between *CI* and either performance IQ or ß.

A frequency plot of *CI* revealed a bimodal distribution, and suggested two groupings—a low-CI group ($CI < 4$; $N = 16$) and a high-CI group ($CI > 5$; $N = 9$). Statistical analysis revealed no significant differences between groups for demographic variables, nor for number of previous hospitalizations. Similarly, there were no significant differences between groups in the frequencies of conduct disorder, oppositional defiant disorder, or

Table I. Correlation Coefficients for Behavioral, Attentional, and Intellectual Variables (N = 25)[a]

	CI	*d'*	β	VIQ	PIQ
CI	–	−.373	−.083	−.511[c]	−.206
d'		–	.343	.460[b]	.163
β			–	.080	−.009
VIQ				–	.447[b]
PIQ					–

[a]VIQ: verbal IQ score; PIQ: performance IQ score.
[b]$p < .05$, two tailed.
[c]$p < .01$, two tailed.

any comorbid diagnosis. The groups did vary in the diagnosis of ADHD, however, with the high-CI group having more such patients (p = .02, Fisher's exact test).

Table II compares the groups—initially, with regard to the same variables examined in Table I. Both *d'* and verbal IQ were significantly lower in the high-CI group. There were no significant group differences for ß or performance IQ. Table II next shows the group means of the three Witkin triad factor scores. There was a significant difference between groups with

Table II. Comparisons of High and Low-Critical Incident Groups with Respect to Behavioral, Attentional, and Intellectual Variables[a]

	High-CI Group (N = 9)		Low-CI Group (N = 16)		
	Mean	*SD*	Mean	*SD*	*p* Value[b]
CI	13.6	10.2	0.6	0.9	<.005
d'	1.61	0.78	2.51	1.08	<.05
β	2.13	1.12	2.60	2.15	ns
VIQ	87.7	14.0	102.1	13.4	<.05
PIQ	101.1	17.0	107.5	15.9	ns
Ver-Comp.	7.1	2.1	10.3	2.0	<.001
Att-Conc.	9.0	2.3	9.7	2.4	ns
Perc-Org.	10.3	2.9	10.7	2.4	ns
Inform.	7.2	2.3	9.8	2.4	<.05
Vocab.	7.3	3.2	9.7	2.8	ns
Comp.	6.9	2.1	11.4	2.6	<.001

[a]VIQ: verbal IQ score; PIQ: performance IQ score; Ver-Comp: Verbal-Comprehension factor score; Att-Conc: Attention-Concentration factor score; Perc-Org: Perceptual-Organization factor score; Inform: Information subtest score; Vocab: Vocabulary subtest score; Comp: Comprehension subtest score.
[b]Results of two-tailed *t*-tests. (Pooled variance estimates for all variables except *CI*, for which separate variance estimate is used [df = 8.07].)

regard to the Verbal-Comprehension factor—but no significant difference with regard to the Attention-Concentration or Perceptual-Organization factors. Table II finally compares the group means of the three subtest scores that comprise the Verbal-Comprehension factor. While groups did not differ on the Vocabulary subtest, significant differences between groups were observed on the Information and Comprehension subtests.

Finally, the effect of the higher frequency of ADHD in the high-CI group was examined by using a correlational approach and scores from the parent checklist of ADHD symptoms. The point-biserial correlation between this score and the diagnosis of ADHD was significant (r_{pb} = .443, p = .01, one tailed). However, there was no significant correlation between the ADHD symptom checklist score and the cognitive variables of interest (*d'*, β, verbal IQ, or performance IQ).

DISCUSSION

These results are consistent with the hypothesis that impulsive, socially maladaptive behaviors are associated with attentional and verbal deficits in unmedicated, adolescent inpatients with disruptive behavior disorders. Specifically, deficits were found in the perceptual sensitivity aspect of vigilance and in the comprehension aspects of verbal intelligence. These deficits appear not to be explained by the diagnosis of ADHD.

The results may reflect a greater degree of test uncooperativeness in subjects who were more behaviorally impaired. As no measure of cooperativeness was obtained, this possibility cannot be refuted. However, the lack of significant group differences with regard to ß and performance IQ suggests that cooperativeness with the testing procedure was not of primary importance in these results. Additional limitations of this study are that the sample size is small, and that the sample is heterogeneous for comorbid diagnoses. With respect to the latter, however, it is important to note that this heterogeneity reflects the clinical heterogeneity of the seriously impaired, behavior disordered adolescents who are admitted to inpatient settings.

The findings are of interest in two ways. First, the inverse relationship between *d'* and *CI* confirms previous observations that inattention is associated with behavioral dyscontrol (Moffitt and Silva, 1988c; Shapiro and Garfinkel, 1986). The specific finding that perceptual sensitivity, rather than decision criterion, is associated with disordered behavior is of particular interest. Previous studies have noted abnormally low *d'* values in children at risk for schizophrenia (Nuechterlein, 1983; Rutschmann *et al.*, 1977, 1986); children with behavior disorders—and ADHD in particular—have been found by some to have low *d'* values (O'Dougherty *et al.*, 1984), and

by others to have low ß values (Nuechterlein, 1983). The present finding that behavioral dyscontrol is associated with poor perceptual sensitivity in unmedicated behavior-disordered patients raises the question of the effects of stimulant medication on *d'*. It has, for instance, been suggested that catecholamines may improve signal detection performance in neural networks (Servan-Schreiber *et al.*, 1990). The effects of medication on behavior and on signal detection in this sample will be the topic of a separate report.

Of equal interest is the negative association between *CI* and verbal IQ—particularly the Verbal-Comprehension factor and Comprehension subtest scores. The relationship between verbal intelligence deficit and socially maladaptive behavior can be understood in at least two different ways. One view is that the verbal deficit results in poor internal language mediation of impulse and affect—hence, resulting in impaired self-regulation of behavior (Burke *et al.*, 1989; Tarter *et al.*, 1984). An alternative view is that verbal deficits result in the misperception or misinterpretation of socially relevant cues—and that these processing difficulties, in turn, result in socially maladaptive behavior (Dodge *et al.*, 1990; Milich and Dodge, 1984).

Inasmuch as multiple psychosocial factors contribute to verbal impairment, this type of deficit needs to be remedied at multiple levels. Nonetheless, the association between such impairment and severely maladaptive social behavior suggests the potential utility of cognitive-behavioral interventions that seek to remediate those aspects of social functioning most affected by verbal comprehension deficits—such as the internal mediation of affect by language, and social problem solving. At the least, clinicians who work with behavior-disordered adolescents may want to consider verbal comprehension deficits as possible mediators of maladaptive social behavior.

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