Child Abuse and Performance Task Assessments of Executive Functions in Boys

Enrico Mezzacappa
The Children's Hospital, Boston, U.S.A.

Dan Kindlon
Project on Human Development in Chicago Neighbourhoods, Chicago, U.S.A.

Felton Earls
Project on Human Development in Chicago Neighbourhoods, Chicago, and Harvard Medical School, Cambridge, U.S.A.

We examined executive functions using performance tasks in 126 boys aged 6 to 16 years, who attended public schools and therapeutic schools for children with emotional and behavioral problems. Children were further grouped based on the presence or absence of substantiated abuse histories. Based on their abuse histories and schools of origin, children were classified as Therapeutic, Abused (TA, N = 25), Therapeutic, Nonabused (TN, N = 52), and Public School (PS, N = 48). Controlling IQ and medication status, we compared children in the three groups on teacher ratings of behavior, on experimenter observations of behavior during testing, and on performance tasks challenging the capacities to inhibit an act in progress, and to passively avoid responses associated with adverse consequences. We examined mean group differences in symptoms, behaviors, and task performance, as well as differential age-dependent changes in these dimensions. Independent of abuse history, therapeutic school children demonstrated comparable levels of internalizing and externalizing symptoms, and comparable levels of redirections to task during testing sessions, that were significantly higher than those of the public school children. Both groups of therapeutic school children also showed comparable overall performance on the capacities to inhibit an act in progress, and to passively avoid responses associated with adverse consequences that were poorer than the performance of children from the public school. Children with histories of substantiated abuse showed diminished improvement with increasing age in the capacity to passively avoid responses associated with adverse consequences when compared not only to the public school children, but also to the children from the therapeutic schools without histories of abuse. Our findings complement reports of behavioral observations of abused children, and reports associating child abuse with altered cognitive development in other areas of competence. They suggest that child abuse may negatively influence the expected developmental progression of competence in certain executive functions. This in turn could have implications for the nature and the persistence of certain forms of psychopathology associated with abuse and poor self-control. Given the cross-sectional nature of our data, however, longitudinal developmental studies of the relations between child abuse and executive functions are needed to elucidate the influence of abuse on the growth and development of such organizing principles of behavioral self-regulation.

Keywords: Child abuse, computerized testing, executive function, impulsivity.

Abbreviations: AP: Attention problems-Immaturity scale; AW: Anxiety-Withdrawal scale; BAS: Behavioral Activation System; BIS: Behavioral Inhibition System; CD: Conduct Disorder scale; DSS: Department of Social Services; ME: Motor Excess scale; NAS: Nonspecific Arousal System; PS: Public School group; R-BPC: Revised Behavior Problem Checklist; TA: Therapeutic Abused group; TBI: traumatic brain injury; TN: Therapeutic, Nonabused group.

Sequelae of Child Abuse

Children who have experienced abuse show more emotional and behavioral disturbances, and fewer socially desirable or adaptive behaviors than those who have not experienced such treatment (Feldman et al., 1995; Kinard, 1995; Spatz-Widom, 1997; Vissing, Strauss, Gelles, & Harrop, 1991). Impulsive, disruptive, and aggressive behaviors are prominent among the undesirable behaviors manifested by children who are victims of abuse, and often lead to clinical impressions that abused children behave in a fashion characteristic of the Disruptive Behavior Disorders (American Psychiatric Association, 1994).

Impairments in cognitive and neuroendocrinological...
functioning have also been identified in children with histories of abuse when compared to children without such histories. For example, Carrey and colleagues (Carrey, Butter, Persinger, & Bialik, 1995) found Verbal IQ scores in children to be inversely related to severity of abuse. Debellis and colleagues (Debellis et al., 1994a; Debellis, Lefter, Trickett, & Putnam, 1994b) found altered regulation of cortisol secretion, as well as altered plasma dopamine beta-hydroxylase (DBH) activity in adolescents with histories of sexual abuse. Galvin and colleagues (Galvin et al., 1995) noted abnormalities in plasma DBH activity in abused boys as well. Earlier onset of abuse was associated with greater dysregulation.

Examples of how abuse may affect cognitive development is found in the work of Ito, Teicher, and colleagues (Ito, Teicher, Glod, Harper, Magnus, & Gelbard, 1993; Ito, Teicher, Glod, & Ackerman, 1998; Teicher, Ito, Glod, Andersen, Dumont, & Ackerman, 1997). Using quantitative EEG to examine the coherence between vicinal electrodes, their data indicated a reversal of the normal pattern of hemispheric asymmetry of EEG coherence in abused children, as compared to those without such histories. The left hemisphere of abused children showed evidence of increased coherence, and therefore diminished cortical differentiation when compared with the pattern of nonabused children. The authors concluded from these findings that altered catecholaminergic activation of the developing cerebral cortex, in response to abusive experiences in early childhood, could have contributed to such aberrant cortical differentiation.

Neurobiological Aspects of the Stress Response and of Executive Functions

Reactions to stressors involve well-coordinated responses from several neuroendocrinological systems. Paramount among these systems are the hypothalamic-pituitary axis (HPA), and the locus ceruleus-noradrenergic (LC-NA) system. The HPA and LC-NA systems are known to influence each other in a positive reverberatory feedback loop in response to stress (Chrousos & Gold, 1992). However, problems can arise in relation to the persistently unregulated activation of these systems. For example, deleterious effects of prolonged stress on the central nervous system (CNS) may be mediated in part by altered regulation of cortisol secretion (Chrousos & Gold, 1992). The hippocampus may be especially vulnerable to such effects (Gould & Tanapat, 1999). Short-term memory dysfunction is one manifestation of hippocampal damage resulting from the abnormal secretion of cortisol secondary to traumatic experiences (McEwen & Magarinos, 1997; Yehuda, 1997).

Executive control of behavior comprises, among other capacities, those for directing and sustaining attention, planning actions, anticipating consequences, programming and initiating purposeful sequences of behavior, monitoring the outcome of behavior, and interrupting or modifying unsuccessful behaviors. Effective development of these executive controls is essential to adaptive functioning in the social, academic, and vocational realms (Derryberry & Rothbart, 1997; Kochanska et al., 1996; Posner & Rothbart, 1998). In turn, these executive controls are subserved by the well-integrated functioning of various brain regions, including the prefrontal and orbitofrontal cortices, the thalamus, the septohippocampal region, the amygdala, the basal ganglia, and brainstem nuclei, including the raphe nuclei and the locus ceruleus (Affi, 1994a, b; Rogeness, Javors, & Fliszkow, 1992; Southwick et al., 1997; Teicher et al., 1997).

Taking the findings of Ito and colleagues into account, and integrating these with the above considerations, exposure to traumatic stressors such as child abuse can lead to alterations in the regulation of neuroendocrinological systems, which if protracted over time may have profound implications for the development of cognitive functions such as language, memory, and executive functions related to attention, conditioning, and inhibitory control.

There is a paucity of research in both children and adults examining the relations of abuse to executive functions (Stein, Hanna, Koverola, Torchia, & McClarty, 1997). Furthermore, regardless of the domain of investigation, most studies tend to compare only abused and nonabused participants. Studies that include comparison groups similar to abused participants in relevant ways, such as psychopathology, are generally lacking.

Our goal for this study was to examine how children with abuse histories fare on challenges to specific executive functions when compared not only to an unselected sample of children but to children with comparable types and severity of emotional and behavioral symptoms, who were not abused as well. The executive functions in question involved the capacity to inhibit an act in progress, and the capacity to passively avoid responses associated with adverse consequences. Since these capacities are expected to mature throughout childhood and adolescence (Mezzacappa, Kindlon, & Earls, 1999; Williams, Ponesse, Schachar, Logan, & Tannock, 1999), and could be influenced by medication and general intellectual aptitude, in our comparisons we controlled differences in task performance associated with IQ and medication treatment, and we explored the relationship of task performance to the age of the children as a function of their abuse histories and emotional/behavioral status.

Methods

Participants

All 126 boys who participated in a study of the psychometric properties of executive control measures were included in this study (Kindlon, Mezzacappa, & Earls, 1995). Given their small numbers, the 10 females who participated in the original study were not included.

Of the 126 boys, 78 attended therapeutic schools for emotionally and behaviorally disturbed children, and 48 attended a regular public school. The age range of the sample was 6.2 to 16.2 years (Mean = 10.5, SD = 2.1). The sample included 13 African-American, 99 Caucasian, 6 Hispanic, and 8 boys of other racial-ethnic origins. The public school served a working-class, suburban community, while all three therapeutic schools served children referred from a wide range of neighborhoods, from inner-city to affluent suburban communities. The common denominator for children in the therapeutic schools was high levels of persistently unmanageable behavior in mainstream classroom settings, necessitating more restrictive educational environments.

There were 84 unmedicated students, 36 of whom attended therapeutic schools. The 42 students in the study receiving psychotropic medication all attended therapeutic schools. Of these children who were medicated, 14 were receiving psycho-stimulants, 16 were receiving antidepressants (1 student was prescribed a selective serotonin re-uptake inhibitor, the others all were receiving tricyclic antidepressants). The remaining 12
were receiving a variety of other agents, particularly mood stabilizers and alpha-2 adrenergic agonists. Children were classified into groups based on these data: No Medications (N = 34), Stimulants (N = 14), Antidepressants (N = 16), and Other Medications (N = 12).

**Ascertainment of Abuse**

Our inquiries regarding maltreatment focused on physical and sexual abuse. Informants were the parents, caretakers, or guardians who completed the informed consent for participation of the children in the study. Clinicians working with the children in the therapeutic schools also served as informants.

Informants were asked whether they had knowledge that the child in question had been or was being abused, the type(s) of abuse experienced (i.e., physical, sexual, or both), the alleged perpetrator(s) and their relationship(s) to the child, the timing of onset, duration, frequency, and severity of abuse, and whether or not the Department of Social Services (DSS) had investigated and confirmed the allegations of abuse. Data concerning the timing of onset of abusive events in relation to the child’s age or to the time of assessment, the frequency and severity of these events, and the duration of the abuse over time, were not available for many of the children. Therefore a graded severity index could not be derived.

For 25 of the children in our study, all of whom attended therapeutic schools, the DSS had investigated and confirmed allegations of physical and/or sexual abuse. In 22 of these 25 cases the alleged perpetrator was an adult in a caretaking role, including biologic, step, adoptive, or foster parents, extended family members, sitters, or child-care staff. An older child was the alleged perpetrator in one instance. Both adults and children were implicated as perpetrators in two other instances. In 13 of these 25 cases both physical and sexual abuse were reported. In 10 cases only physical abuse, and in 2 cases only sexual abuse.

Children were classified into the following groups based on whether the DSS had investigated and confirmed allegations of abuse, and on their schools of origin: Therapeutic, Abused (TA, N = 25), Therapeutic, Nonabused (TN, N = 52), and Public School (PS, N = 48).

**Assessment of Intellectual Aptitude**

For all the children from the therapeutic schools, intellectual aptitude was represented by the WISC-R Full-Scale IQ (Wechsler, 1991). Children from the public school did not have WISC-R data. Here total achievement scores from the Stanford Achievement Test-8th Edition (Kelley, Ruth, & Terman, 1992) were converted to IQ equivalents (Mean = 100, SD = 15). Although these two instruments do not assess identical constructs, the inter-relationship between WISC-R Full-Scale IQ and total scores on standardized scholastic achievement tests is substantial (r = .74) (Wechsler, 1991).

**Behavioral Assessment**

Parents, caretakers or guardians, and teachers completed the Revised Behavior Problem Checklist (R-BPC) (Quay & Peterson, 1987). This instrument provides scale scores comparable to other dimensional measures of psychopathology. The scales utilized in our study were Conduct Disorder (CD), Attention Problems-Inimmaturity (AP), Motor Excess (ME), and Anxiety-Withdrawal (AW). Scores for the AP and ME scales were combined to generate a composite that would reflect more closely the features of Attention Deficit Hyperactivity Disorder (American Psychiatric Association, 1994).

All but one teacher report was completed and returned. Approximately 60% of parent/guardian questionnaires were completed and returned. As a result, comparisons reported here for children’s observed behaviors are based on the teacher reports, and on the experimenter’s observations of the children’s behaviors during testing (see below).

**Performance Task Assessment**

In a previous study we attempted to identify reliable, discriminating measures of executive functions regarded as important to impulse control (Kindlon et al., 1995). Using a battery of computerized and paper-and-pencil tasks, we assessed children’s control over behavioral impulses in the laboratory at two points in time.

Controlling age and intellectual aptitude, we examined the stability, discriminant validity, and factor structure of this battery of performance measures. Selecting only those measures that were reproducible and discriminating, the data reduction process generated a 4-factor solution we interpreted as representing cognitive and motivational dimensions of executive control over behavioral impulses. In selecting measures for the current study we added the requirement of comparability of variance in the dependent variables between our comparison groups. This resulted in two performance tasks, one from each previously identified factor, remaining for the comparisons reported here. From the cognitive factor, the Stop Signal paradigm, a test of the capacity to inhibit an act in progress, was retained. From the motivational factor, the Passive Avoidance Learning task, a test of the capacity to avoid making responses known to be associated with negative outcomes, was retained.

The **Stop Signal task**. This task challenges the capacity to inhibit an act in progress, which involves executive processes at the level of response execution, adjustment, and inhibition. The ability to initiate and to change behavior in relation to changing information are believed to be under the control of neural circuits involving the lateral and dorsolateral prefrontal cortices, the striatum of the basal ganglia, and the thalamus (Affifi, 1994a,b; Teicher et al., 1997).

Based on the work of Logan and colleagues (Logan, Cowan, & Davis, 1984; Oosterlaan, Logan, & Sergeant, 1998; Schachar, Tannock, Marriott, & Logan, 1995), the Stop-Signal task models a race between independent “Go” and “Stop” processes. Whether an act is brought to completion or not depends on which of the two processes runs to completion first. Where individual differences are concerned, it is assumed that the balance between the inherent latencies of the “go” and “stop” processes represents a stable characteristic.

The primary task involves a choice letter discrimination (Xs and Os). Periodically and randomly on 30% of trials, participants hear a tone (Stop-Signal) indicating that they should not respond to the visual stimuli. The tone always occurs after presentation of the visual stimulus, when the response to the primary task is presumably already underway. Participants are told to proceed as quickly and as carefully as possible, and not to wait for the signal. Excessive delays in responding to non-Stop-Signal trials lead to the registration of omission errors.

The delay between presentation of the visual stimuli and the Stop-Signal tone varies randomly and equally over four time intervals. Longer delay intervals are associated with diminished probability of inhibiting the response to the primary visual stimulus. Failures of inhibition are registered whenever participants respond on a Stop-Signal trial, regardless of whether the response corresponds correctly to the visual stimulus presented or not; so that X-O errors of commission are included together with failures of inhibition. The variable of interest meeting all the inclusion criteria for this study was the mean probability of inhibition over all delay intervals, corrected for the percentage of omission errors on trials that warranted an active response.

The **Passive Avoidance Learning task**. This task assesses the capacity of an individual to avoid responses associated with adverse consequences. Jeffrey Gray (1987) proposed a three-component model of impulsive control involving a Nonspecific Arousal System (NAS), a Behavioral Activation System (BAS), and a Behavioral Inhibition System (BIS). Nonspecific arousal represents the inherent intensity of an individual’s response tendencies. The processes of behavioral activation and inhibition are believed to operate in reciprocity, and the prevailing response tendencies of an individual are thought to represent characteristic, stable features reflecting an individual’s overall

The functions of the BIS are presumably mediated by noradrenergic neurons originating in the locus ceruleus and ending in the septo-hippocampal region, and by serotonergic neurons from the median raphe nuclei, ending in multiple cortical and subcortical regions (Gray, 1987; Rogeness et al., 1992). The BIS is associated with passive avoidance and with extinction of responses that lead to aversive consequences. The BIS is sensitive to cues for danger, punishment, and uncertainty. BIS-dominant individuals are more prone to inspect and reflect on novel stimuli before responding (Bachorowski & Newman, 1990; Patterson et al., 1987; Wallace et al., 1990).

The functions of the BAS are presumably mediated by dopaminergic neurons originating in the ventral tegmental area and substantia nigra, ending in multiple cortical and subcortical regions (Gray, 1987; Rogeness et al., 1992). The BAS is associated with activating the planning and execution of motor responses. The BAS is responsive to cues for reward and relief of frustration, and facilitates approach and active avoidance behaviors. BAS-dominant individuals are response oriented and less prone to reflect before responding to novel stimuli (Bachorowski & Newman, 1990; Patterson et al., 1987; Wallace et al., 1990).

The task of passive avoidance learning utilized here is similar to the “passive avoidance learning with loss of reward” paradigm used with adolescents (Scerbo et al., 1990) and adults (Patterson et al., 1987). Participants must first learn through trial-and-error conditioning which four randomly selected numbers from the set 1 through 8 require an active response (key press), and which require no response (passive avoidance), in order to maximize points earned. Points are awarded for correct active and correct passive responses. Points are lost for incorrect active responses and incorrect passive responses. The number of correctly withheld responses (passive avoidance) met all the inclusionary criteria for this study.

**Experimenter Observations During Testing: Redirections to Task**

In order to complement teachers’ observations and to address the matter of ecological validity associated with the testing conditions (Barkley, 1991; Kalverboer, 1989), we recorded off-task behaviors by quantifying the number of times during the test battery a child required redirection back to the task at hand. This measure reflected the capacity to inhibit extraneous motor behavior.

**Statistical Analyses**

Controlling IQ and medication status, we compared the three groups for differences in teachers’ and experimenters’ ratings of behavior, and performance on the two tasks challenging executive functions. In all the analyses we examined the main effects of group membership, age, and the interaction between age and group status on the observed behaviors and on task performance. Children with missing data for either of the executive function tasks were assigned the mean value of their designated abuse group.

For the statistical tests performed we report the standard indices F and p, as well as overall model effect sizes f and partial effect sizes eta for the independent variables of interest. Cohen (1988, pp. 283–287; 1998) has suggested that for both f and eta, values around .10 represent small effects, values around .25 represent medium effects, and values around .40 and greater represent large effects.

**Results**

Children in the TN group were older than those from the PS group, model F(2,122) = 5.9, p < .004, R² = .09, f = 0.31. Consistent with the findings of others, there was a trend for the Full-Scale IQ scores of children in the TA group to be lower than those for children in the TN group, model F(2,122) = 2.4, p < .09, R² = .04, f = 0.20. Results for age and IQ comparisons are reported in Table 1.

**Teacher and Experimenter Ratings of Behavior**

As expected, children from the therapeutic schools differed from the public school children on all the behavioral indices. They manifested significantly higher levels of symptomatology for AW, model F(9,114) = 18.6, p < .0001, R² = .60, f = 1.2; group partial F = 40.3, p < .0001, eta = .64, CD, model F(9,114) = 12.8, p < .0001, R² = .50, f = 1.0; group partial F = 31.9, p < .0001, eta = .60, and AP–ME, model F(9,114) = 10.3, p < .0001, R² = .45, f = 0.90; partial F = 20.0, p < .0001, eta = .51, than the public school children. The group means of the therapeutic school children did not differ from each other on any of the behavioral dimensions. Nor were there any significant differential age-dependent changes in symptomatology for these dimensions across the three groups.

Comparisons for Redirections to Task revealed that children in the therapeutic schools had more difficulty staying on task when compared to the PS group, model F(9,115) = 4.2, p < .0001, R² = .25, f = 0.58. Children in both the TA and the TN groups performed more poorly than the PS group, partial F = 6.9, p < .002, eta = .33. Consistent with the teacher reports of observed behavior, there were no significant differences observed between the two therapeutic school groups in the mean number of redirections required.

Increasing age was associated with evidence for overall improvement in the capacity of the children to inhibit extraneous motor behavior, partial F = 14.8, p < .0002, eta = .34. The rate of decline in the number of redirections with increasing age for children from the therapeutic schools was greater than that for the public school children, partial F = 4.4, p < .02, eta = .27, with no significant differences between the two clinical groups. Nonetheless, throughout the age range of our sample, the therapeutic school children required significantly more redirections than their age counterparts in the public school. Adjusted means for teacher and experimenter observed behaviors are reported in Table 2.

**Comparative Task Performance**

Comparisons for the Probability of Inhibiting an Act in Progress (Stop Task) indicated that children in the therapeutic schools performed more poorly than their public school counterparts where the mean probability of successfully inhibiting an act in progress was concerned, model F(9,115) = 5.8, p < .0001, R² = .31, f = 0.67. Chil-

---

**Table 1**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Age</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>48</td>
<td>9.8 (1.6)</td>
<td>100.0 (13.1)</td>
</tr>
<tr>
<td>TN</td>
<td>52</td>
<td>11.2 (2.3)</td>
<td>105.7 (16.2)</td>
</tr>
<tr>
<td>TA</td>
<td>25</td>
<td>10.4 (2.2)</td>
<td>99.9 (12.1)</td>
</tr>
</tbody>
</table>

---

1044 E. MEZZACAPPA, D. KINDLON, and F. EARLS
Table 2

Adjusted Means (SE) as a Function of Abuse History and Clinical Status, Controlling Age, IQ, and Medication Status, for Teacher- and Experimenter-observed Behaviors

<table>
<thead>
<tr>
<th>Group</th>
<th>AW (SE)</th>
<th>AP-ME (SE)</th>
<th>CD (SE)</th>
<th>RED (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>1.8 (0.8)</td>
<td>6.7 (1.6)</td>
<td>1.8 (2.1)</td>
<td>46.7 (3.0)</td>
</tr>
<tr>
<td>TN</td>
<td>9.7 (0.5)</td>
<td>16.7 (1.0)</td>
<td>16.9 (1.4)</td>
<td>53.9 (1.9)</td>
</tr>
<tr>
<td>TA</td>
<td>8.8 (0.7)</td>
<td>17.7 (1.4)</td>
<td>21.4 (1.8)</td>
<td>56.4 (2.6)</td>
</tr>
</tbody>
</table>

RED = Redirections to task.

*a PS < TN, TA, p < .0001.
*b PS < TN, TA, p < .002.

Table 3

Adjusted Means and Age-dependent Relations (SE) as a Function of Abuse History and Clinical Status, Controlling IQ and Medication Status, for the Probability of Successfully Inhibiting an Act in Progress (STOP), and Total Correct Passive Responses (PA)

<table>
<thead>
<tr>
<th>Group</th>
<th>STOP Mean (SE)</th>
<th>Age effect (SE)</th>
<th>PA Mean (SE)</th>
<th>Age effect (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>54.4 (2.0)</td>
<td>3.1 (0.8)</td>
<td>55.3 (1.7)</td>
<td>2.3 (0.7)</td>
</tr>
<tr>
<td>TN</td>
<td>48.5 (1.3)</td>
<td>3.1 (0.8)</td>
<td>46.7 (1.1)</td>
<td>2.3 (0.7)</td>
</tr>
<tr>
<td>TA</td>
<td>48.1 (1.7)</td>
<td>0.9 (1.1)</td>
<td>47.5 (1.5)</td>
<td>-0.2 (1.0)</td>
</tr>
</tbody>
</table>

*a PS > TN, TA, p < .02.
*b TA < PS, TN, p < .07.
*c PS > TN, TA, p < .0001.
*d TA < PS, TN, p < .01.

Post Hoc Analyses

In order to ensure that our findings for the age-dependent relationships to task performance were not just an artifact of including a comparison group, the public school children, from whom differences were more likely to be observed and which therefore would have accounted for a lion's share of the variance between groups, we conducted the same comparisons for the executive function tasks excluding the PS group. None of the findings regarding mean differences or age-dependent relations for task performance comparisons between the two clinical groups were changed or diminished by eliminating the comparisons with the public school children. Using the TN group as the referent this time, results for the Stop Task were as follows: model \( F(7,69) = 4.1, \ p < .0008, \ R^2 = .29, \ f = 0.64; \) no mean group differences; age effect partial \( F = 12.9, p < .0006, \ eta = .40; \) group by age interaction partial \( F = 3.9, p < .06, \ eta = .23. \) Results for the Passive Avoidance Learning task were as follows: model \( F(7,69) = 3.7, p < .002, R^2 = 2.7, f = 0.61; \) no mean group differences; age effect partial \( F = 5.6, p < .02, \ eta = .27; \) group by age interaction partial \( F = 8.2, p < .006, \ eta = .33. \)

Post hoc determination of the statistical power to detect effects based on the tests performed, the sample size, the degrees of freedom of the independent variables, and the observed effect sizes, indicated that in all cases the power to detect effects at the .05 level of significance equaled or exceeded .95 (Cohen, 1988, pp. 321–324), even for the comparisons excluding the PS group.

Discussion

Our focus in this study was to explore the capacity of boys with abuse histories to perform tasks challenging the executive functions to inhibit an act in progress, and the capacity to passively avoid responses associated with...
adverse consequences. In our comparisons we included unselected children without abuse histories, as well as nonabused children with comparable levels of emotional and behavioral symptoms to those with abuse histories. In this fashion, overt symptomatic behaviors commonly associated with both poor executive functions and with child abuse were controlled.

In general, children from the therapeutic schools differed in an expected fashion from those in the public school on all the dimensions examined. The degree of overt emotional and behavioral symptomatology reported by teachers, the direct observations of experimenters assessing behavioral control during testing sessions, and overall competence on each of the tasks challenging executive functions were significantly more problematic for the therapeutic school children. Further, on the average none of these dimensions was uniquely related to the abuse histories of the therapeutic school children.

On the other hand, a history of substantiated abuse was associated with differences in age-dependent competence for the executive functions associated with passive avoidance learning. Since performance was found to be more problematic with increasing age for the abused children, they could be expected to manifest greater problems with harm avoidance, or more difficulties around concern for the consequences of their actions, as they get older. These age-dependent differences could also have implications for the response to therapeutic interventions designed to enhance self-control based on motivational contingencies.

Given the nature of our sample, a number of questions can be raised as to the generality of our findings. Confirmation of maltreatment by the DSS, and the study of children attending therapeutic schools, may have selected for a degree of maltreatment and of psychopathology not generally representative of children who have experienced abuse in the community at large. As a result our findings may only be representative of the more severe end of the spectrum where both maltreatment and psychopathology are concerned.

Since we did not include females in our comparisons, we could not examine whether gender differences would emerge in the relationship patterns between abuse histories and executive functions. Although our sample was diverse in composition, the preponderance of boys in the sample were of Caucasian origin, precluding any comparisons along ethnic or cultural lines. There were insufficient numbers of children with histories of only one type of abuse. Therefore comparisons between the effects of physical and sexual abuse on executive functions could not be conducted.

We could not rule out the possibility that the relationships identified between abuse histories, age, and executive functions were not mediated in part by other, concomitant factors, such as the adequacy and consistency of caretaking, or the sequelae of closed (occult) traumatic brain injury (TBI). The home environment has been identified as a critical factor in the cognitive development of children. In general, warm, responsive parenting is associated with evidence for better cognitive development in young children (Bradley & Caldwell, 1984). Even in situations of economic, social, and biological (prematurity) adversity, such positive behaviors on the part of primary caregivers towards their children can have noticeable protective effects on various aspects of cognitive development (Bradley et al., 1994; Brooks-Gunn, Klebanov, & Duncan, 1996). Beyond stressors such as frank abuse, home environments may exert negative influences on mental and physical development in more subtle ways. Deficient nurturance and chronic conflict may result in neuroendocrinological changes similar to those noted for more overtly abusive experiences (Repetti & Taylor, 2000).

There is evidence to support the notion that even when gross external or internal head injuries are not observed, occult TBI following head trauma may evolve over time, leading to a variety of cognitive, emotional, and behavioral changes (Black, Blumer, Wellner, Shepard, & Walker, 1981, pp. 171–180; Black, Jeffries, Blumer, Wellner, & Walker, 1969, pp. 142–149).

Although we explored relations between abuse histories and executive functions with respect to the age of the children in our study, ours was not a longitudinal investigation of individual growth and change in the executive competencies of children in response to environmental influences. As a result, we could not address the matter of causal relationships between the experience of abuse and the development of competence in executive functions.

Despite these limitations, our findings are consistent with, and complement, previous research relating alterations in behavior, cognitive, and neuroendocrinological functioning to child abuse. Our data and findings draw upon strengths including the independent corroboration of abuse in a sizable subsample of children, the use of validated indices of executive functions based on clearly elaborated models of behavioral regulation, the comparison of abused children with a sample of nonabused children displaying comparable levels of overt emotional and behavioral disturbance, control of intellectual aptitude and medication effects on task performance, and the exploration of relationships between task performance and age.

The study of specific executive functions and the inclusion of a comparable clinical comparison group are particularly salient. As previously noted, the majority of studies of child abuse have tended to compare abused children with unselected controls. Furthermore, in the case of child abuse and cognitive development, it is typically more global indices that have been studied, rather than indices reflecting more specifically identified neuropsychological processes and functions.

In conclusion, behavioral observations of children who have been abused, however detailed and systematic, may not capture the extent of the impact of such adverse experiences on the development of capacities sub serving behavioral regulation. Cicchetti and Toth (1995) have stated this eloquently: ‘...the effect of poor-quality caregiving and traumatic experiences on biological processes can provide important insight into the role of experience in altering the course of neurobiological growth’. How abuse influences the development of executive organizing principles of behavioral regulation, whether differences in the development of executive functions have predictive value for outcomes evidenced by stable pathologic behavioral patterns, and whether such differences also have implications for response to interventions, remain open questions at this time. Our cross-sectional findings suggest that further study of developmental relations between child abuse and executive functions is warranted to elucidate the influence of abuse on the growth and development of these organizing principles of behavioral self-regulation.
Acknowledgements—This research was supported by grants from the National Institute of Justice, and the John D. and Catherine T. MacArthur Foundation to Felton Earls, MD.

References
and the mental and physical health of offspring. Unpublished manuscript.


Manuscript accepted 1 January 2001