

Effects of Childhood Sexual Abuse on Neuropsychological and Cognitive Function in College Women

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Twenty-six college women with a history of repeated childhood sexual abuse were recruited from the community and compared with 19 healthy female collegiate subjects on neurocognitive measures. Abused subjects showed increased response latency variability and diminished inhibitory capacity during a GO/NO-GO/STOP vigilance task. A strong association was found between duration of abuse and memory impairments. Math Scholastic Aptitude Test (SAT) scores were significantly lower in abused subjects when matched against comparison subjects and when compared to their own Verbal SAT scores. Childhood sexual abuse appears to be associated with a constellation of neuropsychological deficiencies even in a group of relatively healthy women.

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The neuropsychological effects of childhood sexual abuse have recently received increased attention. Deficits in short-term verbal memory have been observed in adults with childhood sexual abuse.¹ Deficient inhibitory capacity,² problems with verbally mediated higher cognitive abilities,³ and distractibility and impaired sustained attention⁴ have been observed in abused children.

Our laboratory, and others, have shown that a history of abuse is related to 1) increased electrophysiological abnormalities, predominantly in the left frontotemporal region⁵; 2) a higher prevalence of ictal temporal lobe epilepsy-like symptoms⁶; 3) abnormally elevated left hemisphere EEG coherence⁷; 4) reduced volume of the left hippocampus^{8–11}; 5) smaller size of the corpus callosum^{12–15}; 6) alterations in the paramagnetic properties of the cerebellar vermis¹⁶; 7) abnormalities in cortical size, symmetry, and neuronal density^{17–20}; and 8) highly lateralized hemispheric responses to memory recall.²¹ Together, these findings, and others, support the hypothesis that abuse has a deleterious effect on brain development.

A major limitation of previous studies has been a reliance on clinical samples, which runs the risk of overemphasizing the consequences of childhood sexual

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abuse. Published imaging and electrophysiological studies have focused on abused subjects with posttraumatic stress disorder (PTSD).^{7,8,10,12,13} However, only about one-third of individuals with childhood sexual abuse have a lifetime diagnosis of PTSD.²² Hence, past findings may not be applicable to most victims of childhood sexual abuse who never develop PTSD.

Second, a serious unforeseen problem arises as a consequence of restricting trauma studies to subjects with PTSD. Gilbertson et al.²³ found that nontrauma exposed monozygotic twins of subjects with combat-related PTSD had reduced hippocampal volume, which strongly suggests that reduced hippocampal volume may be a risk factor for the development of chronic PTSD, rather than a consequence of trauma exposure and PTSD. Hence, studies that only evaluate abused subjects with PTSD cannot disentangle whether observed differences are a consequence of the traumatic stress, or a preexisting risk factor for PTSD. However, if all exposed subjects are examined regardless of diagnosis and outcome, then this conundrum is avoided.

We investigated the effects of childhood sexual abuse on neuropsychiatric status and cognitive development in a nonclinically referred, community-based sample. Young adults, ages 18 to 22 years, were recruited to focus on a circumscribed period of brain maturation. Based on previous literature, we hypothesized that young adults with childhood sexual abuse would have problems with memory recall,^{1,24} left hemisphere processing,⁵ left-right hemispheric integration,²¹ and inhibitory capacity.^{25,26}

METHOD

Participants

Subjects were recruited via advertisements (i.e., bulletin board postings, newspaper ads, and subway and bus ads) looking for healthy right-handed individuals ages 18 to 22 interested in participating in "psychiatric research." Subjects (N = 732) were initially screened with 1) telephone interviews to obtain basic demographic information and ascertain whether any exclusion criteria were met; 2) rating scales to assess current psychiatric symptoms and parent-child attachment; and 3) questionnaires to ascertain family history of psychopathology and lifetime history of exposure to traumatic stressors. The primary entry criterion was a history of three

or more episodes of "forced contact sexual abuse before their 18th year and at least 2 years prior to enrollment. An abusive episode was defined as one in which the subject was forced against her will into contact with the sexual part of her body or the perpetrator's body." The contact had to be accompanied by threats of harm to self or others, or feelings of fear or terror. Details of the abuse were ascertained through the use of the Traumatic Antecedents Questionnaire.²⁷

Other criteria for participating included: 1) absence of any alcohol, drug, or medication use for at least 2 weeks; 2) excellent hearing; and 3) good medical health. Potential subjects were excluded if they presented with a history of medical disorders (including neurological disease/insult, head injury, migraine headaches, and seizures); psychotic disorders; pregnancy; past or present alcohol/substance abuse; premature birth; complications during mother's pregnancy or delivery; in utero exposure to alcohol or drugs; a history of physical abuse (defined as any degree of intentional injury above the shoulders, or any intentional injury below the shoulders that received or should have received medical attention); or exposure to any other forms of trauma (e.g., motor vehicle accidents, natural disasters, near drowning, witnessing abuse, animal attacks, gang violence).

These criteria were used to obtain a select sample of individuals with childhood sexual abuse who were free of extraneous factors that could adversely affect neurocognitive development. These criteria excluded 95% of the 732 initial respondents. Twenty-eight percent of the subjects who completed all of the prescreening instruments (N = 564) had a self-reported history of childhood sexual abuse, but only 9.5% of the prescreened sample had a history of childhood sexual abuse unaccompanied by exposure to other forms of abuse.

The final experimental sample consisted of 29 subjects. Because only three men were in the abused sample, we chose to focus on the 26 abused women (mean age = 20.0 years). Nineteen women with no current or past DSM-IV axis I disorder (based on the Structured Clinical Interview for DSM-IV Axis I Disorders [SCID-I])²⁸ and with no history of abuse nor exposure to other traumatic events served as a very healthy contrast group (mean age = 19.4 years). Subjects were paid for their participation, and the study was approved and monitored by the McLean Hospital Institutional Review Board.

Design and Procedure

Eligible subjects were invited to participate in a neuropsychiatric evaluation. First, subjects were interviewed

with the SCID-I. They were then administered the Memory Assessment Scale (MAS)²⁹ a dichotic listening task developed by Springer *et al.*³⁰ and a computerized continuous performance task developed by the senior author (MHT). The MAS assesses short-term, verbal, and visual memory. Validity studies indicated that MAS scores are sensitive to left versus right hemisphere dysfunction. Patients with left-hemisphere lesions had deficient verbal memory and those with right hemisphere injury had deficient visual memory on this test.²⁹ The Springer dichotic listening task consisted of precisely timed paired words presented to the right and left ears. The words were of equal duration and similar sound (e.g., "boat" and "goat"). This test has been used to assess one component of hemispheric integration. Springer *et al.*³⁰ found that traumatic brain-injured patients with symptoms suggestive of temporal lobe epilepsy had a diminished capacity to recognize both words. Carbamazepine was found to enhance their capacity to recognize both of the paired words.

The continuous performance task consisted of two parts. The first component was a 5-minute, two-choice GO/NO-GO test designed simply to determine reaction time. Targets and nontargets (50:50) were 8-pointed and 5-pointed stars presented for 500 msec at random screen positions with a fixed 2-sec interstimulus interval. The second component was a GO/NO-GO/STOP continuous performance task. The stop signal was presented as a visual change in the 8-pointed star in which a large red octagon ("stop sign") appeared in the center of the target between 30 and 330 msec after its appearance. This component was 15 minutes in duration, with a 2-sec interstimulus interval and 500 msec stimulus duration. The stimuli were equally divided between targets, nontargets, and variably delayed stop signals.

Lastly, subjects provided via self-report Scholastic Aptitude Test (SAT) scores, which reflect their verbal and mathematical reasoning skills.

Statistics

To ascertain differences between the abused and healthy groups on neurocognitive functioning, analysis of covariance (ANCOVA) was conducted on the scores from the various measures. Covariate analysis was performed to control for potential moderating effects, such as current symptoms of depression (Hamilton Depression Rating Scale),³¹ anxiety (Hamilton Anxiety Rating Scale)³² and PTSD (Mississippi PTSD Scale Civilian Version)^{33,34} and socioeconomic status (SES).³⁵ Linear

regression analyses were also performed to ascertain the relationship(s) between the nature/extent of childhood sexual abuse and neurocognitive function.

RESULTS

Abuse history. Subjects reported an average of eight sexual abuse incidents (range = 3 to 50+ episodes) with 15 subjects abused by only one perpetrator and the remaining subjects abused by two to five perpetrators (Table 1). A total of 45 perpetrators were reported across subjects. Mean age at abuse onset was 6.3 years (SD = 3.2, range = 2–15), and the mean duration of abuse was 3.2 years (SD = 2.2, range = 1–10). Subjects in the abuse group had an average Hollingshead SES score of 3.8 (SD = 0.9) versus 4.2 (SD = 0.7) for healthy comparison subjects ($F = 1.89$, $df = 1, 43$, $p = 0.18$)

Diagnostic interview. Eighteen abused subjects (69%) had a lifetime history of a DSM-IV axis I disorder (Table 1), and seven subjects (27%) had a current axis I disorder. Three subjects (12%) currently met criteria for a major mood disorder, and three subjects met criteria for PTSD (12%). Although all subjects denied a history of substance use on a paper-and-pencil measure, one subject was found on interview to have had a past history of substantial cannabis use during 1 year of high school. No subject had a current substance use problem. Breathalyzer tests and urine drug screens assured that no subject was using drugs at the time of testing.

Neuropsychological Data

Memory testing. Table 2 displays group scores on the MAS. The abused and comparison groups did not differ in short-term or verbal memory. Intriguingly, childhood sexual abuse subjects exhibited a trend for higher overall visual and global memory scores than healthy comparison subjects. The duration of childhood sexual abuse by the most closely related perpetrator (parent > sibling > uncle > other family > friend > authority figure > stranger/acquaintance) was strongly associated with impairments in all memory categories. Linear regression analyses indicate that for each year of abuse, there was a 2.4 (SD = 0.8%), 2.0 (SD = 1.0%), 1.9 (SD = 0.6%), and 2.3 (SD = 0.5%) reduction in short-term, verbal, visual and global memory scores, respectively (see Table 2 for statistics). Age at abuse onset, the number of per-

perpetrators, and number of years abused by other individuals did not significantly enhance the association between maltreatment and memory performance beyond that accounted for by duration of abuse by the most closely related perpetrator. Symptoms of depression, anxiety, or PTSD or history of these disorders did not influence the strong relationship between duration of abuse by the most closely related perpetrator and measures of memory function.

To ascertain whether specific differences in patterns

of memory performance were present, MAS subscale scores were analyzed with ANCOVA using global memory as a covariate to adjust for differences in overall performance. Abused subjects had lower visual span (abuse group: 9.41 [SD = 2.65]; comparison group: 11.96 [SD = 2.71]; $F=8.78$, $df=1, 38$, $p<0.005$) but superior verbal span (abuse group: 12.42 [SD=2.71]; comparison group: 10.59 [SD=2.76], $F=4.35$, $df=1,38$, $p=0.04$). No other significant differences emerged in their pattern of memory performance on the 12 subscales.

TABLE 1. Subject Abuse History and Diagnoses

Subject	Age (years)	Age at Abuse Onset (years)	Total Abuse Duration (years)	# of Perpetrators	Perpetrator Relation ^a	Prior Diagnoses ^b	Current Diagnoses ^b
1	20	3	5	2	F	MDD, PTSD	DD-NOS, AD-NOS
2	20	4	10	1	F	MDD	None
3	19	4	2	1	EF	MDD	None
4	18	11	3	1	F	None	None
5	19	6	7	1	EF	BD	PTSD, GAD
6	22	14	9	3	B	MDD	None
7	22	5	1	1	EF	None	None
8	19	5	3	1	F	PTSD, SAD	None
9	18	8	3	1	EF	MDD, OCD, DD	None
10	18	4	2	1	F	None	None
11	21	6	4	3	B	MDD	PTSD
12	19	15	2	1	EF	None	PTSD
13	21	5	2	1	EF	MDD, DD	None
14	21	15	4	2	EF	MDD	None
15	21	5	8	1	F	MDD	MDD
16	20	12	3	2	EF	MDD	None
17	19	6	5	2	B	None	None
18	20	3	1	1	F	None	None
19	20	7	2	3	EF	MDD	None
20	21	10	3	1	F	MDD	None
21	18	13	1	1	F	None	None
22	22	2	5	1	F	MDD	None
23	20	3	9	3	B	None	MDD
24	19	7	3	3	B	CU, BN	MDD, BE
25	20	6	6	5	B	None	None
26	22	13	4	1	EF	None	None

^aF = familial; EF = extra-familial; B = both familial & extra-familial

^bMDD = major depressive disorder; PTSD = posttraumatic stress disorder; BD = bipolar disorder; SAD = separation anxiety disorder; OCD = obsessive-compulsive disorder; DD = depersonalization disorder; AD = adjustment disorder; CU = cannabis use; BN = bulimia nervosa; GAD = generalized anxiety disorder; BE = binge eating; DD-NOS = depressive disorder not otherwise specified; AD-NOS = anxiety disorder not otherwise specified; NOS = not otherwise specified; SP = specific phobia

TABLE 2. Memory Assessment Scale Scores and Regression Analysis of Abuse Duration Effects

Measure	Comparison Group	SD	Abused Group	SD	p value	Regression Analysis—Abuse Duration					
						Intercept ^a	SD	Slope ^b	SD	r (correlation)	p value
MAS											
Short-term	110	11	109	11	0.80	116	3	-2.4	0.8	-0.50	0.009
Verbal	106	13	110	13	0.35	116	4	-2.0	1.0	-0.39	0.05
Visual	112	13	119	13	0.07	125	2	-1.9	0.6	-0.54	0.004
Global	111	12	118	12	0.06	125	2	-2.3	0.5	-0.65	0.0003

^aEstimated MAS scores for abused subjects at abuse duration = 0 years, based on linear regression

^bNumber of points lost in MAS scores for abused subjects per year of abuse, based on linear regression
SD = standard deviation

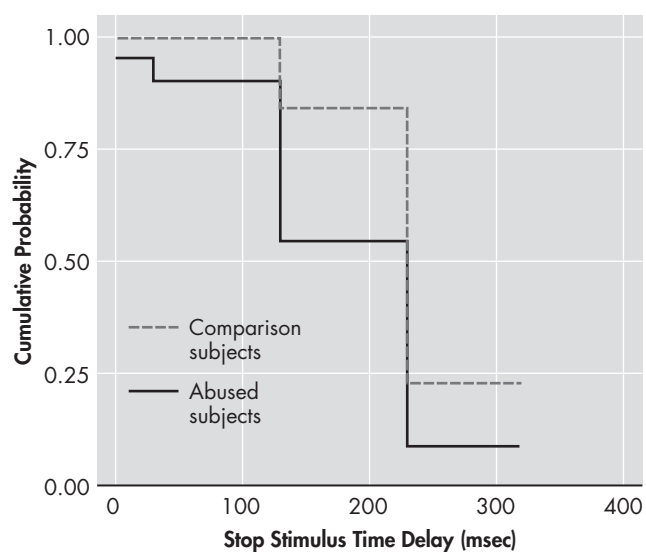
Dichotic listening task. No significant differences emerged between groups on the dichotic listening task for each ear in isolation as well as both in unison. Subjects with childhood sexual abuse correctly identified 41.2 (SD=6.0) of the words presented bilaterally; healthy subjects identified 41.5 [SD=6.0] ($F=0.024$, $df=1,37$, $p=0.80$).

Attention tasks. On the brief GO/NO-GO task, subjects with childhood sexual abuse performed as well as the healthy group. On the GO/NO-GO/STOP task, abused subjects were more variable in their reaction times (115 msec versus 98 msec, respectively; $F=4.56$, $df=1,32$, $p=0.04$). However, their accuracy and latency scores were not significantly different than healthy subjects ($p>0.20$). Abused subjects and healthy subjects slowed their reaction time by the same degree (48.1 [SD = 18.8%] and 40.0 [SD = 18.7%]; $F=1.53$, $df=1, 32$, $p>0.20$) to contend with the stop signal.

The primary purpose of the STOP task was to assess the capacity to inhibit responses. A survival analysis was conducted on subjects' failure to sustain near error-free (>95% accuracy) responding as the delay between target presentation and stop signal increased from 30 to 130, 230, and 330 msec. Figure 1 illustrates the calculated survival curve.³⁶

Between-group differences at each interval were as-

FIGURE 1. Survival Analysis Indicating Fraction of Abused and Comparison Subjects Who Continue to Perform Almost Flawlessly by Inhibiting Response to a CPT Target That Turns Into a Stop Target After Variable Delay



certained using z tests. At the 30 msec and 130 msec delay intervals, no differences were observed between groups in inhibitory responses ($z = -1.05$, $p>0.2$; $z = -1.53$, $p>0.1$; respectively). However, a significantly greater percentage of comparison subjects continued to perform nearly flawlessly at the 230 msec ($z = -2.2$, $p = 0.03$) and 330 msec delay intervals ($z = -2.0$, $p=0.04$).

Scholastic Aptitude Test (SAT). Self-reported SAT scores were available for 85% of abused subjects and 89% of comparison subjects (two subjects took alternative tests, three could not recall their scores). No significant differences were found between SAT reporters and nonreporters on all of the major MAS subscale scores (all $p>0.05$). Relative to the healthy group, abused subjects scored 66 points lower on the test (verbal + math, 1221 [SD=26] versus 1287 [SD=31]; $F=2.47$, $df=1, 34$, $p=0.13$). Interestingly, the abused group did not differ from the healthy group on the verbal test (636 [SD=18] versus 628 [SD = 21]; $F=0.07$, $df=1, 34$, $p>0.60$), but scored on average 74 points lower on the math section (585 [SD=14] versus 659 [SD=17], respectively; $F=9.3$, $df=1, 34$, $p=0.004$) after covarying for depression, anxiety, PTSD-associated symptoms, and socioeconomic status. Math SAT scores were strongly affected by a history of childhood sexual abuse, but were not affected by history of depression ($F=0.414$, $df=1, 35$, $p>0.5$) or PTSD ($F=0.321$, $df=1, 35$, $p>0.5$). Within group analyses indicated that the verbal-math difference was significant for abused subjects ($t=3.28$, $df=22$, $p=0.003$) but not for comparison subjects ($t=1.29$, $df=16$, $p>0.20$). A significant correlation was also found between verbal and math SAT scores for abused subjects ($r=0.51$, $p<0.02$) but not for comparison subjects ($r=0.06$, $p>0.80$).

DISCUSSION

Differences emerged between healthy female college students with no history of trauma or psychiatric illness and a community sample of young adult college women with childhood sexual abuse in inhibitory capacity, memory functions, and scholastic aptitude. A number of factors must be considered when interpreting these findings and comparing them with previous reports. First, we selected subjects with childhood sexual abuse without regard to psychiatric symptoms. Although

childhood sexual abuse is a substantial risk factor for later psychopathology,^{37,38} many children exposed to such abuse never develop any psychiatric condition in general nor PTSD in particular.^{39,40} Recruitment of abused subjects without regard to psychiatric illness avoids the possibility (discussed in the introduction) that observed alterations were not a consequence of the maltreatment but a risk factor for PTSD or other pre-specified diagnosis.²³

A second, important aspect of this study was that all of the recruited subjects were college students. Further, they were unmedicated, had no significant history of alcohol use, and had no other exposure to traumatizing events. Studies of older adults are often complicated by varying degrees of drug or alcohol use and by a lifetime history of exposure to other traumatic experiences. Subjects in this study also had a history of repeated, forced, and unwanted sexual contact, but penetration was not required for enrollment. Forced penetration may be an important factor related to the degree of adverse psychiatric outcome.^{41,42}

Overall, these selection criteria biased the sample to include a substantial number of less traumatized subjects with good psychiatric health and above-average cognitive capacity. Subjects were intentionally recruited in this manner to provide a rigorous challenge to the hypothesis that childhood sexual abuse is accompanied by neuropsychiatric and neurocognitive abnormalities. Hence, observed differences between the abused sample and healthy comparison subjects are particularly compelling.

These findings are in accord with some previous reports. First, diminished inhibitory capacity was reported by Mezzacappa et al.² using a GO/NO-GO/STOP continuous performance task. Their sample consisted of abused boys who were enrolled in therapeutic schools for children with emotional and behavioral problems. The present study suggests that alterations in inhibitory capacity may transcend age, sex, and educational setting.

Abused subjects in the present study had deficits in inhibitory capacity, but no evidence emerged of impaired sustained attention or distractibility on the continuous performance task. Beers and De Bellis⁴ found that abused children performed more poorly on measures of freedom from distractibility and sustained visual attention. However, they focused specifically on abused children with PTSD and used different means to study attention.

Various cognitive deficits have been reported in several studies, including short-term memory deficits,^{1,43}

and lower levels of intellectual ability, academic attainment, abstract reasoning, and executive function.^{4,44,45} Koenen et al.⁴⁶ found that children exposed to high levels of domestic violence had intelligence scores that were lower than unexposed children and that domestic violence was associated with a dose-dependent intellectual decline independent of latent genetic influences. Similarly, we found a strong graded association between duration of childhood sexual abuse and memory function. No overall difference between abused subjects and the contrast group was found because the majority of subjects had a relatively short duration of abuse. Abused subjects with the most profound memory impairments are probably unlikely to matriculate. It should be noted that extrapolating scores for the abuse group back to the zero abuse point (regression intercept) yields mean MAS scores 3.6% to 9.8% greater than comparison subjects (Table 2). If it were true that childhood sexual abuse produces a duration-dependent decrease in memory function, then some of the abused subjects might have had high MAS scores if they had never been abused. This does not imply that individuals with superior memory abilities are at greater risk for abuse, but that by attenuating memory ability abuse may reduce an individual's likelihood of attending college, suggesting that those who attend may have had greater than average innate ability.

The selective deficit in math SAT scores in the abused group is interesting, as is the observation that abused subjects had a significant correlation between their verbal and math SAT scores whereas comparison subjects did not. Imaging and lesion studies have provided strong evidence for the involvement of left frontal regions in mathematical abilities.⁴⁷⁻⁵⁰ However, evidence also exists for bilateral processing with the two hemispheres contributing different capabilities. For instance, the whole left dorsolateral frontal cortex was activated when a verbal strategy was used to perform subtractions, whereas both right and left prefrontal regions were activated when a visual imagery strategy was utilized.⁵¹ Dehaene et al.⁵² demonstrated that exact arithmetic is left lateralized and recruits networks involved in word-association processing, but approximate arithmetic shows language independence, relies on a sense of numerical magnitudes, and recruits bilateral areas of the parietal lobes involved in visuospatial processing. The math SAT questions focus on algebra, geometry, and magnitude estimation and have been designed so

that they can be answered correctly using both exact and approximate approaches.

With these considerations in mind, we hypothesize that the lower math SAT scores of the abused sample could stem from a defect in hemispheric integration. Schiffer *et al.*²¹ found that subjects with a history of childhood abuse predominantly activate their left hemisphere while recalling neutral material, and predominantly activate their right hemisphere when recalling disturbing personal events. Hence, subjects with a childhood abuse history may be strongly reliant on left hemisphere function during the SAT, and may be less able to utilize more right hemisphere-based visuospatial mathematical skills that could enhance test performance. The hypothesized reliance of abused subjects on left hemisphere-based mathematical skills involved with word-association is consistent with the observation that math and verbal SAT scores were correlated in the abused group but not in the comparison subjects. Reduced hemispheric integration may be a consequence of reduced corpus callosal area that has been observed in abused children.^{12–15}

There are several significant limitations to this study. First, these subjects were less symptomatic and possibly less severely affected by childhood sexual abuse than subjects in other studies. One reason for this is that we limited the abused sample to subjects who had experienced childhood sexual abuse as their only traumatic experience. Exposure to disparate traumatic events is a common occurrence, and it appears to exert an additive or even synergistically deleterious effect.⁶ Limiting the sample in this way, however, provides strong evidence that identified group differences are related to childhood sexual abuse and not to another type of maltreatment, nor to the interaction of exposure to multiple traumas.

Second, there is the relatively narrow focus of the instruments utilized. We intentionally limited testing to instruments for which we had specific predictions and chose not to include a comprehensive test battery to avoid the statistical problems that accompany global explorations. The results of the present study show that neurocognitive differences exist that are consistent with observations made using imaging and electrophysiological techniques. They do not, however, detail the full breadth of possible neuropsychological differences.

The third limitation is the use of self-report for SAT scores. Subjects were not required to provide official documentation as proof of their SAT performance. However, the potential validity of self-report SAT scores is

supported in the literature. For example, in a sample of predominantly white women, Cassidy⁵³ found quite high correlations between self-report and actual performance for the SAT total score ($r = 0.88$, $p = 0.0001$), verbal scale ($r = 0.73$, $p = 0.0001$), and math scale ($r = 0.89$, $p = 0.0001$). Nonetheless, our preliminary finding of greatly diminished SAT math scores of the abused group needs to be replicated in a separate sample by directly evaluating mathematical abilities with a standardized achievement test.

The fourth limitation is the exclusive focus on young women. Several studies suggest that early maltreatment may exert an even more deleterious effect on men.^{13,15} Further research is needed to ascertain whether boys exposed to childhood sexual abuse show the same constellation of neuropsychological differences in adulthood. It must also be noted that associations between childhood sexual abuse and altered neurocognitive function are correlational. We cannot exclude the possibility that these subjects had preexisting abnormalities that increased their risk of being sexually abused, although it is difficult to imagine very young children bringing forth their own sexual abuse.

The fifth limitation is that the onset of abuse occurred during widely different stages of neural development. We have speculated that a given brain region is most vulnerable to insult (e.g., traumatic stress) during phases of most rapid development.^{54,55} Accordingly, we have preliminary data suggesting that childhood sexual abuse during early childhood has a negative impact on gray matter volume of more primitive brain regions whereas later childhood sexual abuse (e.g., adolescence) affects primarily neocortical areas. However, many brain regions, including the corpus callosum,⁵⁶ hippocampus,⁵⁷ and frontal regions,⁵⁸ gradually myelinate over decades and this process appears vulnerable to the effects of stress. Myelination depends on glial cell division,⁵⁹ which occurs throughout life, and stress hormones suppress the critical final mitosis of granule cells from proliferative precursors into postmitotic Schwann cells and oligodendrocytes⁶⁰ that form the myelin sheath. Hence, duration of abuse may be a more critical factor influencing white matter development than age of abuse, and can provide an explanation for why abuse at different ages might exert similar effects on certain neurocognitive measures.

Last, we speculate that the observed math deficit and relative deficiency in visuospatial span in childhood sexual abuse subjects is analogous to individuals with non-

verbal learning disabilities, specifically arithmetic learning disabilities.⁶¹ That is, both are presumed to have problems with right-hemispheric processing. We further speculate, however, that the apparent right hemisphere deficiency in childhood sexual abuse subjects is more directly related to a disruption in right-left hemisphere integration,⁶¹ which may be a consequence of early stress effects on the developing corpus callosum.^{15,19,62} If this were true, then it might follow that these individuals would benefit from efforts to foster right-left hemisphere integration. We have postulated that this might be possible through training in tasks that normally require precise right-left hemisphere interactions, such as learning a musical instrument.⁶³ Schiffer⁶⁴ has been working on an alternative approach using lateral visual

field stimulation to preferentially activate right versus left hemispheric cortical regions,⁶⁵ which he has found useful in fostering integration in the course of psychotherapy. Overall, this study provides additional evidence that childhood sexual abuse is associated with neurocognitive abnormalities, and that these abnormalities are discernible in a healthy collegiate sample, are not a consequence of differences in socioeconomic status, or attributable to residual symptoms of depression, anxiety, or PTSD.

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