

# **Tab 10-R**

## **Other Material**

**William G. Kronenberger**

---

## Media Violence Exposure and Executive Functioning in Aggressive and Control Adolescents



William G. Kronenberger, Vincent P. Mathews,  
David W. Dunn, Yang Wang, Elisabeth A. Wood,  
Ann L. Giauque, Joelle J. Larsen, Mary E. Rembusch,  
Mark J. Lowe, and Tie-Qiang Li

*Indiana University School of Medicine*

The relationship between media violence exposure and executive functioning was investigated in samples of adolescents with no psychiatric diagnosis or with a history of aggressive-disruptive behavior. Age-, gender-, and IQ-matched samples of adolescents who had no *Diagnostic and Statistical Manual of Mental Disorders*—fourth edition (DSM-IV; American Psychiatric Association, 1994) diagnosis ( $N = 27$ ) and of adolescents who had DSM-IV Disruptive Behavior Disorder diagnoses ( $N = 27$ ) completed measures of media violence exposure and tests of executive functioning. Moderate to strong relationships were found between higher amounts of media violence exposure and deficits in self-report, parent-report, and laboratory-based measures of executive functioning. A significant diagnosis by media violence exposure interaction effect was found for Conners' Continuous Performance Test scores, such that the media violence exposure-executive functioning relationship was stronger for adolescents who had Disruptive Behavior Disorder diagnoses. Results indicate that media violence exposure is related to poorer executive functioning and this relationship may be stronger for adolescents who have a history of aggressive-disruptive behavior. © 2004 Wiley Periodicals, Inc. *J Clin Psychol*

Keywords: media violence; executive functioning; frontal lobe; television; video games

---

Longitudinal studies, meta-analyses, and research reviews provide converging evidence for a relationship between exposure to media (television and video game) violence and aggressive behavior in children and adolescents (Anderson & Bushman, 2001; Villani, 2001). One leading behavioral-psychological theory for the media violence exposure-

---

This research was supported by a grant from the Center for Successful Parenting. Correspondence concerning this article should be addressed to: William G. Kronenberger, Riley Child and Adolescent Psychiatry Clinic, 702 Barnhill Drive, Indianapolis, IN 46202; e-mail: wkronenb@iupui.edu

aggression relationship, the General Affective Aggression Model (GAAM), proposes that repeated exposure to violence on television and video games causes changes in aggressive beliefs, aggressive perceptual schemata, aggressive expectations, aggressive behavior scripts, and desensitization that interact with the individual's personality and the situation to cause aggressive behavior. GAAM has received support in literature reviews, experimental studies, and correlational studies (Anderson & Bushman, 2001).

In addition to behavioral-psychological theories explaining the relationship between media violence exposure and aggressive behavior, recently attention has turned to neuropsychological theories. Such theories attempt to identify areas of brain functioning that may be affected by media violence exposure and that may underlie aggressive behavior. Studies of the neurological underpinnings of aggressive behavior, for example, indicate that a neural circuit that includes parts of the frontal cortex, amygdala, and temporal lobes is important in emotional regulation and violence (Davidson, Putnam, & Larson, 2000; Filley et al., 2001). One hypothesis for these findings is that underactivity of brain inhibitory mechanisms in the frontal cortex and striatum, coupled with hyperarousal of the amygdala and temporal lobe regions, is responsible for chronic, explosive, and/or severe aggressive behavior. Support for a role of frontal lobe functioning can be found in studies that show reduced activation in frontal lobe regions and poorer performance on tests of executive functioning in individuals who have a history of aggressive behavior (Filley et al., 2001; Wang et al., 2002).

On the basis of findings linking functioning in certain brain regions and aggressive behavior, some researchers have speculated that the functioning of these regions may help to explain the relationship between media violence exposure and aggressive behavior (Murray, 2002). Preliminary research, for example, suggests that areas in the frontal lobe and amygdala may be activated by viewing violent television and video games (Murray, 2002; Wang et al., 2002). Furthermore, high levels of past viewing of violent media have been shown in pilot functional magnetic resonance imaging (fMRI) studies to be related to underactivity in the dorsolateral prefrontal cortex (Wang et al., 2002). Although this research is suggestive, it is preliminary; it uses small samples and focuses on brain activation as opposed to actual performance on tasks involving inhibitory or emotional functioning. Hence, this research should be viewed with caution until larger samples are obtained and results are replicated.

The potential impact of media violence exposure on aggressive behavior increases the need for better understanding of the neuropsychological functions that may mediate the media violence exposure-aggression relationship. The coupling of improved neuropsychological understanding with existing behavioral-psychological theories offers the potential to provide an integrated biobehavioral model that explains research findings of the link between media violence and aggressive behavior.

The purpose of this study was to investigate the relationship between executive functioning and media violence exposure in adolescents. Executive functioning was selected as a key potential neuropsychological process underlying the media violence exposure-aggression relationship because it involves the ability of the individual to inhibit, regulate, direct, plan, and execute behavior. Hence, failure or deficit in the executive functioning area is likely to underlie impulsive, poorly planned, aggressive behavior (Barkley, 1997; Brown, 2001). Additionally, a considerable amount of evidence points to the prefrontal region as a key brain area responsible for executive functioning (Lezak, 1983), and prior studies have provided preliminary evidence of the importance of this area in violent behavior (Filley et al., 2001).

Because of past research that indicates that adolescents who have higher trait aggressiveness may be more affected by exposure to violent media (Bushman, 1995), subsamples

of aggressive and nonaggressive adolescents were included in the study, and aggression was tested as a moderator variable of the relationship between media violence exposure and executive functioning. In addition, executive functioning was measured by using a multimethod approach in order to provide the most reliable and valid measurement of this complex area of neuropsychological functioning

## Method

### *Participants*

The participants were 54 adolescents aged 13–17 years, who had either a Disruptive Behavior Disorder (Disruptive Behavior Disorder with Aggressive Features; DBD-AF;  $N = 27$ ) or no (Control;  $N = 27$ ) psychiatric diagnosis. The DBD-AF and Control subsamples were individually matched on Full Scale IQ score ( $\pm 0.5$  population standard deviation [seven points]; DBD-AF *mean IQ* = 96.7 [ $SD = 10.6$ ], Control = 98.8 [ $SD = 8.6$ ];  $t(52) = 0.79$ ,  $p > .10$ ); gender (21 males, six females per group); and age ( $\pm 2$  years; DBD-AF *mean age* = 14.1 [ $SD = 1.2$ ], Control = 14.4 [ $SD = 1.3$ ];  $t(52) = 0.88$ ,  $p > .10$ ). Although not individually matched on race, the subsamples did not differ significantly in race (11 Caucasians in each group, 13 African American in the DBD-AF group, 14 African American in the Control group, three mixed-race in the DBD-AF group, and two mixed-race in the Control group;  $\chi^2(1)$ [aggregating African-American and mixed-race groups into a single cell to meet chi-square assumptions] = 0.00). Behavior questionnaires were completed by individuals who identified themselves as primary caregivers for the adolescents (50 mothers, three fathers, one grandmother). Caregiver years of education was used as a rough indication of socioeconomic status, and the subsamples did not differ on this variable ( $M = 13.3$  [ $SD = 2.1$ ] for DBD-AF and 14.2 [ $SD = 2.0$ ] for Control,  $t(52) = 1.67$ ,  $p > .10$ ).

On the basis of results of the Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version (K-SADS) Semistructured Diagnostic Interview (Kaufman, Birmaher, Brent, Rao, & Ryan, 1996), adolescents in the DBD-AF group were required to meet *Diagnostic and Statistical Manual of Mental Disorders*—fourth edition (DSM-IV; American Psychiatric Association, 1994) criteria for either Oppositional-Defiant Disorder ( $N = 4$ ) or Conduct Disorder ( $N = 23$ ) and have at least one significant recurrent symptom of aggressive behavior toward people or animals within the past 6 months, as defined in Conduct Disorder diagnostic criteria (American Psychiatric Association, 1994). Additionally, eight adolescents in the DBD-AF Group met criteria for Attention-Deficit/Hyperactivity Disorder (ADHD) Combined Type. Adolescents in the Control group had no DSM-IV diagnosis (as indicated by K-SADS results and clinical interview with the caregiver) and no contact with a mental health professional for treatment of a behavioral-emotional problem within the past 3 years. Adolescents were excluded from the study if they had an IQ of less than 70, current diagnosis of Major Depressive Disorder, or lifetime diagnosis of Bipolar Disorder or Schizophrenia.

### *Procedure*

The data for the present study were obtained during visit 1 of a two-visit protocol involving psychological evaluation at visit 1 and functional magnetic resonance imaging (fMRI) scanning at visit 2. The protocol for the study was approved by the university's Institutional Review Board, and informed consent was obtained before initiation of any study procedures. Participants and parents were compensated a total of \$150 for attendance at

both visits. All tests and clinical interviews were administered by experienced bachelor's-degree- and master's-degree-level technicians.

Participants for the DBD-AF and Control groups were recruited by several methods, including posting flyers at local schools, clinics, and community organizations, as well as requesting that professionals and teachers notify families of the possibility of participation in the study. One hundred eighty-three potential participants called for information about the study during the 2-year recruitment period for the study. On the basis of phone screening, 38 met eligibility criteria for the DBD-AF group and 54 met eligibility criteria for the Control group. Of the 38 eligible for the DBD-AF sample, 29 attended testing sessions at the research site (one of the 29 subsequently did not meet IQ criteria for study entry), eight did not appear and/or did not respond to scheduling calls, and one refused to participate. Of the 54 eligible for the Control sample, 43 attended testing sessions, five did not appear and/or respond to scheduling calls, three refused to participate, and three were not able to be tested during the period of the study. For the matching procedure, subjects in the Disruptive Behavior Disorder sample were matched to the same gender-same age ( $\pm 2$  years) Control subject who had the closest IQ value. One subject in the Disruptive Behavior Disorder sample could not be matched; the resulting sample size was 27 in that group (with 27 corresponding matched Controls, for a total sample size of 54). Descriptive information about the level of media violence exposure in these subsamples has been reported elsewhere (Kronenberger et al., in press).

### *Measures*

#### *Measures of Diagnosis and Media Violence Exposure.*

Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version (K-SADS). The K-SADS (Kaufman et al., 1996) is a semistructured diagnostic interview based on the DSM-IV. In the present study, only the Behavioral Disorders module was administered to parents as a measure of Attention-Deficit/Hyperactivity Disorder, Oppositional-Defiant Disorder, and Conduct Disorder diagnoses. In addition, an Aggressive Features designation was made on the basis of parent endorsement of one of the seven Conduct Disorder symptoms involving aggression to people or animals. The K-SADS is very widely used for the diagnosis of ADHD and Disruptive Behavior Disorders in assessment (Ruchkin, Koposov, Vermeiren, & Schwab-Stone, 2003) and clinical outcome (Michaelson et al., 2002) research. In expert consensus guidelines for the evaluation and treatment of ADHD, semistructured clinical interviews in general (and the K-SADS in particular) have been identified as recommended and useful in the clinical setting (Conners, March, Frances, Wells, & Ross, 2001). Studies have shown the K-SADS to have good to excellent reliability and validity (Shanee, Apter, & Weizman, 1997).

Media Exposure Measure. The Media Exposure Measure (MEM) is a semistructured self-report adolescent interview and parent questionnaire measure of the adolescent's television and video game viewing and playing habits (Kronenberger et al., in press). The Media Exposure Measure has three sections: Self-Report Past Week, Self-Report Past Year, and Parent-Report Past Year. The Self-Report Past Week section is designed to provide a very detailed and specific account of television and video game use during the preceding week. It consists of an interview during which the interviewer asks the adolescent to recall specific television shows and video games viewed or played on each day of the past week, as well as the amount of injury (defined as an actual video depiction of a person's being injured) and graphic injury (defined as an actual video depiction of an

injury that shows blood, loss of body parts, or similar graphic physical damage) portrayed in the shows and games. Summary scores of past week exposure to violent television and video games are derived on the basis of the sum of duration (in minutes) of any shows or games depicting injury or graphic injury. The other two sections of the Media Exposure Measure, Self-Report Past Year and Parent-Report Past Year, are based on self-report and parent-report estimates of the total amount of television watched or video games played by the adolescent over the past year, multiplied by the estimated proportion of injury or graphic injury present in television and video game exposure over the past year. Hence, the MEM yields six subscale scores relating to media violence exposure: Television–Self-Report–Past Week, Television–Self-Report–Past Year, Television–Parent-Report–Past Year, Video Games–Self-Report–Past Week, Video Games–Self-Report–Past Year, Video Games–Parent-Report–Past Year.

Reliability and validity of the MEM have been established by analyses demonstrating moderate to strong relationships between past-week and past-year self-report estimates of media violence exposure ( $r = 0.38$  for video games and  $0.42$  for television), as well as moderate relationships between parent- and self-report of the adolescent's exposure to media violence ( $r = 0.38$  for agreement between parent-report and self-report of past year video game violence exposure, but only  $0.07$  for television violence exposure). MEM scores have been shown to differ between adolescents who had a history of aggressive behavior and adolescents who had no such history (Kronenberger et al., in press). A factor analysis of the six MEM subscale scores yielded a single media violence exposure factor consisting of all subscale scores except Television–Parent-Report–Past Year, further supporting the validity of the MEM as a measure of a single media violence exposure construct (Kronenberger et al., in press). In the present study, the total MEM score based on this factor (MEM Media Violence Exposure score, derived by adding the  $z$ -transformed scores of all MEM subscales except Television–Parent-Report–Past Year) was used as the measure of media violence exposure.

*Self-Report and Parent-Report Questionnaire Measures of Executive Functioning.*

**Adolescent Symptom Inventory—4.** The Adolescent Symptom Inventory—4 (ASI-4; Gadow & Sprafkin, 1998) is a 120-item, parent-completed questionnaire of adolescent behaviors based on DSM-IV criteria. ASI-4 items cluster into subscales corresponding to DSM-IV axis I diagnoses; the subscale severity scores were derived by adding ratings made on a four-point (never–sometimes–often–very often) scale. On the basis of theory and research evidence that strongly supports the nature of ADHD as a disorder of executive functioning (Brown, 2001), the ASI-4 ADHD subscale severity score (derived by adding parent ratings of items corresponding to the 18 DSM-IV ADHD symptoms) was used as a measure of parent-reported executive functioning of the adolescent in the home environment. Interrater reliability (parent–teacher) for the ASI-4 ADHD subscale is adequate ( $r = 0.27$ ; Gadow & Sprafkin, 1998) in the context of other behavior rating scales, and concurrent validity studies have shown strong relationships ( $r = 0.69$  to  $0.72$ ; Dunn, Austin, Harezlak, & Ambrosius, 2003; Gadow & Sprafkin, 1998) with the Attention Problems subscale of the Child Behavior Checklist (Achenbach, 1991).

**Personality Inventory for Youth.** The Personality Inventory for Youth (PIY; Lachar & Gruber, 1995) is a 270-item true–false self-report personality inventory for children and adolescents. PIY items fall into nine clinical subscales, and reliability and validity of the PIY are well established (Lachar & Gruber, 1995). The Impulsivity and Distractibility (ADH) subscale of the PIY includes items that ask about disinhibited behavior, distractibility, overactivity, and impulsivity. Validity studies have shown ADH scores to correlate



significantly with the Disinhibition subscale of the Sensation Seeking Scales ( $r = 0.51$ ), with the Hypomania scale of the Minnesota Multiphasic Personality Inventory ( $r = 0.45$ ), and with the Uncontrolled scale of the Personal Experience Inventory ( $r = 0.56$ ; Lachar & Gruber, 1995). Higher scores on the subscales of the ADH are associated with endorsement of self-descriptive adjectives such as *jumpy*, *edgy*, and *careless* (Lachar & Gruber, 1995). Therefore, in the present study, the adolescent's raw score on the ADH subscale of the PIY was used as a self-report measure of executive functioning, on the basis of extensive theory and research that show that impulsivity and distractibility are hallmarks of deficits in executive functioning (Barkley, 1997).

#### *Laboratory-Based Measures of Executive Functioning and Intelligence*

**Stroop Color and Word Test.** The Stroop Color and Word Test (SCWT; Golden, 1978) is an individually administered measure of ability to inhibit an overlearned-automatic response (word reading) in favor of a more effortful, incongruent response (color naming). It consists of three timed, speed-based subtests: In the word reading subtest, the subject reads a list of words (red, green, or blue); in the color naming subtest, the subject names the color of ink (*red*, *green*, or *blue*) for a series of Xs; in the color-word labeling subtest, the subject names the color of the ink in which the words (*red*, *green*, or *blue*) are printed. For this latter subtest, the name of the word and the color of the ink are different, and the subject must suppress word reading (a more automatic response) in favor of color naming. In addition to scores for number of correct responses in each subtest, the SCWT yields an Interference score, which is based on the color-word raw score and corrects for the subject's performance on the word reading and color naming subtest. Higher values on all SCWT scores indicate better performance (stronger executive functioning).

Because of the significant role of inhibition, effortful processing, and mental control in performance on the color-word and interference scores, these scores have been hypothesized to reflect executive or frontal-lobe functioning (Lezak, 1983; Spreen & Strauss, 1998). The uncorrected color-word raw score includes components of both fluency and speed (of color naming) and inhibition and control (of the reading response in favor of the color naming response), whereas the Interference score controls for fluency and speed and is therefore a more focused measure of the interference component of response inhibition. Prior research has shown significant relationships between the color-word raw score and various criteria associated with executive functioning (including a relationship between fluency and speed and lesions in the left frontal lobe; Perret, 1974), but significant relationships between the Interference score and conditions associated with executive functioning deficits have been less consistently found (Bedard, Ickowicz, & Tannock, 2002; Doyle, Biederman, Seidman, Weber, & Faraone, 2000; Spreen & Strauss, 1998). For this reason, the SCWT Color-Word raw score was used as the primary Stroop measure of executive functioning for the present study.

**Conners' Continuous Performance Test.** The Conners' Continuous Performance Test (CPT; Conners, 2000) is a computer-administered test of vigilance and response inhibition. Subjects are instructed to press the space bar on a keyboard after the appearance on the computer screen of any letter except the letter X. Scores on the Conners' CPT and related CPT tests have been found to predict deficits in attention and executive functioning (Conners, 2000; Spreen & Strauss, 1998), and CPT scores have been linked to response inhibition ability (Barkley, 1997; Bedard et al., 2002). Neuroimaging studies show activation of the prefrontal cortex during completion of a CPT task (Casey et al., 1997).

The CPT yields several scores based on accuracy and speed of responding during the test. However, in order to reduce the number of variables in the present study, the Hit

Reaction Time Standard Error raw score (RTSE) was chosen as the key measure of executive functioning performance on the CPT. The RTSE score is the standard error of the subject's response time to all targets for which there are responses, and it is by far the strongest contributor to overall discriminant function indexes that predict attention problems in children and neurological impairments in adults (Conners, 2000). Higher RTSE scores indicate more variability in responding and therefore poorer performance in terms of attention, consistency, and executive functioning. Conversely, lower RTSE scores indicate better executive functioning. Although the CPT yields an overall confidence index score based on several of the subscale scores, this score was not used in the present study because it has been the subject of much less validation research and because there are concerns that it may not be normally distributed in the population.

**Wechsler Abbreviated Scale of Intelligence** The Wechsler Abbreviated Scale of Intelligence Two Subtest Form (WASI) is a brief test of intellectual ability based on the Vocabulary and Matrix Reasoning subtests of longer Wechsler Intelligence Scales (Psychological Corporation, 1999). The WASI has excellent psychometric properties, and the WASI Full Scale IQ score has been shown to correspond closely to scores on longer IQ tests (Psychological Corporation, 1999). The WASI Full Scale IQ score was used as a measure of global intellectual ability in this study.

#### *Data Analysis*

Correlational and regression techniques were used to test the association between executive functioning and media violence exposure. First, the four executive functioning measures (parent-report ASI-4 ADHD score, self-report PIY ADH score, and the two laboratory-based measures [SCWT Color-Word score and CPT RTSE score]) were correlated with the aggregate measure of media violence exposure (MEM Media Violence Exposure score) in order to test zero-order relationships between media violence exposure and executive functioning. Second, four hierarchical regression analyses were performed (one equation for each criterion measure of executive functioning), in order to test the relationship between media violence exposure and executive functioning while accounting for possible confounding and moderating variables.

In each regression analysis, the variables of age, race, gender, IQ, total exposure to television and video games (derived by summing the MEM self-reported estimates of exposure to television and video games over the past year), DBD diagnostic group (DBD-AF versus Control), presence or absence of an ADHD—Combined Type diagnosis, and MEM Media Violence Exposure were simultaneously entered in an initial block. This equation tested the main effects of each of these variables on executive functioning, independently of (controlling for) the effects of the other variables. In the second step of the regression analyses, the interaction (product) variable of the MEM Media Violence Exposure score and DBD diagnostic group (DBD-AF versus Control) was entered into the equation as a single block. This second step tested the hypothesis that the media violence exposure—executive functioning relationship was moderated by the presence or absence of a DBD-AF diagnosis.

### Results

#### *Correlations Between Executive Functioning Measures and Media Violence Exposure*

Moderate to strong intercorrelations were found between the executive functioning variables (Table 1). Scores on the SCWT, CPT, and parent-report ASI-4 were more strongly



Table 1  
*Correlations Between Measures of Executive Functioning and Media Violence Exposure<sup>a</sup>*

	SCWT Color-Word	CPI RISE	ASI-4 ADHD (Parent-Report)	PIY ADH (Self-Report)
MEM Media Violence Exposure	-.033**	.047****	.054****	.031**
SCWT Color-Word		-.047****	-.040***	-.024*
CPI RISE			.067****	.021
ASI-4 ADHD (Parent-Report)				.028

<sup>a</sup>SCWT, Stroop Color and Word Test; CPI Continuous Performance Test; RISE, Reaction Time Standard Error; ASI-4, Adolescent Symptom Inventory—4; ADHD, Attention-Deficit/Hyperactivity Disorder; PIY, Personality Inventory for Youth; MEM, Media Exposure Measure.

\* $p < .10$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ ; \*\*\*\* $p < .001$

intercorrelated with each other than was any of these scores with the self-report PIY. In addition, zero-order correlations between the executive functioning measures and the MEM Media Violence Exposure score indicated that higher media violence exposure was associated with poorer executive functioning across all executive functioning variables (Table 1).

#### *Regression Equations Predicting Executive Functioning*

The results of hierarchical regression equations predicting executive functioning while controlling for potential confounding variables are shown in Table 2. For the CPT RTSE score, the regression weight for MEM Media Violence Exposure reached statistical significance, indicating that adolescents who had more media violence exposure showed weaker scores on that executive functioning variable, even after key demographic (age, gender, race), diagnostic (DBD and ADHD), intellectual functioning (IQ), and total media exposure variables were statistically controlled. The interaction effect of media violence exposure and diagnosis group (DBD versus Control) as predictive of executive functioning was also statistically significant for the CPT RISE measure, indicating that the magnitude of the relationship between media violence exposure and CPT scores was larger for adolescents who had DBDs than it was for Controls. The overall equation predicted 46% of the variance in CPT scores.

For the parent-report measure of executive functioning (ASI-4 ADHD score), adolescents who had diagnoses of ADHD and/or DBD, as well as adolescents who reported more media violence exposure, showed weaker executive functioning. The overall equation accounted for 69% of the variance in the ASI-4 ADHD score. No variable significantly predicted self-reported SCWT Color-Word or PIY-ADH scores in the regression equations (Table 2).

#### Discussion

The results of this study indicated moderate relationships between media (television and video games) violence exposure and executive functioning, which remained for CPT and parent-report executive functioning measures even when key demographic, intellectual functioning, clinical diagnosis, and television and video game total viewing time variables were statistically controlled in regression equations. Furthermore, for CPT scores,

Table 2  
Regression Equations Predicting Executive Functioning

	Executive Functioning (Dependent) Variable			
	SCWI Color-Word	CPI RTSE	ASI-4 ADHD (Parent-Report)	PIY ADH (Self-Report)
<i>Block 1</i>	(0.27)	(0.41)	(0.69)	(0.24)
Age	0.19	-0.14	-0.08	-0.26*
Gender	0.04	-0.15	0.00	0.06
Race	-0.12	0.04	0.05	-0.08
IQ	0.26*	-0.10	0.05	-0.06
Total Media Time	0.19	-0.30*	-0.21*	0.11
DBD Diagnostic Group (DBD vs Control)	0.05	-0.24*	-0.52****	-0.21
ADHD Diagnosis	-0.05	0.21	0.31**	-0.05
MEM-Media Violence Exposure	-0.39*	0.46**	0.31**	0.19
<i>Block 2</i>	(0.27)	(0.46)	(0.69)	(0.26)
MEM-Media Violence Exposure x DBD Diagnostic Group (Interaction Effect)	0.09	-0.26**	-0.10	0.16

*Note.* Values not in parentheses are beta weights obtained after the entry of all variables in each block. Values in parentheses are  $R^2$  for each block. For all equations, beta weights from block 1 did not change substantively with the addition of the interaction variable in block 2. SCWI, Stroop Color and Word Test; CPT, Continuous Performance Test; RTSE, Reaction Time Standard Error; ASI-4, Adolescent Symptom Inventory—4; PIY, Personality Inventory for Youth; DBD, Disruptive Behavior Disorder; MEM, Media Exposure Measure; ADHD, Attention-Deficit/Hyperactivity Disorder.

\* $p < .10$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ ; \*\*\*\* $p < .001$

the media violence exposure–executive functioning relationship was moderated by presence or absence of a DBD diagnosis.

These results provide support for the hypothesis that the relationship between media violence exposure and aggressive behavior may be mediated or accompanied by a similarly strong relationship of media violence exposure and deficits in executive functioning. Even with total television and video game viewing time statistically controlled, media violence exposure was significantly related to executive functioning. This result suggests that violent media viewing time specifically, and not total media viewing time, relates to executive functioning. Furthermore, because the media violence–executive functioning relationship also persisted when the ADHD diagnosis was statistically controlled, this relationship does not appear to be solely a result of an association of media violence exposure and executive functioning with the ADHD diagnosis. Studies of executive functioning find a close relationship with frontal lobe functioning, and deficits in executive and frontal-lobe functioning have been associated with both aggressive behavior and media violence exposure (Davidson et al., 2000; Wang et al., 2002). Hence, the media violence exposure–executive functioning relationship fits with a broad neuropsychological theory of frontal lobe functioning as important in explaining the relationship between media violence exposure and aggressive behavior.

The finding of a significant moderator effect of diagnosis group on the relationship between CPT RTSE scores and media violence exposure suggests that the relationship between the CPT measure of executive functioning and media violence exposure was significantly stronger for the DBD-AF group than for the Control group. Because disruptive behaviors are often characterized by poor self-control, it may be that adolescents who have DBD-AF have fewer self-control mechanisms to mitigate the deleterious effects

of violent media on executive functioning. Such a finding replicates research that shows that individuals who have trait aggressive behavior are more vulnerable to the effects of violent media (Bushman, 1995). On the other hand, moderator effects were not found for the other executive functioning measures.

Despite the finding of a significant correlation between media violence exposure and self-reported problems in executive functioning (PIY ADH score), the regression weight for this association in the context of potential confounding variables was nonsignificant. Self-report of executive functioning, however, may not be as valid as other methods of measuring executive functioning, because self-awareness and self-monitoring (which are crucial for self-report) may be reduced in some individuals as a result of poor executive functioning (Barkley, 1997). Some support for this hypothesis may be found in the present data, as parent-report and laboratory measures of executive functioning showed much stronger intercorrelations ( $r = 0.40$  to  $0.67$ ) than those measures did with the PIY ADH score ( $r = 0.21$  to  $0.24$ ).

One advantage of the present study was the use of a multimethod approach to assess executive functioning, including two laboratory-based measures, a parent-report measure, and a self-report measure related to executive functioning. Study findings that showed significant zero-order correlations between media violence exposure and executive functioning across these different measurement modalities therefore suggest a broad relationship between these constructs. Significant intercorrelations between the executive functioning measures also support their validity as measurements of the same construct, and the different results from the regression equations also indicate that they are not redundant.

A potential concern that arises from the use of parent- and self-report measures of impulsivity-distractibility as indexes of executive functioning is the degree to which these measures actually reflect the executive functioning construct. A significant amount of theory and research supports the close relationships among hyperactivity-impulsivity, inattention-distractibility, the ADHD diagnosis, and deficits in executive functions (Barkley, 1997; Brown, 2001), as intercorrelations of questionnaire measures of these constructs range from about 0.60 to 0.70 (Gioia, Isquith, Guy, & Kenworthy, 2000). The validity of the parent- and self-report impulsivity-distractibility measures used in this study is also supported by their intercorrelations with each other and with the laboratory-based executive functioning measures.

A second set of measurement issues to consider in interpreting results is the selection of instruments to reflect laboratory-based executive functioning. Admittedly, the SCWT Color-Word score and CPT RIASE do not cover the full range of tests of executive functioning. These tests focus more on the inhibition, attention, vigilance, resistance to distraction, and fluency-shifting components of executive function, as opposed to other tests that emphasize planning, flexible reasoning, and novel problem solving (Spren & Strauss, 1998). The former components of executive functioning have been associated more with disinhibited behavior and therefore may have more relevance to behavioral control and aggression (Barkley, 1997; Brown, 2001). Hence, the focus of this study was on the subset of executive functions that emphasize mental control and behavioral inhibition rather than on executive functions in the broadest sense of that term.

Related to the issue of the measurement of executive functions is the selection of the specific subscales used from the laboratory executive functioning measures. In the case of the CPT and SCWT, subscales (RIASE and Color-Word raw score) were selected on the basis of research that indicates their validity in differentiating individuals with and without attentional and behavioral control problems (Conners, 2000; Doyle et al., 2000). Other scores derived from these tests have received less consistent support in validity studies of individuals who have attention problems and disinhibition.

Several other methodological issues also are important in the interpretation of study results. First, as this was a cross-sectional, correlational study, causal conclusions cannot be drawn from study results. Hence, the finding of a relationship between media violence exposure and executive functioning could indicate that adolescents who have poorer executive functioning seek out more media violence, that adolescents who have more media violence exposure have poorer executive functioning, or that some third variable is responsible for the relationship (although the likelihood of this latter explanation has been diminished markedly by the use of regression equations controlling for a large number of possible confounding variables). Additionally, media violence exposure was not directly measured in the home environment but was assessed by parent- and self-report that used a new instrument (the MEM) that has promising psychometric properties but is at an early stage of development. Furthermore, some components of the MEM scores are based on ratings of media violence exposure during the past year, which will have some estimation error. Although these characteristics of the MEM can introduce some error and method bias into results, the use of multiple reporters (parents and adolescents), multiple timelines (past week and past year), and multiple measurement modalities (interview and questionnaire) reduces the likelihood that this error would systematically account for study results.

Another methodological consideration is that a relatively large number of predictor variables (eight, not including the interaction variable) were entered into the regression equations in relation to the study sample size of 54. However, this large number of predictor variables was necessary to control for possible confounding variables. Despite this relatively high variable-to-subject ratio, media violence exposure and executive functioning were significantly related in two of the four regression analyses. Furthermore, the significant relationships found between media violence exposure and measures of executive functioning in the regression equations were also found in zero-order correlations.

Overall, the results of this study suggest a moderate relationship between greater amounts of media violence exposure and weaknesses in executive functioning in both control and aggressive adolescents, and for the CPT this relationship may be stronger for aggressive adolescents. Because of the key role of executive functioning in DBD diagnoses, improved knowledge of factors related to executive functioning deficits is important in understanding contributing factors, intervention and prevention targets, and evaluation components for these disorders. In particular, the impact of exposure to violent media on the behavior of children who have ADHD diagnoses may be an important area for future research. This study also raises questions about specific vulnerability of adolescents who have DBD-AF to violent media exposure as well as the contribution of violent media not only to aggressive behavior but also to broader characteristics of self-control and impulsivity-distractibility. Clinical evaluation and intervention programs directed at these disorders may benefit from increased attention to violent media exposure.

#### References

- Achenbach, T.M. (1991). *Manual for the Child Behavior Checklist/4-18 and 1991 Profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Anderson, C.A., & Bushman, B.J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science*, 12, 353-359.
- Barkley, R.A. (1997). *ADHD and the nature of self control*. New York: Guilford.

- Bedard, A.C., Ickowicz, A., & Tannock, R. (2002). Methylphenidate improves Stroop naming speed, but not response interference, in children with Attention Deficit Hyperactivity Disorder. *Journal of Child and Adolescent Psychopharmacology*, 12, 301–309.
- Brown, T.E. (2001). *Brown Attention-Deficit Disorder Scales for Children and Adolescents manual*. San Antonio, TX: The Psychological Corporation.
- Bushman, B.J. (1995). Moderating role of trait aggressiveness in the effects of violent media on aggression. *Journal of Personality and Social Psychology*, 69, 950–960.
- Casey, B.J., Trainor, R.J., Orendi, J.L., Schubert, A.B., Nystrom, L.E., Giedd, J.N., Castellanos, F.X., Huxley, J.V., Noll, D.C., Cohen, J.D., Forman, S.D., Dahl, R.E., & Rapoport, J.L. (1997). A developmental functional MRI study of prefrontal activation during performance of a go–no-go task. *Journal of Cognitive Neuroscience*, 9, 835–847.
- Conners, C.K. (2000). *Conners' CPT II technical guide and software manual*. North Tonawanda, NY: Multi-Health Systems.
- Conners, C.K., March, J.S., Frances, A., Wells, K.C., & Ross, R. (2001). Treatment of Attention-Deficit/Hyperactivity Disorder: Expert consensus guidelines. *Journal of Attention Disorders*, 4 (Supplement 1), S7–S13.
- Davidson, R.I., Putnam, K.M., & Larson, C.L. (2000). Dysfunction in the neural circuitry of emotion regulation—a possible prelude to violence. *Science*, 289, 591–594.
- Doyle, A.E., Biederman, J., Seidman, L.J., Weber, W., & Faraone, S.V. (2000). Diagnostic efficacy of neuropsychological test scores for discriminating boys with and without attention deficit-hyperactivity disorder. *Journal of Consulting and Clinical Psychology*, 68, 477–488.
- Dunn, D.W., Austin, J.K., Harezlak, I., & Ambrosius, W.T. (2003). ADHD and epilepsy in childhood. *Developmental Medicine & Child Neurology*, 45, 50–54.
- Filley, C.M., Price, B.H., Nell, V., Antoinette, T., Morgan, A.S., Bresnahan, J.F., Pincus, J.H., Gelbort, M.M., Weissberg, M., & Kelly, J.P. (2001). Toward an understanding of violence: Neurobehavioral aspects of unwarranted physical aggression: Aspen Neurobehavioral Conference Consensus Statement. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 14, 1–14.
- Gadow, K.D., & Sprafkin, J. (1998). *Adolescent Symptom Inventory—4 Norms manual*. Stony Brook, NY: Checkmate Plus.
- Gioia, G.A., Isquith, P.K., Guy, S.C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function professional manual*. Odessa, FL: Psychological Assessment Resources.
- Golden, C.J. (1978). *Stroop Color and Word Test*. Wood Dale, IL: Stoelting.
- Kaufman, J., Birmaher, B., Brent, D., Rao, U., & Ryan, N. (1996). *Kiddie-SADS—Present and Lifetime version (K-SADS-PL)*. Pittsburgh: Western Psychiatric Institute.
- Kronenberger, W.G., Mathews, V.P., Dunn, D.W., Wang, Y., Wood, E.A., Larsen, J.J., Rembusch, M.E., Lowe, M.J., Giauque, A.L., & Lurito, J.T. (in press). Media violence exposure in aggressive and control adolescents: Differences in self- and parent-reported exposure to violence on television and in video games. *Aggressive Behavior*.
- Lachar, D., & Gruber, C.P. (1995). *Personality Inventory for Youth manual*. Los Angeles: Western Psychiatric Services.
- Lezak, M.D. (1983). *Neuropsychological assessment* (2nd ed.). New York: Oxford.
- Michaelson, D., Allen, A.J., Busner, J., Casat, C., Dunn, D., Kratochvil, C., Newcorn, J., Sallee, R., Sangal, R.B., Saylor, K., West, S., Kelsey, D., Weinicke, J., Trapp, N.J., & Harder, D. (2002). Once-daily atomoxetine treatment for children and adolescents with Attention-Deficit/Hyperactivity Disorder: A randomized, placebo-controlled study. *American Journal of Psychiatry*, 159, 1896–1901.
- Murray, J.P. (2002). IV violence and brainmapping in children. *Psychiatric Times*, 18, 1–8.
- Perret, E. (1974). The left frontal lobe of man and the suppression of habitual responses in verbal categorical behavior. *Neuropsychologia*, 12, 323–330.



- Psychological Corporation (1999). Wechsler Abbreviated Scale of Intelligence. San Antonio, TX: The Psychological Corporation
- Ruchkin, V., Kuposov, R., Vermeiren, R., & Schwab-Stone, M. (2003). Psychopathology and age at onset of conduct problems in juvenile delinquents. *Journal of Clinical Psychiatry*, 64, 913-920.
- Shanee, N., Apter, A., & Weizman, A. (1997). Psychometric properties of the K-SADS-PL in an Israeli adolescent clinical population. *Israel Journal of Psychiatry & Related Sciences*, 34, 179-186.
- Spren, O., & Strauss, E. (1998). *A compendium of neuropsychological tests: Administration, norms, and commentary* (2nd ed.) New York: Oxford.
- Villani, S. (2001). Impact of media on children and adolescents: A 10-year review of the research. *Journal of the American Academy of Child and Adolescent Psychiatry*, 40, 392-401.
- Wang, Y., Mathews, V.P., Lurito, J.T., Lowe, M.J., Dzemidzic, M., Phillips, M.D., Kronenberger, W., & Dunn, D. (2002). Adolescents with Disruptive Behavior Disorder have different frontal lobe fMRI activation patterns as compared to control subjects. *Proceedings of the International Society for Magnetic Resonance in Medicine 10th Scientific Meeting* (p. 128).