

# THE RELATIONSHIP BETWEEN ENCODING ABILITY AND AGGRESSIVE BEHAVIOR

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While past research efforts have reported a relationship between encoding ability and aggressive behavior in children, the relationship between encoding ability and adult aggressiveness has not been examined. Encoding, an element of attention, refers to the ability to recall and reorder information stored in memory. Using selected cognitive tests and a self-report measure of aggressive behavior in a sample of community college students ( $n=55$ ), this study investigated the relationship between encoding ability and aggressive behavior, (i.e., physical aggression, verbal aggression, anger, hostility, indirect aggression, and total aggression). Aggressive behavior was assessed by the Aggression Questionnaire of the Buss-Durkee Hostility Inventory, a widely-used measure of aggressive behavior. Encoding was measured using the WAIS-III Digit Span and Arithmetic subtests. Initial analyses showed no significant correlations between the cognitive measures and the five scales of aggressive behavior. However, there was a significant age-related association between scores on the cognitive measures and the indices of aggressive behavior. Two groups were created, those who reported attention problems and those who did not report attention problems. When the two groups were compared, participants who had a history of attention problems were verbally more aggressive than participants with a negative history of attention problems, and they were generally more aggressive. A composite score, called an "encoding score," was related to scores on the aggressive behavior scales. Moreover, the age-related relationship between these two variables suggests that the relationship is maturational and may disappear as an individual ages. Concerning the latter, participants in the current study were enrolled in junior college. Therefore, persons who had attention problems and were aggressive may not have pursued higher education.

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There has been no investigation examining the relationship between encoding ability and aggression among adults. Encoding, an element of attention presumed to be supported by the hippocampus and amygdala, reflects the ability to recall and reorder information stored in memory (Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991). Earlier literature supports the notion that present and long-term socially maladaptive behaviors are associated with impaired encoding ability in children (Kellam et al., 1991; Dolan et al., 1993; Tsamis, 1996). Findings from the Preventive Intervention Trials at the Johns Hopkins Prevention Research Center indicate that encoding problems in childhood cohorts are associated with developmentally significant maladaptive behaviors, (e.g., psychopathological conditions, including early childhood aggressive behavior) and may place individuals at risk for problematic outcomes such as aggression (Kellam et al., 1991; Kellam & Rebok, 1992; Dolan et al., 1993; Tsamis, 1996). Research also shows that aggressive behavior is malleable in children with encoding problems, suggesting a causative relationship between impaired encoding and the development of maladaptive behaviors (Rebok, Hawkins, Krener, Mayer, & Kellam, 1996).

Encoding problems appear to be the common factor underlying both poor social adaptational status (SAS) and psychological well-being (PWB) in both males and females (Kellam & Rebok, 1992). Kellam (1975) suggests that it is useful to view mental health as consisting of two components. One component is SAS or the judgment by society of the adequacy of an individual's social task performance as rated by the natural raters in the various social fields. For example, the teachers are the natural raters in the classroom environment while parents are the natural raters in the home environment. The other component involves an individual's PWB or that area of inner good feeling and self-esteem, which has been the traditional concern of mental health clinicians and whose absence is generally noted by a set of feelings or behaviors traditionally termed "symptoms" or disordered psychological processes. PWB assesses the psychological, physiological, and neuropsychological status of individuals. PWB may interact with an individual's SAS and may play a critical role in social functioning and lead to problematic out-

comes such as aggression. In turn, problems in each domain may result in various problematic outcomes (Kellam & Rebok, 1992). This orientation is a “means for conceptualizing cause or etiology as evolving vulnerability in the person (host), conditions in the environment producing illness, and a causal process of interaction (agent) between the individual and the environment” (Kellam & Rebok, 1992, p. 596). It is critical to understand the distinction between these two components of mental health in order to follow the logic and analysis of this study.

Evidence suggests that cognitive structure may determine how an individual relates to and processes his/her environment. The developing pattern of encoding may be influenced by some form of interaction between biological, sociocultural, and environmental agents, e.g., alcohol and drugs consumed during pregnancy and lead postnatally (Streissguth et al., 1994; Needleman, Schell, Bellinger, Leviton, & Allred, 1989). Within this context, individuals may develop maladaptive tendencies as a function of a vulnerability created by problems in encoding as it interacts with social demands. Altered or impaired underlying brain mechanisms that support the process of encoding may increase the likelihood of an aggressive or maladaptive response developing in reaction to the frustration associated with being unable to compete in the cognitive arena (Mirsky & Siegel, 1994). Along this realm, the environment may be the essential element interacting with an encoding discrepancy resulting in a final expression of aggressiveness (Fishbein, 1992). Previous studies have reported that children who are most likely to become offenders have a significant level of neuropsychological impairments. Across studies, the cognitive function most cited as being impaired in adolescent delinquents is attention (Lewis, Lovely, Yeager, & Della Femina, 1989).

Although aggressive behavior during childhood can be highly stable over time, half of those who exhibit aggressive behavior early in life do not become offenders (Jeffery, 1996). This suggests that while some individuals are susceptible, others are not, necessitating the investigation of the underpinnings of maladaptive responses in an effort to determine underlying factors that may contribute to their

continuity over the life course of individuals. The examination of a possible contribution of encoding to aggressive behavior may shed light on risk behaviors that predispose problematic outcomes such as aggressiveness in adulthood.

We hypothesized that encoding ability would be inversely related to various scales of aggressive behavior. Specifically, it was hypothesized that encoding ability would be inversely related to physical aggression, verbal aggression, anger, hostility, indirect aggression, and total aggression in both genders. In addition, we hypothesized that those participants with a history of attention problems or a diagnosis of Attention/Deficit Hyperactivity Disorder would be more aggressive than those without such history or diagnosis.

## METHOD

### *Participants*

Fifty-five students (males=22; females=33) attending a community college located in the northeastern United States participated in the current study. Participation was voluntary. Participants were students who were registered in introductory psychology courses. All participants were asked to complete a questionnaire that asked questions regarding their gender, race, age, educational level, use of alcohol and drugs, contact with the criminal justice system, and if participants were ever diagnosed with Attention Deficit/Hyperactivity Disorder or if they had ever been diagnosed with having attention problems (Tsamis, unpublished questionnaire).

The mean age of participants was 21.9 years ( $SD = 5.4$  years). For males, the mean age was 21.8 years ( $SD = 4.7$  years) and for females, the mean age was 22.03 years ( $SD = 5.8$  years). The mean years of education of participants was 13.02 years ( $SD = 1.5$  years). None of the participants reported abusing alcohol. Two participants reported using drugs. Ten of the participants reported having had contact with the criminal justice system as adolescents and adults. Fifteen participants (27.3%) reported that they had been previously diagnosed as having attention problems. Six participants (10.9%) reported a previous diagnosis of Attention Deficit/Hyperactivity

**Table 1**  
**Demographics of Participants**

Gender	Number	Percent
Male	22	40
Female	33	60
	N=55	100%
<b>Age of Participants</b>		
Age (in years)	Number	Percent
17-19	23	41.8
20-24	20	36.5
25-41	12	21.7
	N=55	100%
<b>Race</b>		
	Number	Percent
African-American	12	21.8
Caucasian	35	63.6
Hispanic	1	1.8
Asian	2	3.6
Other	5	9.1
	N=55	100%
<b>Education (in years)</b>		
	Mean	SD
17-19	12.26	.7518
20-24	13.25	1.5174
25-41	14.08	2.1088
<b>Previously Diagnosed with Attention Problems</b>		
	Number	Percent
Yes	15	27.3
No	40	72.7
	N=55	100%
<b>Contact with the Criminal Justice System</b>		
	Number	Percent
Yes	10	18.2
No	45	81.8
	N=55	100%

Disorder (AD/HD). In regards to expecting aggression in what may be viewed as a basically normal population, “the central challenge of prevention research on mental disorders . . . derives from the goal of preventing a condition that has not yet occurred, and success is measured by the reduction of the rate of the onset of the target condition” (Kellam & Rebok, 1992, p. 564), but assessment of encoding impairment as a significant predictor of aggressive behavior in an adult sample is also necessary. The gender, age, and race of each participant were recorded. Approval for the study was obtained from the Institutional Review Board of the college that the participants attended. All participants were asked to sign an Informed Consent and were given a copy. A file box containing the consent forms and test forms was maintained in a secure place. Data collection took place in a laboratory at the participating institution.

#### *Instrumentation*

The Aggression Questionnaire of the Buss-Durkee Hostility Inventory (Buss & Warren, 2000) was used to assess aggressive behavior. The WAIS-III Arithmetic and Digit Span subtests were used to assess encoding ability as did the Johns Hopkins Preventive Intervention Trials researchers (Dolan et al., 1993; Kellam et al., 1991; Mirsky, 1995a, 1995b; Mirsky et al., 1991; Rebok et al., 1996). The statistical program, Minitab 14, was used to determine the number of participants required to obtain statistical significance (based on  $SD = 1$  and  $\alpha = .05$ ). Analyses were conducted using SPSS version 14. Analyses revealed that eleven participants would be required to achieve a significance level of  $\alpha = .05$ .

Aggressive behavior was assessed by the Aggression Questionnaire of the Buss-Durkee Hostility Inventory, a widely-used measure of aggressive behavior. Its 34 items are distributed across five aggression scales: Physical Aggression, Verbal Aggression, Anger, Hostility, and Indirect Aggression. Encoding was measured by the Arithmetic and Digit Span subtests of the WAIS-III (Wechsler, 1997). These subtests reflect an individual’s capacity to recall and reorder information in stored memory. Data derived from child and adult samples ( $n = 435$ ) in the Hopkins Preventive Intervention Trials

show that these two measures loaded on a single factor called “encode” in an exploratory factor analysis (Kellam et al., 1991). “Specific measures of attention are often derived from the examiner’s preconception of the tests that best assess attention . . . and . . . may be used to provide indices of attention” (Mirsky, Fantie, & Tatman, 1995, p. 136). These tests involve mental manipulation of numbers, sequential registration of auditory information, and recall.

The WAIS-III Arithmetic subtest consists of 14 items. Every answer on the test is recorded in such a fashion that participants are unaware of their failures. The total arithmetic score was computed by adding the number of correct responses. During the WAIS-III Arithmetic subtest, participants were asked mathematical questions. During the WAIS-III Digit Span subtest, both Digits Forward and Digits Backward, the examiner recites a group of numbers and asks the participants to recall the numbers. In Digits Forward, a participant recites the numbers in the same order as given, while the Digits Backward administration requires the participant to recite the numbers backwards. The number of sequences of randomized digits correctly recalled is recorded.

To measure aggressive behavior, subscale scores on physical aggression, verbal aggression, anger, hostility, and indirect aggression from the Aggression Questionnaire of the Buss-Durkee Hostility Inventory were used. Scaled scores on the Wechsler Adult Intelligence Scale-III, Arithmetic and Digit Span subtests were used as encoding indices.

## RESULTS

The means and standard deviations for the encoding measures and the aggressive behavior measures are presented in Tables 2 and 3 [page 54]. Scores earned on these measures by participants in this study were initially submitted to Pearson product moment correlation analyses. Encoding indices were not significantly related to the five measures of aggressive behavior. Hypotheses 1 to 4 were, therefore, not confirmed. As expected, scores on the aggres-

sive behavior subscales were positively correlated with the total aggression scores. Scores on the different encoding indices were also highly correlated.

**Table 2**  
**Means and Standard Deviations of Encoding Measures (n=55)**

<b>Measure</b>	<b><i>M</i></b>	<b><i>SD</i></b>
Digit Span Forward	10.78	2.42
Digit Span Backward	6.16	1.93
WAIS-III Arithmetic	8.25	2.34
WAIS-III Digit Span	9.81	2.24

**Table 3**  
**Means and Standard Deviations of Aggressive Behavior Measures (n=55)**

<b>Measure</b>	<b><i>M</i></b>	<b><i>SD</i></b>
Physical Aggression	15.16	7.24
Verbal Aggression	12.70	4.14
Anger	13.85	5.42
Hostility	15.96	6.14
Indirect Aggression	12.87	3.34
Total Aggression	70.43	21.02

Given the absence of significant gender-related correlations, the data were examined in terms of age-related effects. Age groups were created as follows: 1) teenager, 2) early young adulthood, or 3) later young adulthood. Specifically, 17-19, 20-24, and 25-41 years of age groups were formed. These groups were formed based on evidence that the myelination process which is associated with the development of social skills continues to develop through the second decade of life. In essence, the refined configuration from the teenage years to the adult brain undergoes a change process (Barkovich, 1990). The WAIS-III Digit Span scale scores and verbal aggression ( $r = -.56$ ,  $p=.006$ ) of participants aged 17 - 19 years old ( $n = 23$ ) were inversely related. Among participants aged 20 - 24



years ( $n = 20$ ) performance on the WAIS-III Digit Span total score was inversely related to scores earned on the measure of verbal aggression ( $r = -.49$ ,  $p = .03$ ). In addition, performance on the WAIS-III Digit Span total score was inversely related to scores earned on the measure of indirect aggression ( $r = -.51$ ,  $p = .02$ ) among participants aged 20-24 years.

Because the WAIS-III Digit Span scaled score is an aggregate measure, we looked at performances on the tests used to compute the Digit Span score (Digit Span Forward and Digit Span Backward). Performance on the WAIS-III Digit Span Backward subtest was inversely related to scores earned on the measure of verbal aggression ( $r = -.51$ ,  $p = .01$ ) for participants aged 17-19 years. Furthermore, performance on the WAIS-III Digit Span Backwards subtest was inversely related to scores earned on the measure of hostility ( $r = -.59$ ,  $p = .006$ ) among participants aged 20-24 years.

Next, the WAIS-III-Arithmetic scaled scores and WAIS-III Digit Span scaled scores were combined to form a composite measure called "encoding ability." These two encoding measures were used as an index of encoding ability because they loaded on a single factor in the Johns Hopkins Preventive Intervention Trials from children and adults. Specifically, standard scores were computed for each of the encoding measures (with  $\mu = 10$  and  $SD = 3$ ) and summed. This new variable was termed "encoding" and produced a mean =  $-.64$  and  $SD = 1.19$ . Pearson product moment correlation analyses then were used to compare the relationship between the encoding measure and the subscales of aggressive behavior. When these variables were submitted to analyses for the entire sample ( $n = 55$ ), no significant relationships were found between encoding and any of the aggressive behavior measures. Again, the encoding and aggression measures were not significantly correlated when the groups were compared in terms of gender. But, when the encoding and aggression variables were compared across age groups a significant negative relationship emerged between encoding and verbal aggression ( $r = -.47$ ,  $r = .02$ ) among participants aged 17—19 years. A significant inverse relationship was also found between encoding and verbal aggression measures ( $r = -.46$ ,  $p = .04$ ) among partici-

pants aged 20-24 years. No significant correlations were revealed for participants aged 25-41 years.

There were fifteen participants in the study who reported that they had been diagnosed with attention problems prior to participating in the study. Participants with attention problems ( $n = 15$ ) were assigned to one group, while a second group ( $n = 40$ ) was comprised of participants without attention problems. The means and standard deviations of the encoding measures and scales of aggressive behavior of both groups are presented in Table 4 [below]. A  $t$ -test for independent samples was conducted for the group of participants who reported attention problems and the group of participants who reported no attention problems. Equal variance was assumed. When the two groups were compared, participants who had a history of attention problems were verbally more aggressive than participants with a negative history of attention problems [ $t = 2.47$ ,  $df = 53$ ,  $p = .02$ ], and they were generally more aggressive [ $t = 2.05$ ,  $df = 53$ ,  $p = .05$ ].

**Table 4**  
**Means and Standard Deviations of Encoding Measures and Aggressive Behavior of Participants With ( $n=15$ ) and Without Attention Problems ( $n=40$ )**

Measure	With		W/O	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Digit Span Forward	10.73	3.26	10.80	2.07
Digit Span Backward	5.66	1.98	6.35	1.90
WAIS-III Arithmetic	7.60	2.26	8.50	2.35
WAIS-III Digit Span	9.13	2.06	10.07	2.26
Physical Aggression	17.46	9.84	14.30	5.91
Verbal Aggression	14.86	4.82	11.90	3.60
Anger	16.06	6.87	13.02	4.61
Hostility	17.20	7.51	15.50	5.58
Indirect Aggression	14.20	4.36	12.37	2.77
Total Aggression	79.67	26.99	66.98	17.46

The encoding cluster was then examined in relation to the aggressive behavior scales using a Pearson product moment correlation analysis for the two groups, (i.e., the group that reported attention problems and the group that did not). A significant inverse relationship was found between encoding and anger in the group who reported no attention problems ( $r = -.32, p = .04$ ).

The database was then split and examined according to age groups. Among participants aged 17-19 years ( $n = 15$ ) who reported no attention problems, significant inverse relationships were found between encoding and verbal aggression ( $r = -.58, p = .02$ ), encoding and anger ( $r = -.65, p = .009$ ), encoding and indirect aggression ( $r = -.55, p = .03$ ), and encoding and total aggression scores ( $r = -.55, p = .03$ ). Significant positive relationships were found in the group who reported attention problems among participants aged 17-19 years old ( $n = 8$ ) between the WAIS-III Arithmetic scaled score and anger ( $r = .85, p = .008$ ), hostility ( $r = .88, p = .004$ ) and total aggression ( $r = .78, p = .02$ ). Multiple regression and Analysis of Variance revealed no significant differences between the two attention groups. A Fisher analysis revealed a significant difference in correlation coefficients between physical aggression and the Digit Span scaled score ( $z = 1.68, p = .04$ , one-tailed).

## DISCUSSION

The hypothesized relationship between encoding ability and aggression was not confirmed in the present investigation. Initial analyses involving the entire sample showed that the encoding measures were not related to any of the aggression indices. The same is true when gender-based groups were created and submitted to correlation analyses. Given the absence of significant gender-related correlations, the database was then divided into age groups. The rationale for splitting the database in terms of age was based on the notion that aggressive behavior may present differently across age groups based on the myelination process. Age groups were created as follows: 1) teenagers (17-19 years of age), 2) early young adulthood (20-24 years of age), or 3) later young adulthood (25-41 years of age). Performance on the WAIS-III Digit Span Backwards

subtest and the WAIS-III Digit Span scaled score was inversely related to verbal aggression for participants aged 17-19 years of age. Among participants aged 20-24 years an inverse significant relationship was revealed between the WAIS-III Digit Span Backwards subtest and hostility. There were no significant correlations for participants aged 25-41 years old.

While it is not clear how to interpret these findings, it suggests that aggressive tendencies may be a function of age level and cognitive maturity. Kohlberg (1969) links the evolution of aggressive behavior to age and cognitive development. Moral behavior is derived in part from cultural rules that govern social action internalized by participants. Internalization has been defined as acquiring cultural values and mores through learning and socialization. Punishments and rewards influence the process of internalization and may be reflected in a person's reduced tendency to engage in aggressive behavior. Younger participants who are verbally aggressive tend to perform poorer on the Digit Span Backwards and the Digit Span subtest. Conceivably, participants in the teenage and young adults groups may not have internalized the cultural values and mores that discourage aggressive behavior. The absence of significant correlations among participants aged 25-41 suggests that this group may use an alternate means of handling frustrations associated with failure rather than engaging in aggressive verbal behavior.

Previously, an encoding cluster comprised of the WAIS Arithmetic and WAIS Digit Span subtests predicted aggressive behavior (Tsamis, 1996). Likewise, we chose to look at the relationship between aggression and this encoding cluster. The encoding cluster was created by computing standard scores for the WAIS-III Digit Span scaled score and the WAIS-III arithmetic scaled score. These scores were then summed. Among participants aged 17-19 years and participants aged 20-24 years, encoding cluster scores were inversely related to verbal aggression. Decreased performance on the encoding cluster was associated with increased verbal aggression. These participants may have not yet learned to adapt and require more time to adapt to failure experiences and necessitate more time to adapt to such failures.

During their lifetime 15 participants in the current study reported on the screening questionnaire that they had been diagnosed with attention problems, while 40 participants reported no attention problems. Consequently, two groups were formed. One group was comprised of those participants reporting attention problems while the second group was comprised of those participants without a previous diagnosis of attention problems. Participants who reported a history of attention problems were verbally more aggressive than participants with a negative history of attention problems. These results provide additional support for the notion that impairments in encoding ability are linked to aggressive behavior in childhood samples (Dolan et al., 1993; Kellam et al., 1991; Tsamis, 1996).

The two groups were then divided into age groups. No significant correlations were found in the group of participants who reported attention problems. In contrast, among participants aged 17-19 years who reported no attention problems, encoding and verbal aggression, encoding and anger, encoding and indirect aggression, and encoding and total aggression scores were inversely related. In other words, participants who rated themselves as more verbally aggressive, angrier, and displayed more indirect aggression performed less well on encoding. Conceivably, there were participants with undiagnosed attention problems in the group who reported no attention problems. It is also plausible that participants with a history of attention problems had successfully managed their disability while those persons who had not successfully adapted to the attention problems were less likely to attend college. If this is true, then, a selection bias may have been introduced in this study and is a limitation of this investigation. Conceivably, the hypothesized effect is more likely to occur among persons who were diagnosed with attention problems but did not attend college. An additional limitation of the present study is that a random sample was not used; thus limiting generalizability. To this end, analysis is underway of a random sample who were neuropsychologically assessed for encoding in second grade, and data regarding problematic outcomes was collected at age 19-20.

The present findings may imply that there may be changes in the manifestation of aggressive behavior based on age. It is possible that as one gets older, they may have been socialized to decline participating in behavior that is perceived as aggressive. On the other hand, younger individuals may not be socially equipped to resolve problems that may arise without participating in aggressive-type behaviors. It may be said that the older an individual gets, the more likely they may be to resolve situations without displaying aggressive-type behaviors.

### CONCLUSION

The goal of the present study was to examine the relationship between encoding ability and aggressive behaviors in an adult sample of community college students. In the current study, analyses revealed that the encoding variables were significantly related to verbal aggressiveness in age-based groups and in the group who reported no attention problems.

Social behavior has been linked to cognitive development and a person's preparedness to respond to the demands of his/her environment (Kohlberg, 1969). Individual differences in conscious mental effort may lead to varied levels of motivation based on incentive, effort, or interest. Any temporal fluctuations based on everyday experiences, (e.g., influence of peers, families, or school environment), may affect behavior by altering attention, interest, and energy levels. Any factor may act alone or interact with others to subsequently cause or mitigate test performance.

It is suggested that additional studies should assess the whole range of personality traits that are relevant to understanding these antisocial behaviors. These investigations must be conducted using longitudinal data. In all likelihood, such studies are more sensitive to the trajectory laid out in this investigation. Identifying the neurocognitive elements of aggressive behavior may, in turn, be used to better understand the nature of the relationship between the brain and behavior.

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