

ADHD Symptomatology and Risky Health, Driving, and Financial Behaviors in College: The Mediating Role of Sensation Seeking and Effortful Control

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Abstract

Objective: To examine the extent to which effortful control (EC) and sensation seeking (SS) tendencies explain the association between the severity of ADHD symptoms and risky behaviors. **Method:** Participants included 555 college students (66% females) who completed self-report measures assessing their ADHD symptoms, EC abilities, SS tendencies, and risky health (e.g., substance use) and driving/financial behaviors (e.g., misuse of credit cards). **Results:** Severity of college students' ADHD symptoms, EC abilities, and SS tendencies were related to all risky behaviors. Multiple mediational analyses further indicated that students' SS tendencies significantly mediated the association between ADHD symptoms and the risky health factor but not the risky driving/financial factor. EC, however, significantly mediated the association between ADHD symptoms and both the risky health and driving/financial factors. **Conclusion:** The current study provides initial data showing potentially different mechanisms that explain the link between college students' severity of ADHD symptoms and risky behaviors. (*J. of Att. Dis.* 2015; 19(3) 179-190)

Keywords

ADHD, college students, effortful control, sensation seeking, risky financial behaviors, risky driving, risky sexual activity, substance use

The transition to college marks a crucial period in development in which adolescents experience role and identity changes (Arnett, 2000), a surge in stress and pressure that comes with performing academically and deciding on their future careers (Misra & McKean, 2000), and increased exposure to social experiences, which are often accompanied by an increase in exposure to substances (Kahler, Read, Wood, & Palfai, 2003). Not surprisingly, a significant portion of college students have difficulty with this transition and subsequently engage in maladaptive health behaviors (Von Ah, Ebert, Ngamvitroj, Park, & Kang, 2004). For example, rates of substance use and binge drinking are significantly higher during college than at any other time period (O'Malley & Johnston, 2002; Schulenberg & Maggs, 2002) leading to significant health consequences, including personal injury, legal problems, educational difficulties, and/or suicide and death (Jackson, Sher, & Park, 2005). Moreover, higher rates of substance use, particularly alcohol, have been linked to increased risky sexual behavior (e.g., unprotected sex) among college-aged individuals (Cooper, 2002; Kiene, Barta, Tennen, & Armeli, 2009). Higher rates of risky driving behaviors (e.g., speeding; Boyce & Geller, 2002; Yagil, 1998) and risky financial

behaviors (e.g., misusing credit cards) are also found among college students (Mowen & Spears, 1999). Taken together, college students' engagement in risky behaviors is recognized as a significant public health problem (Wechsler et al., 2002). Clearly, understanding what factors contribute to college students' risky behaviors would allow for a more targeted clinical intervention.

ADHD and Risky Health, Driving, and Financial Behaviors

The core symptoms of ADHD, consisting of inattention, hyperactivity, and impulsivity, are associated with significant impairment across domains of functioning (Barkley,

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Fischer, Smallish, & Fletcher, 2006) and follows a relatively chronic course into adulthood (DuPaul, Weyandt, O'Dell, & Varejao, 2009; Faraone, Biederman, & Mick, 2006). Individuals with ADHD are at high risk of various risky behaviors. For example, recent longitudinal follow-up of children in the Multimodal Treatment Study of ADHD (MTA) found that 64% of adolescents with ADHD were likely to engage in both alcohol and illicit drug use compared with 24% non-ADHD controls (Molina et al., 2013), making exposure to alcohol/substances one of the most significant health-related issues for youth with ADHD. Notably, childhood ADHD has been found to increase the odds of lifetime alcohol, marijuana, or other substance abuse dependence/abuse, a similar rates supporting the notion that the link between ADHD and substance use is not substance specific (Lee, Humphreys, Flory, Liu, & Glass, 2011). Young adults with ADHD also engage in higher rates of risky sexual behaviors (e.g., unprotected sex) compared with other college-aged students (Hosain, Berenson, Tennen, Bauer, & Wu, 2012; Huggins, Rooney, & Chronis-Tuscano, *IN PRESS*) and are at a significantly greater risk of driving-related incidents including accidents and speeding citations (Barkley et al., 2006; Jerome, Segal, & Habinski, 2006). Although relatively understudied, emerging evidence suggest that adolescents and young adults with ADHD are also at a greater risk of credit card use and misuse (Barkley et al., 2006). Taken together, this pattern of results suggests that ADHD symptomatology itself, above and beyond college status, is a significant predictor of risky health and driving/financial behaviors among adolescents and young adults.

Potential Mechanisms Linking ADHD and Risky Health and Driving/Financial Behaviors

Various neurocognitive and temperamental factors have been implicated in the etiology of ADHD. Martel, Nigg, and Von Eye (2009) make a distinction of "top-down" and "bottom-up" processes that are related to ADHD. Top-down processes refer to more effortful aspects of regulation that are thought to rely heavily on prefrontal circuitry (Nigg & Casey, 2005). Temperamental traits of effortful control (EC) and neuropsychological performance on executive functioning tasks are considered top-down processes (Martel & Nigg, 2006; Rothbart, Posner, & Kieras, 2006). Bottom-up processes relate to reactive behaviors that do not require conscious mental resources, are more influenced by emotional stimuli, and are thought to be mediated by subcortical brain regions such as the limbic system (Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003). Temperamental traits of emotional reactivity, negative emotionality, and sensation seeking (SS) are considered bottom-up processes (Martel & Nigg, 2006).

Research within the clinical and developmental literature has clearly shown the importance of top-down processes as it relates to various childhood adaptive functioning outcomes (Eisenberg et al., 2009; Graziano, Keane, & Calkins, 2010). When considering mechanisms that link ADHD to college-related impairments such as risky health acts, driving, and financial management, it may be the case that EC processes are mainly responsible for such impairment via lapses in attention and working memory. It is vital to examine such mechanism as not all children and adults with ADHD have significant top-down processes deficits (see meta-analysis of Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

Another potential mechanism to examine, although categorized as a bottom-up process, would be the temperament dimension of SS. SS refers to a personality trait marked by the proclivity to seek out experiences that are novel, varied, complex, and intense (Zuckerman, 1994). Individuals with ADHD, as well as those with more severe conduct problems, are more likely to have SS tendencies (Shaw & Giambra, 1993). In turn, SS tendencies relate to risky healthy behaviors, although most of this research has taken place without considering ADHD symptomatology. For example, Donohew et al. (2000) found that high school students with greater SS tendencies were more likely to engage in various sexual risky behaviors. Greater SS tendencies are also associated with greater substance use in adolescence (Martin et al., 2002), riskier driving behaviors (Jonah, Thiessen, & Au-Yeung, 2001), and greater financial problems such as misusing credit cards (Worthy, Jonkman, & Blinn-Pike, 2010). Once again, however, it remains unclear the extent to which SS is the primary mechanism linking ADHD symptoms and risky behaviors or if they represent two separate risk factors.

Current Study

In summary, a significant portion of students have difficulty with the transition to college and engage in various risky behaviors. College students with high levels of ADHD symptoms are particularly vulnerable to risky health, driving, and financial behaviors. However, not all college students with ADHD symptoms engage in these maladaptive risky health, driving, and financial behaviors. Hence, it is important to understand the mechanisms that may link ADHD to college impairment as it may help to identify high school students who are at a particular risk of the transition to college. Within a large college sample, this study sought to (a) replicate previous findings linking ADHD symptomatology and risky health, driving, and financial behaviors, and (b) determine whether EC and SS tendencies represent separate risk factors or simply mediate the associations between ADHD symptoms and maladaptive risky behaviors. Given the role of attention and working memory within the EC domain, we expected for EC to fully mediate the

association between ADHD symptoms and maladaptive risky health, driving, and financial behaviors. However, given that SS is a more bottom-up process that has less apparent overlap with ADHD symptoms, we expected SS to be an additional risk factor and not fully mediate the association between ADHD symptoms and risky health, driving, and financial behaviors.

Method

Participants

Participants for this study included 555 college students (66% females). The mean age of the participating students was 20 years (range: 18–24 years of age) with the vast majority being single, never married (98%). In terms of the ethnicity and racial makeup, 81% of the sample came from non-Hispanic backgrounds (49% White/Caucasian, 20% Asian, 8% Black/African American, and 4% as Biracial or “Other”) while 19% of the sample identified themselves as Hispanic White/Caucasian. The median family income was between US\$95,000 and US\$110,000 per year (range = <US\$20,000 to >US\$110,000).

Thirty-two individuals in our sample reported a history of an ADHD diagnosis, with 12 of those individuals reporting current or past history of psychopharmacological therapy. According to the Conners’ Adult ADHD Rating Scale (CAARS; Conners, Erhardt, & Sparrow, 1999), 60 participants reported clinically elevated symptoms indicative of ADHD (*T* score of 65 or higher on the ADHD Index score). Only 4% of participants indicated a history of any diagnosis besides ADHD, the majority of whom reported a history (current or past) of a depressive disorder (51%) or anxiety disorder (30%). Notably, no substance abuse–related disorders were reported.

Procedure

The Institutional Review Board at the study site approved this study and all study procedures adhered to the approved protocol. Participants were recruited from undergraduate classes at a Southeastern university in the United States. After being consented, they were given a participant number and instructions to access the survey online. The questionnaires were administered using a secure survey system and the order of questionnaire administration was randomized. Due to the sensitive nature of the information being collected (e.g., drug use, sexual behavior), online data collection was utilized to increase honesty in response (e.g., Rhodes, Bowie, & Hergenrather, 2003; VanDenKerkhof, Goldstein, Blaine, & Rimmer, 2005). At the end of the questionnaire and to receive extra credit, students were required to call the research center and answer questions about the consenting procedure (e.g., to ensure they were the one to physically consent). All participants contacted

the research center and answered the questions correctly. All online measures also included dummy questions to capture those who randomly responded to receive extra credit and only one student not included in this study inappropriately responded multiple dummy questions.

Measures

ADHD symptoms. The CAARS (Conners et al., 1999), a widely used questionnaire, was administered to assess college students’ current ADHD symptoms. The self-report version contains 68 items, and each item is rated on a 4-point Likert-type scale with respect to the frequency of occurrence. The measure yields raw and *T* scores on hyperactivity/restless, inattention/memory, impulsivity/emotional lability, self-concept, as well as *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000) symptom scales of inattention, hyperactivity/impulsivity, and total symptoms. The CAARS has well-established internal consistency, reliability, and validity (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999). For the purpose of the present study, the total symptoms raw scores ($\alpha = .94$) were used to measure severity of ADHD symptoms.

SS. The Sensation Seeking Scale (SSS) was administered to assess students’ SS tendencies. The self-report version contains 40, forced-choice items that yields four subscales (experience seeking, thrill adventure seeking, disinhibition, and boredom susceptibility) as well as an overall total score. The SSS has well-established internal consistency, reliability, and validity (Roberti, Storch, & Bravata, 2003; Zuckerman, 1994). For the purpose of the present study, the total score ($\alpha = .91$) was used to measure students’ SS tendencies.

EC. The Adult Temperament Questionnaire (ATQ; Derryberry & Rothbart, 1988) was administered to assess students’ EC abilities. The ATQ is a widely used self-report temperament measure that consists of 77 items on a 7-point Likert-type scale. The ATQ yields 19 subscales that combine to yield four index scores: extraversion, negative affect, EC, and orienting sensitivity. The ATQ has well-established psychometric properties (Evans & Rothbart, 2007). The focus of this study is on the EC dimension ($\alpha = .79$), which consists of the activation control, attentional control, and inhibitory control subscales. Higher scores indicate better EC abilities.

Substance use. Our drug use survey was modeled after the *National Survey on Drug Use and Health Questionnaire* (Substance Abuse and Mental Health Services Administration, 2002) and was administered to assess students’ use of alcohol, marijuana, cocaine, hallucinogens, stimulants, and sedatives. Questions pertain to lifetime use of substances,

age of first use, as well as frequency of use over the previous month and year. The reliability and validity of using frequency rates to assess severity of substance use is well-established (e.g., Stacy, Widaman, Hays, & DiMatteo, 1985). Given the lack of frequency rates of cocaine and hallucinogens use reported by our sample ($n = 17$ and 14 , respectively), only alcohol and marijuana were examined. Specifically, how many days in the previous month participants endorsed using alcohol and marijuana as well as how many days of binge drinking (i.e., >five drinks on the same occasion). To reduce the number of analyses, these three items ($\alpha = .74$) were standardized and averaged into a single substance use factor.

Risky driving. The Driving Behavior Questionnaire (DBQ; Lawton, Parker, Manstead, & Stradling, 1997; Reason, Manstead, Stradling, Baxter, & Campbell, 1990) was utilized to measure risky driving behavior, due to the DBQ's extensive use and strong psychometric properties (Lawton et al., 1997). The DBQ consists of 40 items on a 7-point Likert-type scale yielding four subscales measuring Aggressive Traffic Violations, Ordinary Traffic Violations, Driving Errors, and Driving Lapses (Lajunen, Parker, & Summala, 2004). These four subscales were standardized and combined into a single risky driving factor to minimize the number of analyses ($\alpha = .79$).

Risky sexual activity. The Sexual Risk Survey (SRS; Turchik & Garske, 2009) was administered to the students to measure risky sexual behavior over the past 6 months. The self-report version contains 23 items that yield an overall risky sex scale, as well as six separate but correlated subscales (sex risk taking with uncommitted partners, risky sex acts, impulsive sexual behavior, risky anal sex acts, and intent for risky sexual acts). Higher scores indicate riskier sexual activities. The SRS has well-established reliability and validity, and empirical support for its dimensional approach to risky sex behavior (Marcus, Fulton, & Turchik, 2011; Turchik & Garske, 2009). The overall risky sex score was used for this study to reduce the number of analyses and to capture overall risky sex behaviors ($\alpha = .86$).

Risky financial behaviors. To assess students' risky financial behaviors, the Compulsive Buying Scale (CBS; Faber & O'Guinn, 1992) and Credit Card Misuse Scale (CCMS; Roberts & Jones, 2001) were administered. The CBS is a 7-item scale that assesses feelings, thoughts, and behaviors associated with compulsive purchasing of items while the CCMS is a 12-item scale that measures one's propensity for credit card misuse, with higher scores reflecting irresponsible use of credit cards (e.g., having credit cards at their maximum limit). Both measures demonstrate good reliability and validity (Faber & O'Guinn, 1992; Roberts & Jones, 2001). For the purpose of the present study, the total score

of the CBS ($\alpha = .77$) and CCMS ($\alpha = .81$) were used as our measures of risky financial behaviors where lower scores on the CBS and higher scores on the CCMS reflect greater severity.

Data Analytic Strategy

Preliminary analyses were conducted to examine the normative distribution of each variable and to examine whether there were any statistically significant associations between demographic variables and our study variables. Data reduction procedures were implemented to determine the viability of combining substance use, risky sex, risky driving, and risky financial behaviors into a single risky behavior composite. Next, we conducted intercorrelations to examine the associations between severity of students' ADHD symptoms, SS, EC, and risky behaviors. Finally, for our primary analyses, a multiple mediation model was examined to determine whether the relation between the severity of ADHD symptoms and risky behaviors was mediated by students' SS tendencies and EC abilities. While the direction of our model is based on past theoretical and empirical work, we recognize the limitation of a cross-sectional mediation model in terms of inferring directionality.

Following procedures recommended by Preacher and Hayes (2008), a multiple mediation model involves (a) an analysis of the total indirect effect—the aggregate mediating effect of all the mediators being examined and (b) an analysis of the specific indirect effect—the mediating effect of a specific mediator. The significance of the indirect effects was tested via bootstrap analysis, which is commonly performed in multiple mediator analyses given its advantage of greater statistical power without assuming multivariate normality in the sampling distribution (Mallinckrodt, Abraham, Wei, & Russell, 2006; Preacher & Hayes, 2008; Williams & MacKinnon, 2008). As recommended by Preacher and Hayes (2008), parameter estimates and confidence intervals of the total and specific indirect effects were generated based on 2,000 random samples. Mediation is demonstrated via a statistically significant indirect effect (i.e., if the 95% bias-corrected confidence interval for the parameter estimate does not contain zero). To compare the magnitude of the indirect effects, all variables were standardized as suggested by MacKinnon (2000). All analyses were conducted using SPSS 19.0 including an SPSS macro designed for assessing multiple mediation models (Preacher & Hayes, 2008).

Results

Preliminary Analyses and Data Reduction

Descriptive statistics for all of the study's variables are presented in Table 1. Preliminary analyses indicated a significant difference in SS tendencies among students of different

Table 1. Descriptive Statistics.

	M	SD	Minimum	Maximum
GPA	3.49	0.391	1.41	4.0
ADHD DSM-IV total symptoms (CAARS)	18.11	9.37	1	51
Sensation seeking (SSS)	16.97	6.86	0	37
Effortful control (ATQ)	66.98	14.88	25	142
Substance use				
Days used alcohol in previous month	5.14	7.20	0	31
Binge drinking days in previous month	2.27	4.14	0	30
Days used marijuana in previous month	4.06	9.80	0	31
Risky sexual activities (SRS)				
Sex risk taking with uncommitted partners	4.70	9.78	0	80
Risky sex acts	11.10	15.90	0	122
Impulsive sexual behavior	5.76	8.41	0	47
Risky anal sex acts	0.6518	2.43	0	24
Intent for risky sexual acts	2.04	4.87	0	20
Overall risky sex score	24.05	30.70	0	213
Risky driving (DBQ)				
Aggressive violations	2.80	2.87	0	18
Ordinary violations	11.75	7.07	0	41
Driving errors	6.31	5.02	0	28
Driving lapses	8.23	5.09	0	35
Compulsive buying (CBS)				
Overall score	-0.821	1.52	-8.69	0.95
Credit card misuse (CCMS)				
Overall score	20.57	5.93	8	34

Note. All measures are self-report. GPA = grade point average; DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.); CAARS = Conners' Adult ADHD Rating Scales; SSS = Sensation Seeking Scale; ATQ = Adult Temperament Questionnaire; SRS = Sexual Risk Survey; DBQ = Driving Behavior Questionnaire; CBS = Compulsive Buying Scale; CCMS = Credit Card Misuse Scale.

races, $F(2, 305) = 4.30, p < .05$. Specifically, Asian students were significantly less likely to report SS tendencies compared with Caucasian/White students. No other racial differences in SS were found. Students' reported grade point average (GPA) also significantly differed according to race status, $F(2, 508) = 9.02, p < .001$. African American students reported having significantly lower GPA compared with Caucasian/White and Asian students. No other demographic variables, including having a psychological diagnosis besides ADHD, were significantly associated with GPA (with the exception of year in school; $p < .01$), ADHD symptom severity, SS tendencies, or EC abilities. See Table 2 for the means and standard deviations according to students' race.

A principal component factor analysis was subsequently conducted with a promax rotation method to determine the feasibility of having a single risky behavior composite based on our five indicator variables: substance use, risky sex, risky driving, compulsive buying, and credit card misuse. From this analysis, two factors emerged with an eigenvalue above one. The first factor which we term *risky driving/financial behaviors* ($\lambda = 2.16$) explained 43% of the total variance across measures (risky driving, compulsive buying, and credit card misuse) for this sample while the

second factor which we term *risky health behaviors* ($\lambda = 1.20$) explained an additional 24% of the total variance across measures of substance use and risky sex. All indicator variables were retained given their high loadings ($>.70$) and these two factor scores were used in subsequent analyses. In addition, subsequent analyses indicated that the risky health behavior factor differed significantly among ethnic groups, $F(2, 486) = 4.08, p < .05$ and racial groups, $F(2, 486) = 18.01, p < .001, \eta_p^2 = .01$ and $.07$, respectively. Specifically, Hispanic students reported engaging in significantly higher rates of risky health behaviors compared with non-Hispanic students. In terms of race, Caucasian/White students reported engaging in significantly higher rates of risky health behaviors compared with both Asian and African American students. Given these ethnic and racial differences in risky health behaviors and SS tendencies, all subsequent analyses controlled for ethnic and racial status as well as GPA.

Associations Among Variables

Correlations among the study's variables are presented in Table 3. ADHD symptoms were significantly associated with the *risky health factor*, the *risky driving/financial*

Table 2. Profile of Students From Different Ethnicities and Racial Backgrounds.

	Non-Hispanic Caucasian/ White (n = 270)	Asian (n = 106)	Hispanic Caucasian/ White (n = 93)	African American (n = 42)
GPA	3.57 (0.02) _a	3.49 (0.04) _a	3.43 (0.04) _a	3.26 (0.06) _b
ADHD symptoms, z score	0.08 (0.08) _a	0.07 (0.14) _a	-0.03 (0.13) _a	-0.41 (0.22) _a
Sensation seeking, z score	0.17 (0.08) _{a,c}	-0.26 (0.14) _b	0.01 (0.14) _{b,c}	-0.30 (0.23) _{b,c}
Effortful control, z score	0.13 (0.08) _a	-0.06 (0.14) _a	-0.01 (0.13) _a	-0.02 (0.23) _a
Risky health factor, z score	0.15 (0.05) _a	-0.40 (0.09) _b	0.18 (0.09) _a	-0.27 (0.14) _b
Risky driving and financial behaviors factor, z score	0.02 (0.05) _a	-0.02 (0.08) _a	-0.02 (0.09) _a	0.02 (0.13) _a

Note. Values enclosed in parentheses represent standard deviations. Means in the same row that do not share subscripts differ at $p < .05$. Those who described their race as "Other" (5%) or did not report a race (1%) were not included in these analyses. GPA = grade point average.

factor as well as the traits of SS and EC. Thus, college students with greater levels of ADHD symptoms reported engaging in greater levels of risky health and driving/financial behaviors, SS, as well as lower levels of EC. Higher levels of SS and lower levels of EC were also associated with higher levels of risky health and driving/financial behaviors. The significant associations among ADHD symptoms, SS, EC, and both risky health and risky driving/financial behaviors satisfy the requirements to test for mediation.

Mediational Analyses

As seen in Figure 1, the total effect of ADHD symptoms on both risky health and risky driving/financial factors were significant, $c = .13$, $p < .05$, overall model $R^2 = .31$ and $c = .29$, $p < .001$, overall model $R^2 = .27$, respectively. However, after adjusting for the indirect effects of the mediators, the direct effect of ADHD symptoms on the risky health factor was no longer significant, $c' = -.05$, $p = .38$. However, even after accounting for the indirect effects of the mediators, the direct effect of ADHD symptoms on the risky driving/financial factor continued to be significant, $c' = .12$, $p < .05$. While previous statistical methodology (i.e., Baron & Kenny, 1986) would interpret these results as evidence for full mediation scenario for the model that included the risky health factor and no mediation for the model that included the risky driving/financial factor, more recent statistical research suggests the importance of examining the indirect effects separately given that the total effect is not necessary for mediation to occur (MacKinnon, 2000; Preacher & Hayes, 2008; Shrout & Bolger, 2002). Table 4 contains the parameter estimates for the total and specific indirect effects for the association between ADHD symptoms and the risky health and risky driving/financial factors as mediated by SS and EC. The total indirect effect and the indirect effects of EC were all significant as evidenced by confidence intervals that did not contain zero. However, the indirect effects of SS was significant for the model that predicted the risky

health factor but not for the model that predicted the risky driving/financial factor. Hence, students' SS tendencies significantly mediated the association between ADHD symptoms and the risky health factor but not the risky driving/financial factor. EC, however, significantly mediated the association between ADHD symptoms and both the risky health factor and the risky driving/financial factor.

Discussion

The present findings support different mechanisms explaining the link between ADHD college students' symptom severity and risky behaviors in a number of domains, in a large, diverse undergraduate population. First, our hypothesis that EC would mediate the association between ADHD symptoms and risky health and driving/financial behaviors was supported. That is, a higher degree of ADHD symptoms was associated with risky behavior, but only when EC was low. Previous research has documented the associations of EC on a number of health-related issues (e.g., internalizing and externalizing problems; Oldehinkel, Hartman, Ferdinand, Verhulst, & Ormel, 2007; depressive symptoms, Verstraeten, Vasey, Raes, & Bijttebier, 2009). Although ADHD symptomatology has strongly been linked to maladaptive health and risky driving behaviors (e.g., see Jerome et al. (2006) and Lee et al. (2011) for reviews), associations between the disorder and certain areas of financial risk have failed to demonstrate expected conclusions (Barkley et al., 2006). Taken together with results reported here, ADHD symptoms alone may not place individuals at risk of risky behavior. Rather, it is ADHD symptoms, in addition to diminished ability to actively manage and control impulsive responses that may increase likelihood of participation in risky health and driving/financial behaviors.

Our hypothesis that SS would not mediate the link between ADHD symptoms and risky behavior was partially supported, such that students' SS tendencies significantly mediated the association between ADHD symptoms and risky health behavior, but not risky driving/financial

Table 3. Correlations Among Variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. ADHD symptoms (CAARS)	—														
2. SSS	.24***	—													
3. Effortful control (ATQ)	-.53***	-.26***	—												
4. Risky health factor	.15*	.54***	-.22***	—											
5. Risky driving/financial factor	.37***	.23**	-.48***	.28***	—										
6. Overall risky sex score	.15**	.40***	-.22***	.87***	.28***	—									
7. Aggressive violations	.21**	.21***	-.26***	.26***	.48***	.26***	—								
8. Ordinary violations	.37***	.29***	-.37***	.29***	.69***	.29***	.48***	—							
9. Driving errors	.35***	.16**	-.36***	.15**	.71***	.19***	.31***	.58***	—						
10. Driving lapses	.37***	.08	-.36***	.09	.68***	.14**	.28***	.51***	.69***	—					
11. Compulsive buying overall	.30***	.14**	-.34***	.17**	.82***	.23***	.27***	.33***	.42***	.43***	—				
12. Credit card misuse overall	.19***	.06	-.32***	.21***	.76***	.20**	.11*	.27***	.28***	.28***	.45***	—			
13. Days used alcohol in previous month	.16**	.45***	-.25***	.73***	.26***	.54***	.23***	.28***	.13**	.09	.20***	.24***	—		
14. Binge drinking days in previous month	.15**	.40***	-.24***	.78***	.25***	.48***	.28***	.34***	.17**	.14**	.10	.22***	.78***	—	
15. Days used marijuana in previous month	.02	.26***	-.05	.54***	.08	.26***	.08	.05	.03	-.03	.03	.17**	.36***	.33***	—

Note. All correlations controlled for students' grade point average, ethnicity, and race. CAARS = Conners' Adult ADHD Rating Scales; SSS = Sensation Seeking Scale; ATQ = Adult Temperament Questionnaire.

* $p < .05$. ** $p < .01$. *** $p < .001$.

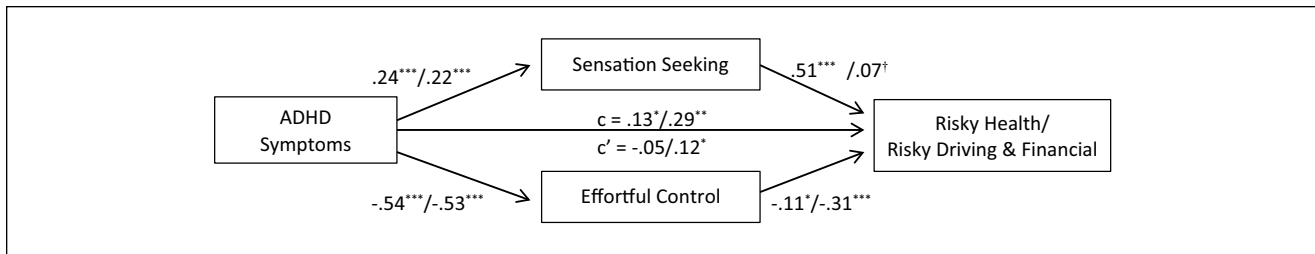


Figure 1. A multiple mediation model of the association between ADHD symptoms and risky health and driving/financial behaviors via sensation seeking and effortful control.

Note. Standardized regression coefficients from a bootstrap procedure are provided along the paths (left side for risky health factor as the outcome, whereas right side depicts coefficients for risky driving and financial behaviors factor as the outcome). Given the cross-sectional nature of this study, the direction of this model is based on past theoretical and empirical work.

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

Table 4. Indirect Effects of ADHD Symptoms on Risky Health Factor and Risky Driving and Financial Behaviors Factor.

Mediator	Parameter estimate	SE	Lower 95% BC CI	Upper 95% BC CI
Total	.181*/.176*	.04/.03	.101/.126	.267/.237
Sensation seeking	.121*/.016	.04/.01	.056/-.003	.193/.043
Effortful control	.06*/.156*	.03/.03	.004/.106	.128/.223

Note. The numbers on the left side of the diagonal pertain to risky health factor as the outcome, whereas the numbers on the right side pertain to risky driving and financial behaviors factor. BC CI = bias-corrected confidence intervals.

* $p < .05$.

behaviors. The contribution of a bottom-up down mechanism is consistent with Sergeant's cognitive energetic model (Sergeant et al., 2003), which posits reward sensitivity, inability to delay reward, and increased activity among individuals with ADHD. In situations where immediate gratification is not possible (e.g., social situations), impulsive and hyperactive individuals may be more driven to seek intense or novel stimulation, thus leading to risky health behaviors. In contrast, driving and spending money may represent more immediate domains of sensory gratification and the impulsive and hyperactive associated with ADHD symptoms may alone be risk factors for engaging in dangerous, immediately gratifying behavior. Indeed, previous research has demonstrated a strong pattern of association between SS and risk taking, with individuals who require higher sociobiological stimulation more likely to engage in risky driving (Schwebel, Severson, Ball, & Rizzo, 2006), thus the contributions of this personality trait may be independent from symptoms of ADHD.

Some potential limitations of this study should be acknowledged. First, our measurements relied solely on self-reported symptoms of ADHD and risky behavior, and therefore may not present a full picture of the symptom severity and impairment experienced by individuals experiencing symptoms of this disorder. Indeed, research suggests that individuals with ADHD underreport the severity of symptoms (Kooij et al., 2008). However, in light of this, we would expect stronger associations between ADHD symptoms and outcomes reported here. Nonetheless, future work may

benefit from including multi-informant data (e.g., parents, significant others), and standardized assessment instruments to elucidate the associations between diagnostic criteria and functional outcomes. Second, it is important to note that we were not able to assess for the presence of more serious anti-social behaviors such as those displayed by individuals diagnosed with Conduct Disorder, which often co-occurs with ADHD (Biederman, 2005). There is some evidence to suggest that individuals with ADHD and antisocial behavior have greater neurocognitive deficits compared with individuals with ADHD only (Séguin, Nagin, Assaad, & Tremblay, 2004) and greater SS tendencies (Russo et al., 1991). Hence, it will be critical for future research within the risky health behavior literature to include full diagnostic assessments of both ADHD and Conduct Disorder. Relatedly, this study did not thoroughly assess participants' current or past treatment history involving other psychological conditions, which may also have an impact on risky behaviors. That being said, only 4% of our participants reported any current or past psychological diagnosis besides ADHD.

Within the risky health factor, it is important to acknowledge the narrow scope of our substance use assessment as only frequency-related questions pertaining to alcohol and marijuana were examined. Other substances such as cocaine and hallucinogens were not examined due to the low frequency of use endorsed. While the merit for using frequency-based substance use questions such as binge drinking rates and overall use is well established (Jennison, 2004; Tucker, Ellickson, Orlando, Martino, & Klein, 2005), it remains

unclear the extent to which psychological dependency on alcohol and marijuana, while typically related to frequency of use, would have provided unique variance toward associations with EC and/or SS tendencies. Last, our sample's socioeconomic status (SES) and overall GPA suggests relatively high functionality. As research suggests that SES effects ADHD symptom presentation (Lasky-Su et al., 2007) and treatment outcomes (Rieppi et al., 2002), it will be important for future research to test the established model with economically diverse groups. To our knowledge, however, our study represents the largest population of Asian American college students and ADHD symptoms, and thus, results should be interpreted in light of the ethnic diversity presented here. On a related note, we did not have information on the extent to which students' finances were dependent on their parents. While financial dependence on parents puts students at less real, *immediate* financial risk (Lyons, 2004), the failure to develop financial self-regulation during college may, even if students are using their parents' credit cards, lead to financial problems in the *future* (e.g., Howlett, Kees, & Kemp, 2008). Although college students offer a particular vulnerable segment to study risky behaviors (Cooper, 2002; O'Malley & Johnston, 2002; Von Ah et al., 2004), it is important to recognize that our findings may not generalize to the general population.

Despite the limitations of our study, the results have clinical implications in terms of the treatment of ADHD among college students, and in particular targeting EC deficits. Currently, stimulant medications are the treatment of choice for college-aged students (Baverstock & Finlay, 2003), however, rates of stimulant misuse and abuse are rising, making the need for additional methods of treatment a priority (Teter, McCabe, LaGrange, Cranford, & Boyd, 2006). The vast majority of behavioral treatments are typically focused on early childhood, with few, if any, cognitive-behavioral interventions targeting college students (DuPaul et al., 2009). Interventions for executive function deficits have demonstrated mixed efficacy in remediating specific areas of difficulty in young adults (Brehmer, Westerberg, & Bäckman, 2012; McNab et al., 2009) with some benefit in remediating symptoms of ADHD (Beck, Hanson, Puffenberger, Benninger, & Benniger, 2010; Klingberg et al., 2005). However, the generalizability and transfer effects of such working memory training have been a significant limitation (see Morrison & Chein, 2011, for a review). Another route of intervention may be effective pharmacological treatment of ADHD symptoms, which has been found to lower risky behaviors (Cox, Merkel, Kovatchev, & Seward, 2000; Upadhyaya et al., 2005; Wilens, Faraone, Biederman, & Gunawardene, 2003). Limitations of a pharmacological approach are that misuse of stimulants is common in college students (McCabe, Sknight, Teter, & Wechsler, 2005) and associated with various risky behaviors including polydrug use (Egan, Reboussin, Blocker, Wolfson, & Sutfin, 2013). Therefore, it is also important to investigate

whether behavioral treatments that directly target the cessation of risky activities can indirectly improve EC abilities among adolescents/young adults.

In conclusion, the present study provides evidence that the link between ADHD symptoms and risky health and driving/financial behaviors in college students is explained through deficits in self-reported EC. However, students' SS tendencies only account for the association between ADHD symptoms and risky health behaviors but confer a separate risk factor for risky driving/financial behaviors. These findings provide further insight into the mechanisms underlying ADHD symptomatology and shed light on the top-down/bottom-up debate surrounding models of ADHD. Due to the cross-sectional nature of this study and shared variance from relying solely on self-report, it will be critical for future research to replicate our mediational model findings using longitudinal and multi-informant data.

Declaration of Conflicting Interests

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