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**PAYING ATTENTION TO ADHD AS A PREDICTOR OF ADOLESCENT
DELINQUENCY AND PEER FRIENDSHIPS**

A Thesis in

Crime, Law & Justice

by

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ABSTRACT

Although ADHD has been shown by psychologists to be a robust predictor of delinquency and has been a topic of substantial public concern in recent years, it has rarely been studied by sociological criminologists. In addition to delinquency, prior psychological studies suggest that ADHD may influence peer friendship selection, peer interactions, and peer delinquency. Using a self-reported and retrospective measure of ADHD from a sample of 5,582 adolescent respondents to The National Longitudinal Survey of Adolescent Health (Add Health), this thesis tests the relationships between ADHD, peer friendships, delinquency, and peer delinquency. Results show that (1) for boys, ADHD is associated with fewer friendship nominations by peers and a reduced likelihood of best-friendship reciprocation, (2) ADHD tends to increase peer delinquency indirectly through lower school grades and increased delinquent behavior, (3) the association between ADHD and delinquency is not mediated by peer influence, and (4) this association is moderated by peer delinquency. Comparisons to recent criminological literature on impulsivity and self-control suggest that ADHD is an independent predictor of delinquency.

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DEDICATION

I would like to dedicate this thesis to my wife, Rachel Marie Hutchison, with much gratitude and appreciation for her support.

CHAPTER 1. INTRODUCTION AND LITERATURE REVIEW

Attention deficit/hyperactivity disorder (ADHD) is a topic of great public concern, and one that has received extensive psychological scrutiny. For example, a recent article in the *New York Times* (Schwartz and Cohen 2013) reported that nearly 20% of high school boys are diagnosed with ADHD based on data from the Centers for Disease Control and Prevention. This high prevalence of ADHD diagnoses is extremely disconcerting, as psychological studies of hyperactive boys have shown that they are much more likely to experience negative outcomes, including school failure, labor market problems, delinquency, arrest, and incarceration, both during adolescence and in young adulthood (Mannuzza et al. 1989, 1997; Pratt et al. 2002). In a similar vein, Moffitt (1993) predicted that adolescents with neuropsychological deficits, such as ADHD, will have higher rates of antisocial behavior during childhood, adolescence and into adulthood.

Although psychologists have long studied the ADHD-antisocial behavior relationship, this important topic has generally been overlooked by sociological criminologists. Unnever, Cullen and Pratt (2003) note that “research on ADHD and youths' problem behavior has been conducted primarily by psychologists and biomedical researchers with few ties to the field of criminology” (p. 495). Instead, criminologists have focused on the relationship between crime and related, but arguably less well-defined, constructs like self-control (Gottfredson & Hirschi 1990) and impulsivity (Thomas & McGloin 2013). This is perplexing given ADHD's strong measurement validity and that it may serve as an underlying or preceding cause of low self-control, high impulsivity, and delinquency. Moreover, criminologists can shed light on the role ADHD plays in shaping peer contexts and peer network structures—areas that are outside the realm of a typical psychological study.

Though few criminologists have studied ADHD in large or nationally representative samples, the concept easily fits into several criminological theories. For instance, differential association and social learning theories (Sutherland 1947, Akers 1998) suggest that influence from delinquent peers causes delinquency, and an association between delinquent peers and individual delinquency has been shown in decades of research with ever-increasing methodological sophistication (Haynie 2001, Osgood et al. 1996). Under theories of peer influence, stable traits such as ADHD are commonly thought to affect crime insofar as they impact the social learning process—a mediation hypothesis. On the other hand, gene-environment interactions observed by biosocial criminologists (Vaughn et al. 2009, Beaver et al. 2010) and Moffitt’s developmental taxonomy suggest that the strength of peer influence may be dependent on whether the adolescent has ADHD symptoms—a moderation hypothesis. Furthermore, prior research on both self-control and ADHD suggest that ADHD may have effects on important peer network characteristics like peer time involvement and friendship reciprocation.

In this thesis, I will use longitudinal and peer network data from the Add Health study to examine the relationship between ADHD and adolescent delinquency. First, drawing upon the psychological literature, I will discuss the nature of ADHD, outcomes associated with ADHD, treatment strategies, and ADHD’s association with substance use. The criminological literature on self-control and impulsivity will then be utilized to explain how concepts related to ADHD have been analyzed in the past. Next, I will combine ideas from psychology and criminology to generate hypotheses about how ADHD and peer delinquency influence future adolescent delinquency. Finally, I will test whether ADHD, impulsivity, and self-control have effects on delinquency independent of one another.

ADHD

ADHD¹ is a disorder characterized by a combination of symptoms including elevated activity levels, low tolerance for frustration (temper), impulsivity, poor behavioral organization, low attention span, and lack of concentration (American Psychiatric Association 2000). Individuals with ADHD are more likely to be diagnosed with other disorders like anxiety, depression, or other learning disorders. The *Diagnostic and Statistical Manual IV* lists 18 symptoms for ADHD split into two 9-item scales: (1) inattentive and (2) hyperactive/impulsive. A diagnosis requires that the individual display 6 of the 9 symptoms in one of the scales or 6 of the 9 symptoms in both scales. Therefore, there are three subtypes of ADHD: ADHD-HI (6 of 9 hyperactive/impulsive symptoms), ADHD-IN (6 of 9 inattentive symptoms), and ADHD-C (6 of 9 in both hyperactive/impulsive and inattentive). According to a 2008 review of ADHD research (Cormier 2008), prevalence estimates vary widely—from as low as 2% to as high as 16%. Clinical and epidemiological studies report that boys are many times more likely to receive diagnoses than girls with ratios up to 9:1 (Gershon 2002). Racial disparities were not observed by the Centers for Disease Control and Prevention, but one study showed lower rates of diagnosis and treatment for African-American and Hispanic families when controlling for socioeconomic factors (Pastor & Reuben 2005). Heritability of the disorder is significant: up to 1/3 of parents with ADHD children are affected by ADHD themselves. ADHD has been linked to genetic markers, but is also associated with environmental factors including exposure to lead, brain injuries, prenatal substance abuse, low birth weight, and infections during early childhood.

Treatment for ADHD has ranged from clinical therapy to dieting and chiropractic care (Cormier 2008). The most empirically supported method of treatment is the administration of

¹ From 1980 to 1994, it was known more simply as attention deficit disorder (ADD). It was renamed to ADHD in the DSM-IV and revised to include three subtypes. See the appendix for the ADHD symptom items in the Add Health survey.

medicated stimulants like Ritalin and Adderall. A randomized clinical trial found that all groups assigned to treatment had significant reductions in symptoms after 14 months, and more comprehensive treatment produced greater effects (MTA Cooperative Group 1999). However, the *Times* article highlights the concern among parents that ADHD is being both overdiagnosed and overmedicated. Given the potential severity of the side effects of the prescribed medications, including cardiovascular problems and sudden death, these issues pose a serious risk. Moreover, there is a growing concern about the potential misuse of these stimulants by undiagnosed populations, especially among truck drivers and college students (White, Beacker-Blease & Grace-Bishop 2010). In addition to the availability of medication, the importance of cooperative roles among parents, schools, and healthcare providers to provide effective treatment for ADHD may have negative implications for individuals with weak ties to their parents, schools, or with limited access to healthcare.

An impressive amount of research has uncovered the negative outcomes associated with ADHD. For instance, teenage males with ADHD have rates of arrest that are 36%-58% higher than males without ADHD (Foley, Carlton & Howell 1996). ADHD is associated with a heightened risk of conduct disorder (CD), which is characterized by antisocial behavior and violation of age-appropriate norms. Forty-three percent of hyperactive adolescents in one study qualified for CD compared to 1.6% of controls (Barkley et al. 1990). Similarly, Forehand and colleagues (1991) found that adolescents with both ADHD and CD were arrested earlier in their lives and with greater frequency than adolescents with CD alone. ADHD can have long-term effects on crime as well. Farrington's (1990) longitudinal study found that hyperactivity-impulsivity-inattention was among the strongest predictors of crime at age 32.

ADHD is also associated with an increased risk of substance abuse. For children with average levels of externalizing behavior (e.g. aggressiveness, CD), the presence of ADHD more than doubled the risk of illicit drug use by age 11 (Chilcoat & Breslau 1999). Irrespective of conduct disorder, a study of college students demonstrated that individuals with ADHD faced increased risks of substance abuse compared to non-ADHD college students (Rooney, Chronis-Tuscano & Yoon 2012). The ADHD students were more likely to have ever used marijuana, ever used other illicit drugs, to have experienced greater levels of intoxication from those drugs, and to have used those drugs earlier in their lives. Interestingly, ADHD did not predict more alcohol use in college, but the authors hypothesized that increased use of alcohol by non-ADHD students during college years diluted the effect. Similar to illicit drugs, college students with ADHD were more likely to be smokers, to have smoked more often, and to have smoked earlier. Consistent with these results, Kollins, McClernon and Fuemmeler (2005) found that each additional ADHD symptom reported in Add Health corresponded to an 11% to 16% increase in the likelihood of ever regularly smoking.

Self-Control and Impulsivity

Though most criminologists have not examined the ADHD-crime relationship, they have looked at how self-control and impulsivity relate to crime. For instance, Gottfredson and Hirschi identified six dimensions of self-control in *A General Theory of Crime*: impulsivity, a preference for simple tasks vs. complex tasks, favoring physical activities vs. mental activities, self-centeredness, temper, and risk-seeking behavior. Clearly there is some conceptual overlap between self-control and ADHD. The impulsivity and temper dimensions of self-control correspond to the hyperactive/impulsive ADHD subtype, and the preference for simple and physical tasks directly corresponds to one of the symptoms from the inattentive subtype of

ADHD. Risk-seeking behavior is not included in the DSM-IV's list of ADHD symptoms, though it is associated with ADHD (Milberger et al. 1997; Harpin 2005). The self-centered dimension of self-control is not addressed by ADHD, but symptoms like blurting answers or interrupting others could be perceived by others as self-centeredness. In perhaps the only prior empirical test comparing ADHD and self-control, Unnever, Cullen and Pratt (2003) found that, in opposition to the general theory of crime, receiving ADHD medication predicted self-control and self-control mediated half of the effect of ADHD on delinquency.

Criminologists have made several attempts to examine the relationships between peer influence, self-control, and delinquency. In one study that also included ADHD, Unnever and Cornell (2003) found that self-control was a risk factor for bullying and ADHD was a risk factor for victimization in a sample of six middle schools. ADHD was the best predictor of being victimized by bullies but was not a predictor of being a bully. Naturally, respondents who reported using ADHD medication were more likely to have low self-control. Following research by Perrone et al. (2004), Beaver and colleagues (2008) used 5 questions from Add Health to analyze self-control and gene-environment correlations. They found support for the hypothesis that genetic markers and neuropsychological deficits influence levels of self-control and interacted to increase delinquency. McGloin and Shermer (2009) used the Add Health dataset to look at peer network structures and self-control. The authors used 7 questions from the first wave of the survey (3 of which were in common with Beaver et al.) in an attempt to capture 3 of the 6 dimensions of self-control outlined by Gottfredson and Hirschi. No support was found for the moderation hypothesis, but self-control and peer delinquency were instead interrelated risks. Individuals with low self-control were more likely to have deviant peers, and both were risks for increased delinquency. Being a central member of a delinquent peer group increased the

likelihood of delinquency, but higher involvement in such a group, measured by time spent together outside of school, was unexpectedly associated with less delinquency. Low self-control was associated with greater time spent with peers outside of school whether the peers were delinquent or not. Since self-control and ADHD are related concepts, I expect to replicate this by finding that ADHD is associated with peer time involvement using the same measurement.

H1: Adolescents with ADHD symptoms spend more time with peers outside of school than adolescents without ADHD symptoms.

In comparison to impulsivity, ADHD is a broader construct since it also includes hyperactivity and inattentiveness. While the Young Adult Add Health survey includes 17 of the 18 ADHD symptoms taken from the *DSM*, there has been some inconsistency in the measurement of impulsivity in the few studies examining impulsivity and delinquency/deviance with the data set. For example, Vazsonyi, Harrington and Wiebe (2006) used 4 items to measure impulsivity and found that the relationship between impulsivity and deviance was stable, but levels of impulsivity and deviance varied by the levels of neighborhood disadvantage. Thomas and McGloin (2013) used a dual-systems approach to examine peer influence and impulsivity. Impulsivity was measured in Add Health by 3 of the 4 questions used by Vazsonyi and an additional question that is said to be “the most valid measure of impulsivity contained in the data set” (Nagin & Pogarsky 2004). The authors also used an additional data set in the analysis. Support was found for the hypothesis that individuals in the top 10% and bottom 10% on the impulsivity scales were more susceptible for peer influence. Though the measurements from these studies are not using ADHD symptoms, the conceptual overlap between ADHD and impulsivity suggests that findings in this thesis should be consistent.

Peer Delinquency

Though self-control and impulsivity are conceptually related to ADHD, and there has been research on their relationships to peer delinquency, there has been little work on ADHD and peer delinquency conducted by sociological criminologists. With that said, peer influence is perhaps one of the most well-researched and well-established correlates of delinquency (Agnew 1991). While parental background and attachment are extremely important in early childhood and continue to be relevant into adulthood, peer relationships become more salient in adolescence (Brown 1990; Furlong & Eccles 1993). Social learning perspectives suggest that when adolescents are exposed to peers with values, attitudes, and behaviors in favor of law violation, the risk for delinquency increases (Sutherland 1947, Akers 1998). In addition to normative influence, time spent with peers while unsupervised, especially delinquent peers, provides more opportunities for engaging in delinquent behavior (Osgood et al. 1996). Work in recent years has emphasized the importance of peer network structures (Haynie 2001, 2002) and how peer influence operates under different conditions. Haynie found that the proportion of delinquent peers in a friendship network and the density of that network increase the likelihood of delinquency.

Since ADHD is a learning disorder and is associated with decreased verbal ability, there is reason to suspect that it may have an impact on the social learning process. Normative peer influence could have weaker, similar, or stronger effects for adolescents with ADHD. A weaker peer effect would imply that the effects of ADHD override peer influence, while a stronger effect would suggest that the effects of ADHD make adolescents more vulnerable to peer influence. It is also possible that ADHD influences peer selection: adolescents with ADHD are more likely to be rejected by conventional peers and fall into more delinquent groups. This process could

explain a finding that peer influence mediates the effect of ADHD on delinquency. Marshal, Molina & Pelham (2003) found support for this idea in a small study of ADHD, peers, and substance abuse. Because exposure to peers who engage in substance abuse is a robust predictor of substance abuse and the direct effect of ADHD was reduced in its presence, ADHD was only related to substance abuse indirectly by increasing exposure to deviant peers.

Evidence from prior research suggests that ADHD impacts the way children and adolescents interact with parents, peers, and other important individuals. A double-blind study of boys between the ages of 6 and 12 staying at a 5-week summer camp showed that boys with ADHD demonstrated adherence to different social goals (Melnick & Hinshaw 1996). Aggressive boys with ADHD were more likely to prioritize trouble-seeking and fun at the expense of rules, while seeking attention more often and fairness less often. Based on peer nominations at the end of the camp, control boys were the most popular, followed by low-aggression ADHD boys, and high-aggression ADHD boys were least popular. While they reported that they wanted to be liked, their behaviors and reputations made that difficult. Consistent with this finding, a Canadian study showed that boys with ADHD experience social isolation and bullying due to lacking social skills and immaturity (Shea & Wiener 2003). Hoza (2007) found that this holds true for girls as well and describes a stigmatization process for children with ADHD. Just as for children with any stigma, once they are labeled as “ADHD” by other children, it is difficult for them to overcome their reputations. Treatment regimens for ADHD are not aimed at improving peer relations, so these problems persist even with medication. While these childhood studies found marginalization effects, Moffitt predicts that aggressive youth will become more popular in adolescence. Since the current study uses a

survey of adolescents, I expect to find less evidence for social marginalization than was typically found in childhood studies.

Perhaps the best attempt at understanding the associations between ADHD, peer influence, and delinquency comes from a longitudinal study of a Finnish birth cohort (Savolainen et al. 2010). Consistent with prior literature, adolescents in Finland with ADHD were three times more likely to be convicted of a felony between the ages of 15 and 20 than without ADHD. This effect was reduced but remained significant when controlling for family background, verbal deficits, and conduct problems. Researchers found support for the interaction of ADHD and verbal deficits in predicting felony conviction: respondents with low verbal ability had twice the likelihood to be convicted when they also had ADHD. There was no evidence for mediation of this effect from social marginalization by peers which is more supportive of the direct effect of ADHD on crime.

The psychological literature has described that delinquent children may experience a hostile attribution bias whereby they are more likely to pay attention to hostile social cues and misinterpret benign cues as hostile (Dodge, Murphy & Buchsbaum 1984). In light of that research, I do not necessarily expect that adolescents with ADHD nominate fewer friends in the current study; recall that the boys at the summer camp in Melnick and Hinshaw (1996) still wanted to be liked. I will test the hypothesis for ADHD predicting fewer outgoing nominations as *H2*, though I do not expect to find support for it. Rather, I expect to find that they experience less peer acceptance in terms of incoming nominations and that their outgoing nominations are less likely to be reciprocated. Psychological research has shown that children and adults with ADHD are more likely to misinterpret social cues, emotions in others, and nonverbal communication (Cadesky, Mota, and Schachar 2000, Petersen & Grahe 2012, Singh et al. 1998).

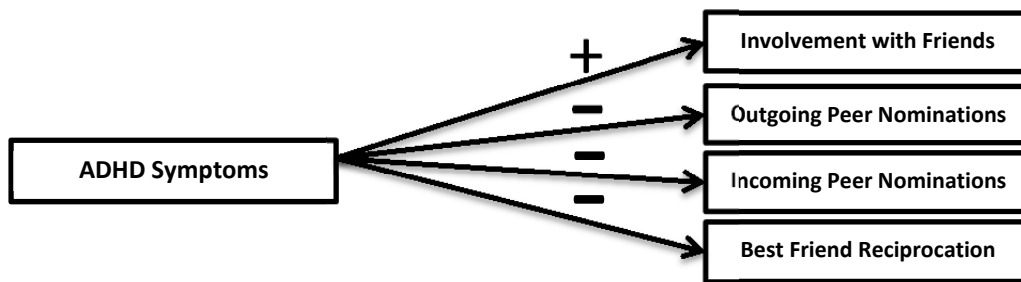
This suggests that individuals with ADHD may perceive their friendships differently than their friends. The hypothesized effect of ADHD on peer relationships is illustrated in Figure 1.

H2: Adolescents with ADHD symptoms have fewer outgoing peer nominations.

H3: Adolescents with ADHD symptoms have fewer incoming peer nominations.

H4: Adolescents with ADHD symptoms are less likely to have “best friend” nominations reciprocated.

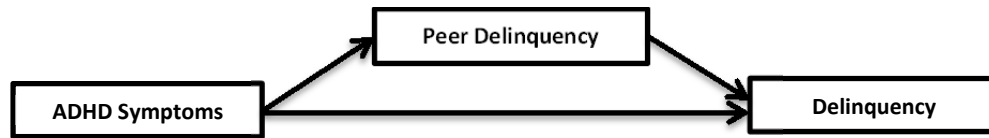
Figure 1. Peer Relationship Hypotheses



A few psychological scholars have attempted to study the strength of peer influence on adolescents with ADHD. In a study of 242 adolescents between 13 and 18, researchers hypothesized that, because deviant peers are the greatest predictor of substance abuse and adolescents with ADHD are more likely to associate with deviant peers, deviant peer relationships mediate the relationship between ADHD and substance abuse (Marshal, Molina & Pelham 2003). Presumably, children with ADHD are more likely to be selected into peer groups that are more tolerant of their delinquent behavior and thus are more delinquent themselves. Once inside these delinquent peer groups, their own delinquency increases. Not only did they find support for the mediation hypothesis, the authors found that the relationship between peer deviance and substance abuse was stronger for adolescents with ADHD than those without ADHD. Based on these findings, I expect to find support in the current study for the hypothesis that ADHD is associated with delinquent peers and that the delinquency of peers mediates the

relationship between ADHD and one's own delinquency. This potential relationship is represented in Figure 2.

Figure 2. Mediation Hypothesis

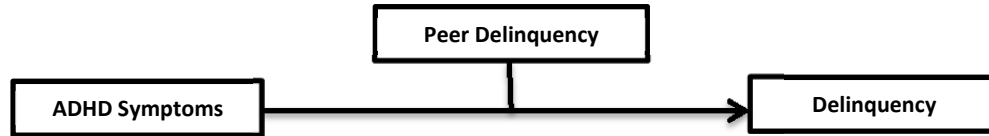


H5: Adolescents with ADHD symptoms are more likely to have delinquent peers.

H6: If H5 is true, the delinquency of peers mediates the influence of ADHD symptoms on delinquency.

Moffitt's (1993; Moffitt, Lynam & Silva 1994) work on adolescent-limited and life course persistent offenders suggests that peer effects vary in the presence of neuropsychological deficits like ADHD. Peers do not have as a great of an influence on adolescents with neuropsychological deficits because the primary cause of their delinquency is stable throughout the life course. In other words, they are already prone to delinquency before engaging with delinquent peers and remain prone to delinquency after their peers are gone. On the other hand, adolescents without deficits are more susceptible to the influence of delinquent peers; they are less likely to be delinquent outside the presence of delinquent peers. While Moffitt did not specifically test ADHD as it is defined for the current study, I would expect to find similar results based on conceptual similarities. Her findings suggest a moderating effect whereby the effect of peer delinquency depends on whether or not the adolescent has ADHD similar to the effect McGloin and Shermer (2009) sought for self-control. This potential relationship is illustrated in Figure 3.

Figure 3. Moderation Hypothesis



H7: The delinquency of peers moderates the effect of ADHD symptoms on delinquency.

The Current Study^{2,3}

The purpose of this study is to examine the relationship between delinquency, ADHD, and peer delinquency. This study will contribute to the literature by bringing together ideas from psychological and sociological criminology. Psychological criminology will benefit from hypotheses testing the effect of ADHD on peer relationships while sociological criminology will be informed by tests of ADHD as a predictor of delinquency compared to low self-control and impulsivity. The method for this study will be to use responses from the Add Health survey to test hypotheses generated from the existing criminological literature. Several regression models will be generated, accompanied by an analysis of the findings, followed by a discussion of the implications and a conclusion.

² Assistance provided by the Population Research Institute at Penn State University, which is supported by an infrastructure grant by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R24-HD041025).

³ This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (<http://www.cpc.unc.edu/addhealth>). No direct support was received from grant P01-HD31921 for this analysis.

CHAPTER 2. DATA AND METHODS

Sample

Many prior studies of ADHD conducted by psychologists used samples of less than 150 clinically-diagnosed subjects either without comparison groups or with demographically similar controls. The handful of studies by sociologists and criminologists pertaining to ADHD and peers used larger and more representative samples but measured perceptions of peer delinquency rather than direct measurements from the peers themselves. As Haynie and Osgood (2005) demonstrated, adolescents tend to overestimate the actual levels of delinquency engaged in by their peers, so direct measures offer increased validity. The author is not aware of any prior studies of ADHD and peer delinquency using direct peer measures.

This thesis utilizes data from the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative study that includes self-reported symptoms to examine the relationships between ADHD, peer influence, and delinquency. Over 90,000 students from grades 7-12 in schools across the United States were administered the Wave 1 in-school Add Health survey from September 1994 to April 1995 (Harris et al. 2009). These participants were continually sampled for 4 waves in total. This thesis uses variables from the Wave 1 in-school survey and the in-home surveys at Wave 1, Wave 2 (1996), and Wave 3 (2001-2002). Peer network data from the in-school survey is available for the majority of the sample which allowed for the direct examination of peer effects. The final sample size for respondents with peer network information at Wave 1 who were retained until Wave 3 was 5582. Table 1 provides weighted descriptive statistics for each variable included in the analyses split by whether or not the respondent reported enough ADHD symptoms to qualify for a diagnosis. T-tests are provided to show which differences in means are statistically significant.

Dependent Variables

Delinquency. Following Haynie (2001), the current study uses a 14-point delinquency scale constructed from questions at Wave 2 as the dependent variable. Respondents were asked about involvement in more serious delinquency including acts like damaging property, shoplifting, stealing, burglary, “borrowing” a car, selling drugs, getting into group fights, seriously injuring someone in a fight, threatening someone with a weapon and shooting or stabbing someone. If a respondent indicated that he or she engaged in that activity in the past 12 months, the response was coded as a “1.” These responses were summed and combined into a single_scale. Since ADHD should precede both Wave 1 and Wave 2, delinquency at Wave 2 was chosen as the dependent variable to allow for the use of Wave 1 delinquency as an additional control. The dependent variable, therefore, represents how many different acts engaged in by the respondent in the year preceding Wave 2. This scale of Wave 2 delinquency yielded a Cronbach’s alpha value of .80 which indicates that the scale is internally consistent.

Outgoing Nominations. This measure indicates how many friends the respondent nominated at Wave 1. Each respondent could nominate up to 5 friends from each gender, so the maximum possible value is 10. This measure also represents the “send” network—the network as measured by the ego’s nominations. Perhaps especially because these are adolescent respondents, they were more likely to nominate more friends of the same gender.

Incoming Nominations. This indicates how many peers nominated the respondent as one of their 10 friends. These constitute the “receive” network—the ego’s network as defined by the ego’s friends (alters). The theoretical maximum value would be total number of peers in the network, but the highest actual value was 30. Combining this with the outgoing nominations

Table 1. Population Weighted Descriptive Statistics

Variables	ADHD N=398		Non-ADHD N=5184		T-Test	Min	Max	% Missing
	Mean (%)	SD	Mean (%)	SD				
<u>Wave 1</u>								
Wave 1 Delinquency	1.31	1.07	.92	.98	<0.001***	0	6	30.82%
Peer Delinquency	1.09	.68	.94	.58	<0.001***	0	6	29.45%
Peer Network Size	6.96	4.04	8.06	4.42	<0.001***	0	31	29.07%
Outgoing Peer Nominations	4.62	2.85	5.23	2.89	0.004**	0	10	29.07%
Incoming Peer Nominations	4.41	3.36	5.29	4.05	<0.001***	0	30	29.07%
Best Male Friend Reciprocation	43.78%	-	56.46%	-	0.057	-	-	67.89%
Best Female Friend Reciprocation	51.24%	-	63.22%	-	0.178	-	-	63.21%
Involvement with Peers	1.4	1.47	1.14	1.26	0.01**	0	10	29.07%
Loner (Network Size = 0)	2.70%	-	1.49%	-	0.212	-	-	29.07%
Attachment to Parents	4.62	.74	4.74	.57	0.016*	1	5	29.31%
Parent Education	2.98	1.26	3.07	1.19	0.286	1	5	35.48%
Average Grades	2.58	.86	2.94	.77	<0.001***	1	4	33.71%
Impulsivity ^A	3.18	1.2	2.96	1.1	0.001**	1	5	0.80%
Low Self-Control ^B	.2	.61	-.02	.58	<0.001***	-1.29	3.08	3.02%
<u>Wave 2</u>								
Male	62.13%	-	44.21%	-	<0.001***	-	-	0.00%
White (Non-Hispanic)	78.98%	-	72.87%	-	0.023*	-	-	0.18%
Black (Non-Hispanic)	8.34%	-	12.60%	-	0.019*	-	-	0.18%
Hispanic	7.58%	-	7.67%	-	0.948	-	-	0.18%
Other Race (Non-Hispanic)	6.04%	-	7.02%	-	0.568	-	-	0.18%
Age	16.19	1.59	15.91	1.61	0.032*	11	21	0.00%
Wave 2 Delinquency	1.74	2.53	1.19	1.95	0.007**	0	14	1.11%
<u>Wave 3</u>								
Retrospective ADHD Symptoms	10.95	2.77	2.12	2.28	<0.001***	0	17	21.92%

*p < .05 **p < .01 ***p < 0.001

^A See also Thomas and McGloin (2013)

^B See also McGloin and Shermer (2009)

yields the “send or receive” network which includes all incoming and outgoing ties.

Reciprocation. In addition to network size, the current study will use best friend reciprocation as another measure of peer relationships. Each respondent could nominate one of their 5 friends per gender as a best friend. In other words, each respondent could have a “best

male friend” and a “best female friend.” The current study utilizes the “lenient definition” of reciprocation from Vaquera and Kao (2008) such that best friend reciprocation occurs when the ego nominates someone as a best friend, and that person nominates the ego as either a friend or best friend. While it would be possible to look only at best friend-to-best friend reciprocation, the “strict definition”⁴, this seems unreasonably restrictive given the limited number of total nominations. Given the strong impact of gender on reciprocation, analyses for this variable were split by gender and limited to reciprocation from best male friends for males and reciprocation by best female friends for females. Furthermore, reciprocation is not possible if the respondent nominated someone who did not complete the Wave 1 in-school survey (absent or not a student of that school), and this increased the amount of missing data. Separate analyses were therefore conducted on this variable to avoid sample reduction in the other models.

Involvement. Time spent with friends is included in the current study as an “involvement” measure of peer relationships using the method done by McGloin and Shermer (2009). Respondents were asked a few questions about each friend who was nominated, including whether they met after school during the week and whether they spent time together over the weekend preceding the survey. Each response was coded as “0” for “no” and “1” for “yes.” The sum of these two values was divided by the square root of the “send” network in a procedure following Haynie and Osgood (2005). This calculation provides “a compromise between the sum across friends and the average across friends” (p. 1126). The final involvement measure represents how often the respondent meets with his/her nominated friends outside of school.

⁴ Vaquera and Kao (2008) report that the definition decision may be irrelevant: “We opted for the more lenient definition of the term because friendships are likely to occur not only in dyadic form but also in small cliques. Our findings are virtually identical using either definition” (p. 60).

Independent Variables

ADHD. The ADHD measures were constructed from 17 questions in Wave 3 of the Add Health survey. Respondents were aged 18-26 at that point in time, but questions were asked retrospectively to ages 5-12. The 17 items were directly taken from ADHD symptoms in the *Diagnostic and Statistical Manual III (DSM)*. Though the DSM has 18 symptoms for ADHD, one symptom was omitted from the Add Health survey (see the Appendix for a list of ADHD symptoms in Add Health). Each response was coded as a “1” if the respondent reported that he or she often or very often experienced the symptom during ages 5-12. Two variables were used in the final analysis—one dichotomous and one a count of reported symptoms. The dichotomous variable indicates whether the respondent reported enough symptoms to qualify for an ADHD diagnosis. Following the *DSM*, the items are broken into “hyperactive/impulsive” and “inattentive” categories, and a respondent must have 6 or more symptoms in one or both of those categories to get a “1” on the dichotomous variable. From the final sample, 398 respondents were coded as ADHD yielding a 7.1% prevalence rate. The continuous variable (ADHD symptom scale) ranged from 0 to 17 indicating how many symptoms the respondent reported. The Cronbach’s alpha for the ADHD symptom scale was .85. The continuous variable was used in most analyses while the dichotomous variable was used to split the sample to create Table 1 and report other differences.

The ADHD symptoms in the current study are therefore both retrospective and self-reported. One important advantage of using self-reported symptoms versus clinical diagnosis is the avoidance of disparity in diagnoses across gender and racial/ethnic lines (Morgan et al. 2013). While access to health services may impact diagnosis rates, self-reported symptoms should be less vulnerable to this bias. Furthermore, Kollins, McClernon, and Fuemmeler (2005)

report that it is a common practice for psychologists working with adult ADHD patients and cite four studies supporting the validity and reliability of this method (Murphy & Schachar 2000; Zucker et al. 2002; Ward, Wender & Reimherr 1993; Stein et al. 1995). The relative stability of ADHD over time further strengthens the validity of this measure (August, Braswell & Thuras 1998).

Peer Delinquency. At Wave 1, respondents were asked to nominate up to five friends of the same sex and up to five friends of the opposite sex. The current study used the “send or receive” network, meaning that “peers” were defined as those respondents who were either nominated as a friend by the ego or who nominated the ego as a friend. Again following Haynie (2001), peer delinquency was calculated as the mean of responses by peers to the Wave 1 in-school survey delinquency scale described below. Respondents with no friends were given a value of “0” on this measure and were coded “1” on a “Loner” dummy variable.

Impulsivity. Part of the contribution of this study is to compare ADHD to existing variables of interest in criminology. Following several studies by McGloin, most recently Thomas and McGloin (2013), the current study will use a single-item measure of impulsivity. At Wave 1, respondents were asked “When making decisions, you usually go with your ‘gut feeling’ without thinking too much about the consequences of each alternative” with responses ranging from strongly agree to strongly disagree on a 5-point scale. The responses were coded for the current study such that a higher value corresponds to a greater tendency for the respondent to go with “gut feelings.” Thomas and McGloin point out that others (Nagin and Pagarsky 2004) have said this is “the most valid measure of impulsivity” in Add Health.

Low Self-Control. While there have been several attempts at measuring Gottfredson & Hirschi’s concept of self-control in Add Health, the current study will follow the method used by

McGloin and Shermer (2009). The measure represents a 7-item scale constructed from survey items asking how much the respondent agrees with 4 statements combined with responses to 3 questions. The four statements were: “When you have a problem to solve one of the first things you do is get as many facts about the problem as possible”; “When you are attempting to find a solution to a problem you usually try to think of as many different ways to approach the problem as possible”; “When making decisions you generally use a systematic method for judging and comparing alternatives”; “After carrying out a solution to a problem you usually try to analyze what went right and what went wrong.” Each response was on a 5-point scale, much like the impulsivity measure. The three questions were: “How often do you have trouble paying attention in school in the past year?”; “Have you had trouble getting your homework done in the past year?” and “Have you had trouble keeping your mind on what you were doing during the past year?” Responses to these questions were on a 4-point scale, so z-scores were used to construct the final measure. The items were coded such that higher values indicate lower self-control. The Cronbach’s alpha for the self-control scale was .68.

Control Variables

Gender. To examine the effect of being male—a consistent predictor of delinquency—alongside ADHD and peer delinquency, females were used as the reference category for the gender control variable. Analysis of the peer relationship variables was conducted with the sample split by gender due to the impact of gender on adolescent relationships. The gender observation from Wave 2 was used to minimize missing data.

Race/Ethnicity. Race/ethnicity was constructed using a hierarchical scheme described in the Add Health documentation. Respondents were allowed to indicate whether they were of Hispanic ethnicity and were allowed to select multiple responses for race. In the current study,

“Hispanic” means Hispanic of any race and “Black” means the respondent was Black or African-American but did not select Hispanic. “Other Race” indicates that the respondent did not select Hispanic or Black but did select another category, most frequently Asian or Native American. Therefore, the White reference category represents respondents who only selected White as their race and did not select Hispanic ethnicity. The race/ethnicity observation from Wave 2 was used to minimize missing data.

Age. Age represents the respondent’s age at Wave 2 calculated from the respondent’s date of birth.

Network Size. In order to prevent bias in peer delinquency due to having many or few friends, network size was included as a control variable. Peer network size was calculated as the mean amount of respondents who were included in the peer delinquency scale. In other words, a respondent’s peer network size represents the average amount people in the ego’s send-or-receive network who answered the Wave 1 delinquency questions.

Wave 1 Delinquency. Minor delinquency at the Wave 1 in-school survey was included as a control for a more rigorous test of ADHD and peer delinquency. Wave 1 minor delinquency was self-reported by adolescents in grades 7-12 during the in-school survey. Following Haynie (2001), questions about minor acts of delinquency covered smoking, drinking, getting drunk, racing, doing something dangerous on a dare, and skipping school. Respondents indicated their responses on a 0-6 scale where 0 meant “never” and 6 meant “nearly everyday” engaging in the activity. These responses were averaged in order to align with the peer delinquency measure. Therefore, Wave 1 delinquency represents the respondent’s average level of involvement in several acts of minor delinquency on a scale of 0 to 6. The Cronbach’s alpha for the Wave 1 minor delinquency scale was .68.

Parent Attachment. Attachment to parents at Wave 1 was measured by two questions asking how much the respondent feels that his or her mother and father cares about him or her on a 5-point scale from “not at all” to “very much.” The average of the two responses was taken for respondents who answered the question for both parents while the response for a single parent was used for respondents who did not answer both questions. Thus, the variable remains on a scale from 1 to 5.

Parent Education. Parent education was included as a control variable as the education level of the respondent’s most educated parent reported at Wave 1 by the adolescent respondent. The variable is on a 5-point scale where 1 means less than high school education, 2 means high school diploma or GED, 3 means some college, 4 means college graduate, and 5 means “professional training beyond a four-year college.”

Grades. The respondent’s grades at Wave 1 were measured by questions about the respondent’s current grades in English/Language Arts, Mathematics, Science, and History/Social Studies. Responses were coded such that 1 means “D or lower,” 2 means “C,” 3 means “B,” and 4 means “A.” These responses were averaged to create a single scale. The grades variable in the analysis represents the respondent’s self-reported average class grade on a 4-point scale.

Bivariate Correlations

Table 2 shows the population weighted bivariate correlations between each of the variables. One concern is that there could be a multicollinearity problem between ADHD, impulsivity, and self-control because they are related concepts. However, none of the bivariate correlations exceed .21 between these variables. At this level, ADHD is most closely associated with Wave 1 minor delinquency, being male, low grades, and fewer incoming peer nominations. The dependent variable, Wave 2 serious delinquency, is most closely associated with Wave 1

minor delinquency, peer time involvement, and low self-control. Peer delinquency is most associated with older respondents, Wave 1 delinquency, peer time involvement, and low grades.

Table 2. Population Weighted Correlation Matrix

		WHT	BLK	HISP	OTHR	W1DL	PRDL	NETS	OUT	IN	BMR	BFR
WHT	White	1.00										
BLK	Black	-0.61	1.00									
HISP	Hispanic	-0.47	-0.06	1.00								
OTHR	Other Race	-0.51	-0.09	-0.07	1.00							
W1DL	W1 Delinq.	0.07	-0.10	0.04	-0.04	1.00						
PRDL	Peer Delinq.	0.03	-0.10	0.02	0.04	0.42	1.00					
NETS	Network Size	0.14	-0.10	-0.06	-0.05	0.03	-0.02	1.00				
OUT	Out Noms.	0.11	-0.04	-0.07	-0.06	-0.03	-0.05	0.59	1.00			
IN	In Noms.	0.13	-0.11	-0.02	-0.05	0.04	0.00	0.86	0.24	1.00		
BMR	Best M Recip.	0.06	-0.08	-0.04	0.03	0.02	-0.01	0.16	0.07	0.30	1.00	
BFR	Best F Recip.	0.06	-0.06	0.02	-0.05	-0.02	0.05	0.16	0.02	0.34	0.00	1.00
INV	Involvement	0.03	-0.08	0.03	0.03	0.25	0.20	0.03	-0.09	0.09	0.13	-0.05
LON	Loner	0.02	-0.01	-0.01	-0.01	0.01	-0.07	-0.09	-0.13	-0.05	-0.04	-0.05
ATCH	Attach Parents	-0.01	0.03	0.02	-0.02	-0.18	-0.10	0.02	0.01	0.02	0.02	0.06
PEDC	Parent Educ.	0.10	-0.06	-0.11	0.00	0.00	-0.11	0.06	-0.02	0.09	0.08	0.05
GRDS	Grades	0.09	-0.12	-0.01	-0.01	-0.26	-0.29	0.13	0.08	0.13	0.05	0.07
IMP	Impulsivity	-0.04	0.01	0.06	-0.01	0.25	0.11	0.06	0.04	0.03	0.01	-0.04
LSC	Low Self-Ctrl.	0.05	-0.05	0.03	-0.04	0.25	0.15	-0.03	0.01	-0.03	0.02	-0.04
MALE	Male	-0.02	-0.07	0.02	0.09	0.17	0.00	-0.02	0.03	-0.08	0.20	-0.33
AGE	Age	-0.02	0.05	-0.02	-0.02	0.08	0.26	-0.05	-0.06	-0.03	0.08	0.09
W2DL	W2 Delinq.	-0.05	0.00	0.07	0.02	0.32	0.17	0.05	-0.02	0.07	0.02	0.01
ADHD	ADHD Symp.	-0.03	-0.01	0.04	0.04	0.22	0.15	-0.12	-0.08	-0.13	-0.04	-0.09

		INV	LON	ATCH	PEDC	GRDS	IMP	LSC	MALE	AGE	W2DL	ADHD
INV	Involvement	1.00										
LON	Loner	0.19	1.00									
ATCH	Attach Parents	-0.03	-0.02	1.00								
PEDC	Parent Educ.	0.12	-0.03	0.11	1.00							
GRDS	Grades	0.01	-0.01	0.18	0.24	1.00						
IMP	Impulsivity	0.04	0.03	-0.13	-0.09	-0.24	1.00					
LSC	Low Self-Ctrl.	0.04	0.01	-0.11	-0.01	-0.17	0.21	1.00				
MALE	Male	0.29	-0.03	0.04	0.09	-0.05	0.12	0.07	1.00			
AGE	Age	0.23	-0.04	-0.05	-0.05	-0.15	-0.06	0.03	0.07	1.00		
W2DL	W2 Delinq.	0.20	0.11	-0.13	0.00	-0.07	0.15	0.24	0.14	-0.08	1.00	
ADHD	ADHD Symp.	0.10	-0.01	-0.11	-0.06	-0.23	0.14	0.21	0.13	0.08	0.12	1.00

CHAPTER 3. ANALYSIS AND RESULTS

Analysis

Add Health respondents included in the final analysis were those who responded to the Wave 1 in-school survey, the Wave 1 in-home survey, the Wave 2 survey, and the Wave 3 survey. While 13,570 eligible respondents completed Wave 2, about 3,900 did not complete the Wave 1 in-school survey and an additional 3,000 did not complete the Wave 3 survey. Therefore, the sample size is 5582 for all but two models, and this sample is split by gender for the analysis of peer relationship variables. In particular, the two models used to measure effects on best friend reciprocation have further reduced sample sizes due to missing data generated by nominations for students who were absent or attended another school. For these reciprocation analyses, the sample size equals 1,405 boys and 1,983 girls. The remaining models utilizing peer relationship dependent variables are split by gender to make gender differences more readily apparent.

Because the Add Health survey was constructed with a complex sampling design, survey weighting is necessary to avoid biased results. The grand survey weights created by the Add Health team were used in all analyses, correlations, and descriptive statistics tables. Since the primary dependent variable, serious delinquency at Wave 2, occurs in the second wave of the survey, Wave 2 weights were used. This might seem confusing because the primary predictor of interest in this thesis, self-reported ADHD symptoms, were reported at Wave 3. However, recall that these symptoms were asked retrospectively to between the ages of 5-12, well before Wave 1 of the Add Health survey, and ensuring temporal ordering of the variables.

Results

Several statistical approaches were required for this thesis due to the variety of dependent variables needed to test the seven hypotheses. The first column of Table 3 shows a test of *HI* using peer time involvement as the dependent variable. Involvement was a continuous variable ranging from 0 to 10, so ordinary least-squares regression was utilized. Despite findings from previous authors that self-control reduces peer involvement, there was no relationship between ADHD and peer time involvement for boys or girls net of controls. Age and delinquency at Wave 1 were predictors for increased peer time involvement for both genders. One of the race variables, Black, was negative and significant only for boys, while grades were positive and significant only for girls. The effect of being Black on girls' peer time involvement is less than 20% of the size of the same effect for boys. Interestingly, peer delinquency was positive and significant for girls only. While the coefficient is difficult to interpret due to the way involvement was calculated, results suggest that girls who had more delinquent peers spent more time outside of school with their peers than girls with less delinquent peers.

Incoming and outgoing nominations were count variables that were not overdispersed (i.e., the variance was not significantly larger than the mean), so Poisson regression was used for the second and third columns of Table 3. In line with the lack of evidence in the literature, ADHD was not associated with fewer outgoing peer nominations for either gender. This means that ADHD youth nominate just as many friends as their peers. Grades and Wave 1 minor delinquency predicted more outgoing peer nominations for boys and girls. Minority race variables were significant for both genders, but Black and Hispanic variables were strongest among boys. Looking at the odds ratios reported in Table 3, it is possible to calculate the percent change in the expected count of nominations by evaluating the following expression: $(1 - \text{odds}$

Table 3. Survey Adjusted Regressions of Add Health Peer Friendship Variables
Panel A. Males

	OLS Regression of Involvement ^A		Poisson Regression of Outgoing Nominations ^B			Poisson Regression of Incoming Nominations ^B			Logistic Regression of Best Friend Reciprocation ^{CD}		
	b	SE	b	IRR	SE	b	IRR	SE	b	OR	SE
Intercept	-1.63	(0.67)	1.44	-	(0.39)	0.64	-	(0.35)	0.08	-	(0.10)
ADHD Symptoms	0	(0.01)	-0.01	0.99	(0.01)	-0.02**	0.98	(0.01)	-0.05*	0.95	(0.02)
<i>Wave 2 Variables</i>											
Delinquency	0.08**	(0.02)	0	1.00	(0.01)	0.01	0.81	(0.01)	0.1**	1.11	(0.04)
Black	-0.32*	(0.14)	-0.25**	0.78	(0.07)	-0.23**	-2.83	(0.08)	-0.78***	0.46	(0.09)
Hispanic	-0.07	(0.12)	-0.2*	0.82	(0.08)	-0.2**	-2.96	(0.07)	-0.51	0.60	(0.19)
Other Race	0.06	(0.15)	-0.12	0.89	(0.07)	-0.36***	-3.90	(0.09)	-0.35	0.71	(0.19)
Age	0.1**	(0.03)	-0.03	0.97	(0.01)	0	0.07	(0.01)	0.06	1.06	(0.06)
<i>Wave 1 Variables</i>											
Delinquency	0.2***	(0.04)	-0.04*	0.96	(0.02)	0.06**	1.07	(0.02)	-0.12	0.89	(0.08)
Attach. to Parents	0.08	(0.06)	0.1*	1.11	(0.05)	0.12**	1.13	(0.04)	0.36**	1.44	(0.19)
Parent Education	0.14***	(0.03)	0	1.00	(0.02)	0.02	1.02	(0.02)	0.03	1.03	(0.08)
Grades	0.1	(0.06)	0.07*	1.07	(0.03)	0.12**	1.13	(0.04)	0.22	1.25	(0.14)
Peer Delinquency	0.07	(0.09)	-0.01	0.99	(0.04)	-0.04	0.96	(0.04)	-0.04	0.96	(0.20)

*p < .05 **p < .01 ***p < .001 A N = 2478 males B N = 2478 males C N = 1401 males

D Best friend reciprocation: ego nominates an alter as a best friend of the same gender and the alter nominates ego as any kind of friend

Panel B. Females

	OLS Regression of Involvement ^A		Poisson Regression of Outgoing Nominations ^B			Poisson Regression of Incoming Nominations ^B			Logistic Regression of Best Friend Reciprocation ^{CD}		
	b	SE	b	IRR	SE	b	IRR	SE	b	OR	SE
Intercept	-1.01	(0.30)	1.89	-	(0.26)	1.44	-	(0.32)	0.29	-	(0.35)
ADHD Symptoms	0.01	(0.01)	-0.01	0.99	(0.01)	-0.01	0.99	(0.01)	0	1.00	(0.02)
<i>Wave 2 Variables</i>											
Delinquency	0.03	(0.02)	0	1.00	(0.01)	0.02	1.02	(0.01)	0.01	1.01	(0.04)
Black	-0.06	(0.06)	-0.13**	0.87	(0.05)	-0.19**	0.82	(0.06)	-0.38*	0.69	(0.12)
Hispanic	-0.03	(0.07)	-0.17**	0.84	(0.05)	-0.2*	0.82	(0.08)	-0.26	0.77	(0.19)
Other Race	-0.17	(0.09)	-0.15*	0.86	(0.07)	-0.21**	0.81	(0.08)	-0.49*	0.61	(0.14)
Age	0.08***	(0.01)	-0.03**	0.97	(0.01)	-0.02	0.98	(0.01)	0.04	1.04	(0.05)
<i>Wave 1 Variables</i>											
Delinquency	0.21***	(0.03)	-0.04*	0.96	(0.02)	-0.01	0.99	(0.03)	0.19	1.21	(0.14)
Attach. to Parents	-0.02	(0.04)	0.02	1.02	(0.03)	0.03	1.03	(0.04)	0.14	1.15	(0.13)
Parent Education	0.01	(0.02)	0	1.00	(0.01)	0.04*	1.04	(0.02)	0.15	1.16	(0.09)
Grades	0.11**	(0.03)	0.05**	1.05	(0.02)	0.09***	1.09	(0.02)	0.19	1.21	(0.12)
Peer Delinquency	0.19**	(0.06)	0.12***	1.13	(0.03)	0.12**	1.13	(0.04)	0.17	1.18	(0.21)

*p < .05 **p < .01 ***p < .001 A N = 3104 females B N = 3104 females C N = 1983 females

D Best friend reciprocation: ego nominates an alter as a best friend of the same gender and the alter nominates ego as any kind of friend

ratio). Net of controls, the expected count of incoming nominations for Black or African-American boys was 22% lower than the expected count for White boys while the expected count was 18% lower for Hispanic boys than White boys. Attachment to parents predicted more outgoing nominations for boys but not for girls. Peer delinquency was the strongest predictor of increased outgoing nominations for girls, but it was not at all significant for boys.

Consistent with some of the prior literature, ADHD was a predictor of fewer incoming peer nominations for boys, albeit a modest one. Each additional ADHD symptom reduced the expected count of incoming nominations by 2 percent, but recall that a diagnosis requires at least 6 symptoms. The race variables were again predictive of incoming nominations for both genders, though effect sizes by gender were much closer than those for outgoing nominations. Generally speaking, the effects on outgoing nominations were amplified for incoming nominations. Interestingly, the association with attachment to parents grew for boys' incoming nominations but was still not significant for girls. Peer delinquency remained a significant predictor of incoming nominations for girls only.

The reduced sample models for best friend reciprocation in the fourth column of Table 3 were conducted using logistic regression. The odds ratio for ADHD shows that, net of controls, each additional ADHD symptom for boys decreased the odds of best friend reciprocation by 0.05. A boy reporting 6 ADHD symptoms—the minimum necessary to be eligible for diagnosis—would be about 26% less likely to receive a best friend reciprocation than a boy with no symptoms. The average boy who would be eligible for diagnosis (reporting 11 symptoms, see Table 1) would be 37% less likely to receive reciprocation than the average boy who is not eligible for diagnosis (reporting 2 symptoms). ADHD had no effect on reciprocation for girls, possibly because symptoms were more common among males. Attachment to parents continued

to have a strong impact on peer relationships for boys by increasingly the likelihood of reciprocation. However, race was the strongest predictor of best friend reciprocation for both genders. Net of controls, a non-Hispanic Black or African-American boy was less than half as likely to receive best friend reciprocation as a non-Hispanic White boy.

The dependent variable for *H5*, peer delinquency, was a continuous variable ranging from 0 to 6, so ordinary least squares regression was used to estimate the models in Table 4. Model 1 shows that ADHD symptoms were associated with increased peer delinquency. However later models show that this association is attenuated by the inclusion of certain control variables. The inclusion of controls in Model 2, aside from Wave 1 minor delinquency or grades, decreases the association with ADHD symptoms slightly, though it remains significant at the $p < 0.001$ level. The inclusion of either Wave 1 minor delinquency or grades in Models 3 and 4,

Table 4. Survey Adjusted Least Squares Regression of Add Health Peer Delinquency

	Model 1		Model 2		Model 3		Model 4		Model 5	
	b	SE	b	SE	b	SE	b	SE	b	SE
Intercept	0.901	(0.029)	0.109	(0.185)	0.006	(0.003)	0.504	(0.179)	0.016	(0.176)
ADHD Symptoms	0.017***	(0.004)	0.013***	(0.003)	0.006	(0.003)	0.008*	(0.003)	0.003	(0.004)
<i>Wave 2 Variables</i>										
Male	-	-	0.048*	(0.023)	-0.012	(0.021)	0.03	(0.023)	-0.018	(0.004)
Black	-	-	-0.25***	(0.044)	-0.187***	(0.034)	-0.292***	(0.044)	-0.219***	(0.022)
Hispanic	-	-	-0.051	(0.046)	-0.048	(0.041)	-0.07	(0.046)	-0.061	(0.035)
Other Race	-	-	-0.036	(0.059)	0.003	(0.052)	-0.025	(0.055)	0.007	(0.041)
Age	-	-	0.077***	(0.012)	0.067***	(0.01)	0.071***	(0.01)	0.064***	(0.051)
<i>Wave 1 Variables</i>										
Delinquency	-	-	-	-	0.218***	(0.022)	-	-	0.2***	(0.019)
Attach. to Parents	-	-	-0.051**	(0.018)	0.023	(0.015)	-0.029	(0.017)	0.031*	(0.015)
Parent Education	-	-	-0.044***	(0.01)	-0.037***	(0.009)	-0.022*	(0.009)	-0.023**	(0.008)
Grades	-	-	-	-	-	-	-0.157***	(0.025)	-0.101***	(0.019)
Network Size	-	-	-0.003	(0.003)	-0.002	(0.003)	0	(0.003)	-0.001	(0.003)
Loner	-	-	-1.028***	(0.046)	-0.995***	(0.054)	-1.047***	(0.051)	-1.01***	(0.057)

N = 5582 *p < .05 **p < .01 ***p < .001

respectively, reduces the association with ADHD to marginal significance. Model 5 shows that these two variables, in addition to the remaining controls, reduce the significance of ADHD on peer delinquency to $p > .05$.

Since *H5* was supported, the analysis continued with tests for mediation and moderation. Table 5 was constructed using negative binomial regressions because the dependent variable, Wave 2 serious delinquency, was an overdispersed count outcome. Model 6 shows that, before controls, each ADHD symptom increased the count of wave 2 delinquency by 6%. Adding the standard controls in Model 7 reduced this coefficient by about half. Model 8 shows a test of *H6* by including peer delinquency and its associated network size control variables. However, the

Table 5. Survey Adjusted Negative Binomial Regression of Add Health Wave 2 Delinquency

	Model 6			Model 7			Model 8			Model 9		
	b	IRR	SE	b	IRR	SE	b	IRR	SE	b	IRR	SE
Intercept	0.023	-	(0.048)	2.990	-	(0.461)	2.888	-	(0.454)	2.742	-	(0.462)
Alpha	2.271	-	-	1.738	-	-	1.705	-	-	1.696	-	-
ADHD Symptoms	0.06***	1.06	(0.008)	0.025**	1.03	(0.008)	0.027***	1.03	(0.007)	0.063***	1.07	(0.015)
<u>Wave 2 Variables</u>												
Male	-	-	-	0.435***	1.55	(0.058)	0.452***	1.57	(0.057)	0.453***	1.25	(0.057)
Black	-	-	-	0.301**	1.35	(0.095)	0.384***	1.47	(0.094)	0.395***	1.14	(0.094)
Hispanic	-	-	-	0.334***	1.40	(0.088)	0.351***	1.42	(0.084)	0.345***	1.10	(0.083)
Other Race	-	-	-	0.226	1.25	(0.133)	0.237	1.27	(0.128)	0.244	1.06	(0.129)
Age	-	-	-	-0.153***	0.86	(0.02)	-0.166***	0.85	(0.021)	-0.165***	0.77	(0.021)
<u>Wave 1 Variables</u>												
Delinquency	-	-	-	0.406***	1.50	(0.035)	0.354***	1.43	(0.036)	0.355***	1.42	(0.036)
Attach. to Parents	-	-	-	-0.227***	0.80	(0.047)	-0.244***	0.78	(0.048)	-0.241***	0.79	(0.048)
Parent Education	-	-	-	0.05	1.05	(0.027)	0.051*	1.05	(0.025)	0.048	1.05	(0.025)
Average Grades	-	-	-	-0.113**	0.89	(0.042)	-0.101*	0.90	(0.043)	-0.096*	0.91	(0.043)
Peer Delinquency	-	-	-	-	-	-	0.236***	1.27	(0.052)	0.346***	1.41	(0.068)
Peer Network Size	-	-	-	-	-	-	0.018*	1.02	(0.009)	0.018*	1.02	(0.009)
Loner	-	-	-	-	-	-	0.296	1.34	(0.301)	0.262	1.30	(0.308)
ADHD X Peer Delinquency	-	-	-	-	-	-	-	-	-	-0.034**	0.97	(0.012)

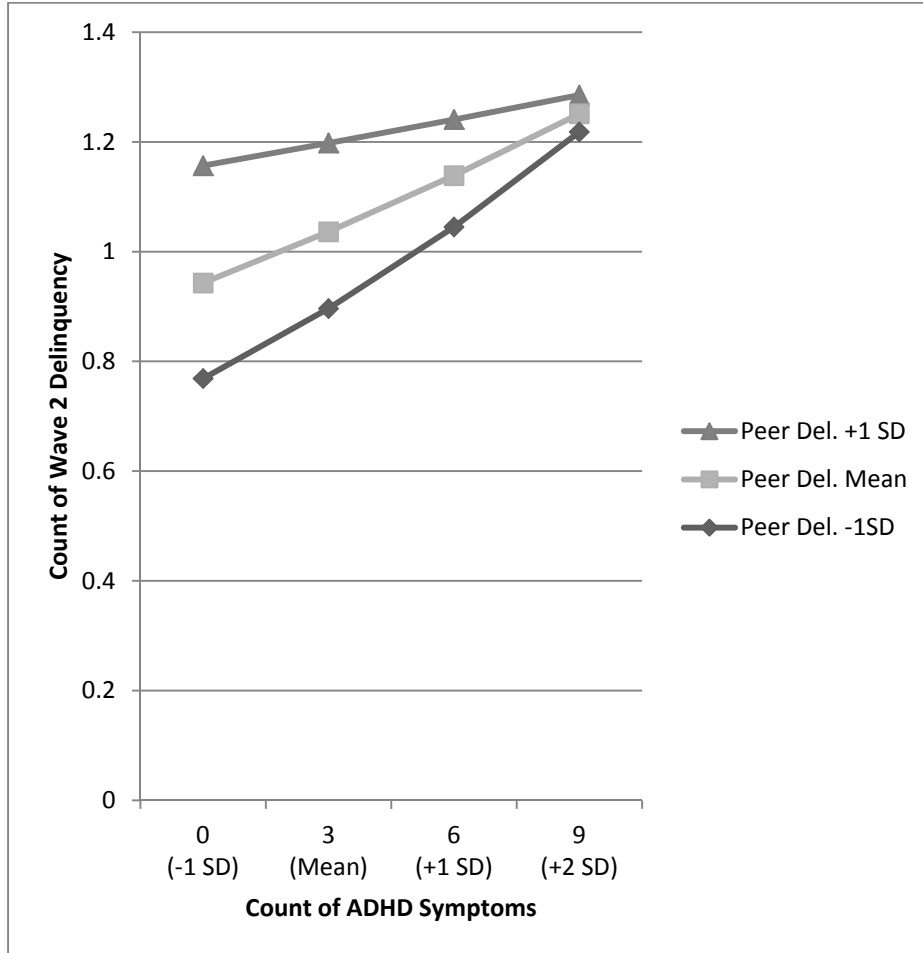
N = 5582 *p < .05 **p < .01 ***p < .001

ADHD effect size remains almost completely unchanged. This does not support *H6* and suggests that ADHD has a direct effect on delinquency that does not operate primarily through peer relationships. Net of all controls, each additional ADHD symptom is associated with a 3% increase in Wave 2 delinquency.

Model 9 tests *H7* by including an ADHD-by-peer delinquency interaction in the model. Interestingly, this relationship is negative and significant at the 0.01 level. One interpretation is that an increase in ADHD symptoms dampens the association between peer delinquency and delinquent behavior. Alternatively, it could be that an increase in peer delinquency dampens the association between ADHD and delinquency. In either case, one variable's effect on delinquency decreases as the other effect increases. Supplementary analyses were conducted that included three-way interactions with the gender and race variables. Only the three-way interaction with non-Hispanic Other Race was marginally significant, but it was not substantively meaningful and therefore not included in the reported models. This indicates that the ADHD-by-peer delinquency interaction varies little by gender or race.

Figure 4 illustrates the ADHD-peer delinquency interaction with predicted counts of the negative binomial regression with all control variables centered at their means. Predicted values were plotted for the mean, one standard deviation above the mean, and one standard deviation below the mean of peer delinquency. While the vertical axis represents Wave 2 serious delinquency, the horizontal axis represents ADHD symptoms for the full sample. The values 0, 3, 6, and 9 were selected because they are closest to standard deviation levels of ADHD symptoms and because 0 and 6 are theoretically relevant (i.e. 6 is the minimum number of

Figure 4. Predicted Values for the ADHD Symptoms X Peer Delinquency Interaction



symptoms required to be eligible for diagnosis).⁵ This figure visualizes several important patterns for ADHD and peer delinquency. Peer delinquency is an important predictor of delinquency, especially at low levels of ADHD symptoms. However, the difference in delinquency levels (the vertical gap between the lines) shrinks as ADHD symptom counts increase. Among respondents with high ADHD symptom counts, peer delinquency has less of an association with delinquency.

⁵ For example, 1 standard deviation fewer symptoms would be -0.51 symptoms (ADHD is overdispersed), but one cannot have negative symptoms in actuality. Therefore, 0 symptoms stands in for -1 standard deviations though it is mathematically only about 0.85 standard deviations below the mean. For ADHD symptoms in the sample, -1 SD = -0.51, mean = 2.82, +1 SD = 6.16, +2 SD = 9.49 symptoms. The figure does not meaningfully change when using these values on the horizontal axis, but for the sake of easier interpretation, 0 symptoms were used to approximate -1 SD, 3 symptoms to approximate the mean, 6 symptoms to approximate +1 SD, and 9 symptoms to approximate +2 SD.

The reverse is also true: among those with high levels of peer delinquency, represented by the topmost line, the rate of increase for delinquency across ADHD levels is much more flat than the line for those with much less peer delinquency.⁶ Furthermore, it can be seen that an increase from 3 to 6 ADHD symptoms among those with low peer delinquency corresponds to the same amount of Wave 2 serious delinquency as if they had increased to the average level of peer delinquency.

Finally, the models in Table 6 extend prior literature by determining whether impulsivity and self-control, variables that have been the subject of extensive study for sociological criminologists, have effects independent of each other and whether ADHD has an effect after controlling for them. Model 10 shows that ADHD does indeed predict Wave 2 delinquency after controlling for impulsivity and net of other controls. Comparing Models 8 and 10 shows that the association with ADHD is attenuated only by a small fraction. Model 11 shows that the association between ADHD and delinquency is reduced by about one fourth when including self-control as a predictor instead. Based on the standard errors for ADHD symptoms across the models and consistent with the correlation matrix from Table 2, there does not seem to be a multicollinearity issue when including all three predictors in the model simultaneously. Model 12 shows that ADHD symptoms retain an independent association with delinquency when controlling for both impulsivity and self-control. Impulsivity is not significant when all three predictors are together, and self-control is not meaningfully reduced when adding impulsivity as an additional control. Model 13 shows that the ADHD-by-peer delinquency interaction remains significant at the 0.01 level after controlling for impulsivity and self-control, and its effect size is only slightly decreased compared to Model 9 from Table 5.

⁶ It is worth noting that the lines do actually intersect and continue on their expected trajectories but, because it occurs beyond 2 standard deviations of symptoms, this represents only a tiny fraction of the sample.

Table 6. Survey Adjusted Negative Binomial Regression of Add Health Wave 2

Delinquency with Impulsivity and Self-Control

	Model 10			Model 11			Model 12			Model 13		
	b	IRR	SE	b	IRR	SE	b	IRR	SE	b	IRR	SE
Intercept	2.549	-	(0.487)	2.557	-	(0.463)	2.379	-	(0.493)	2.208	-	(0.501)
Alpha	1.695	-	-	1.615	-	-	1.612	-	-	1.603	-	-
ADHD Symptoms	0.026**	1.03	(0.007)	0.021**	1.02	(0.008)	0.02**	1.02	(0.007)	0.059***	1.06	(0.015)
<u>Wave 2 Variables</u>												
Male	0.44***	1.55	(0.057)	0.46***	1.58	(0.06)	0.453***	1.57	(0.06)	0.453***	1.57	(0.06)
Black	0.378***	1.46	(0.095)	0.416***	1.52	(0.089)	0.411***	1.51	(0.089)	0.423***	1.53	(0.089)
Hispanic	0.353***	1.42	(0.085)	0.367***	1.44	(0.087)	0.367***	1.44	(0.088)	0.361***	1.43	(0.087)
Other Race	0.231	1.26	(0.127)	0.262*	1.30	(0.128)	0.258*	1.29	(0.127)	0.267*	1.31	(0.129)
Age	-0.16***	0.85	(0.021)	-0.158***	0.85	(0.021)	-0.154***	0.86	(0.021)	-0.153***	0.86	(0.021)
<u>Wave 1 Variables</u>												
Impulsivity	0.07**	1.07	(0.026)	-	-	-	0.038	1.04	(0.026)	0.04	1.04	(0.026)
Low Self-Control	-	-	-	0.402***	1.49	(0.045)	0.391***	1.48	(0.046)	0.395***	1.49	(0.046)
Delinquency	0.341***	1.41	(0.035)	0.308***	1.36	(0.038)	0.302***	1.35	(0.038)	0.304***	1.35	(0.037)
Attach. to Parents	-0.244***	0.78	(0.05)	-0.212***	0.81	(0.05)	-0.213***	0.81	(0.051)	-0.209***	0.81	(0.051)
Parent Education	0.056*	1.06	(0.026)	0.044	1.04	(0.025)	0.047	1.05	(0.025)	0.044	1.04	(0.025)
Average Grades	-0.089*	0.91	(0.043)	-0.075	0.93	(0.04)	-0.069	0.93	(0.04)	-0.064	0.94	(0.04)
Peer Delinquency	0.24***	1.27	(0.054)	0.238***	1.27	(0.05)	0.24***	1.27	(0.051)	0.36***	1.43	(0.067)
Peer Network Size	0.017	1.02	(0.009)	0.02*	1.02	(0.009)	0.02*	1.02	(0.009)	0.02*	1.02	(0.009)
Loner	0.302	1.35	(0.293)	0.252	1.29	(0.295)	0.257	1.29	(0.292)	0.211	1.24	(0.294)
ADHD X Peer Delinquency	-	-	-	-	-	-	-	-	-	-0.037**	0.96	(0.012)

N = 5582 *p < .05 **p < .01 ***p < .001

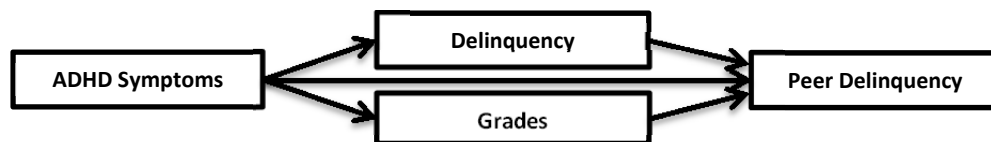
CHAPTER 4. DISCUSSION AND CONCLUSION

The primary goal for this thesis was to evaluate the relationship between delinquency, ADHD, and peer delinquency. While criminologists have studied peer delinquency extensively, many studies of antecedent correlates in recent years have focused on impulsivity and self-control. The primary contribution of this thesis was to replicate some of those studies using ADHD, a similar and well-validated concept from the psychological literature. The Add Health dataset was chosen for the study because it contains measures of impulsivity, self-control, delinquency, peer networks, and self-reported retrospective ADHD symptoms. Least-squares, Poisson, negative binomial, and logistic regressions were used to test seven hypotheses about the association between ADHD and peer relationships in addition to tests of the distinctiveness of ADHD from impulsivity and self-control.

Findings from the analysis showed ADHD to be an important and distinct predictor of delinquency, peer delinquency, and two peer relationship outcomes. While ADHD did not have the same effects on peer time involvement as had been found in prior studies of low self-control (McGloin & Shermer 2009), this actually lends weight to the idea that they are different concepts. ADHD symptoms predicted fewer incoming friend nominations from peers and reduced the likelihood of best friend reciprocation for boys. Peer delinquency and its associated controls did not mediate the association between ADHD and delinquency. Instead, ADHD and peer delinquency were shown to interact in their association with delinquency. Furthermore, ADHD was shown to increase peer delinquency through associations with school grades and delinquency. Finally, the ADHD main effect and the ADHD-by-peer delinquency interaction remaining significant even after controlling for impulsivity and self-control.

Perhaps the most important finding is that ADHD influences delinquency through the tendency to place adolescents in delinquent contexts. While a major issue in peer studies is that of peer selection versus peer influence, the role of ADHD may be more related to selection. Consistent with the psychological literature on ADHD, symptoms were associated with lower grades and increased minor delinquency at Wave 1. Figure 5 illustrates how the majority of the association between ADHD symptoms and peer delinquency operates through delinquency and poor grades. Adolescents with many ADHD symptoms are already predisposed to higher levels of delinquency due to the nature of the internal drives influenced by ADHD, so they are less affected by peer influence. Figure 4 showed that one could substitute a high-delinquency peer group for a diagnosis-eligible adolescent with a low-delinquency peer group, and it would have virtually no effect on the predicted delinquency outcome for that adolescent.

Figure 5. ADHD and Peer Delinquency



Two other important peer relationship variables were influenced by ADHD for boys, each indicating limitations on the peer network structure. Just as Moffitt’s studies pointed out for other neuropsychological deficits, ADHD produces both contemporary and cumulative negative consequences. While boys with ADHD are already predisposed to lower school grades and delinquency in the short-term, they are more likely to have smaller peer networks and less likely to have their best friends reciprocate friendship. This too is consistent with findings that show boys with ADHD tend to misjudge social cues. Curiously, ADHD had no effects on peer relationships for girls in this sample, and the three-way interaction with gender was not significant. It could simply be that female peer networks differ in such a way that ADHD is less

relevant, but it is also possible that there simply are not enough diagnosis-eligible ADHD females in the Add Health sample to produce an effect—about 2.7% of the total sample for this study.

One advantage of using a self-report measure of ADHD is the avoidance of bias in diagnoses. For example, parents may be more likely to send a male child for clinical evaluation than a female child because ADHD is known to be more prevalent among males. Children from economically disadvantaged homes would have less access to clinical specialists, and disaffected parents may be unwilling to assist school officials or healthcare specialists with clinical interventions. A recent study in *Pediatrics* (Morgan et al. 2013) demonstrated that racial and ethnic disparities exist in clinical diagnoses and medication use at least through the 8th grade using a nationally representative sample. A comparison of the prevalence rates reported at the 8th grade in that study compared to Add Health provides even more evidence for bias in diagnosis.⁷ While one naturally expects there to be fewer clinical diagnoses than self-reported symptoms, the rate of diagnoses is only about 10% lower than the rate of self-reported ADHD for Whites while it is about 60% lower for Blacks and Hispanics. Consistent with Morgan and colleagues, this difference suggests that there are many more undiagnosed minorities than Whites.

Though ADHD has not been the subject of many prior large studies of peer networks, the findings suggest that it should be given the same kind of empirical scrutiny as impulsivity and self-control. As measured in Add Health for this study, impulsivity was attenuated by ADHD and self-control, but ADHD remained a significant predictor of delinquency in each model. Interestingly, self-control had a larger effect size than ADHD in several models. Because self-

⁷ Morgan et al. (2013) reported the following prevalence rates for diagnosis: White 7%, Black 3%, Hispanic 4.4%. This thesis found the following rates for self-reported ADHD: White 7.7%, Black 4.8%, Hispanic 7.1%.

control has been measured so many ways, even by different researchers using Add Health, it is difficult to say whether this is due to measurement. The degree of mediation by self-control was less than the amount found by Unnever, Cullen and Pratt (2003), though they used different measurements for both ADHD and self-control. The findings from this thesis are consistent with theirs in supporting the idea that ADHD is an independent and preceding predictor of delinquency. Further comparisons of self-control and ADHD using different datasets could continue to shed light on this issue.

Several limitations in this study should be identified. While it could be argued that using self-reported ADHD symptoms is not as accurate as using clinical diagnoses, self-reported symptoms are not subject to biases stemming from the ability and willingness to seek clinical professionals. Only 17 of the 18 ADHD symptoms from the *DSM* were included in Add Health, but there is little reason to suspect that the addition of another symptom to the scale in the study would have meaningfully changed the results. A limitation of the peer network measures in Add Health was that the Wave 1 in-school survey only included six minor delinquent acts rather than the larger list of serious acts given during the in-home surveys. Since peer networks were only measured in the Wave 1 in-school survey, it was not possible to study network trajectories over time. Respondents were only able to nominate five friends from each gender, and it is possible that increasing that limit would create different results. Finally, the sample size was reduced due to attrition, primarily from the Wave 1 in-school survey and the Wave 3 survey. However, I expect that this attrition is more likely to be correlated with increased delinquency and increased ADHD symptoms, so the current analysis could be considered a conservative test.

Based on the findings from this thesis and reviewing the extant literature, one can imagine the ideal dataset for this topic. The ideal study would need to be longitudinal to capture

the time-ordering of effects and to examine changes over time. Each wave would ask the respondent about ever having received an official ADHD diagnosis and would include an ADHD symptom scale. Respondents would be asked if they are currently taking medication for ADHD. All waves would also include questions about minor and serious delinquent behavior. The first wave would take place around age 10 when ADHD symptoms should have arisen but before peer influences have become most salient. At least two more waves in high school should capture changes in delinquency, peer relationships, and peer networks. In addition to the ADHD and delinquency items, these waves would yield peer network information from friendship nominations. Ideally, surveys at these waves would also ask who the respondent does *not* like to measure effects on disapproval/disliking in addition to effects on friendship. A fourth wave in young adulthood would be useful to look at more long-term outcomes, an area that is sparse even in the psychological ADHD literature.

This thesis has a few implications for policy and future research. To compensate for the missing data issues, multiple imputation techniques should be utilized as a test of the robustness of the findings. Because a few of the peer relationship findings differed by gender and because ADHD is more common among males, another study with a greater emphasis on gender may produce stronger findings. In particular, a study of ADHD on female peer relationships might be difficult to conduct but could prove fruitful since most previous research has been done on males. The relationship between ADHD and peer delinquency could be an important aspect of treatment interventions for children and adolescents with ADHD. The typical method of treatment for ADHD is the administration of medication, but treating a child's ADHD symptoms will not change the peer context for the child that has been influenced by the symptoms up to that point. As Hoza (2007) pointed out, if a delinquent male is diagnosed with ADHD at age 16, he

will still have the same reputation and group of friends that he acquired before treatment.

Indeed, Figure 4 showed that reducing the number of symptoms would be expected to have little effect on his delinquency if he already has delinquent friends. Further research may show that a complete ADHD treatment should address social context in addition to neuropsychological issues addressed by medication.

In summary, the results from this thesis suggest that ADHD is a relevant and independent predictor of delinquency, and it should be subject to further study by criminologists. The four primary contributions of this thesis were that 1) ADHD symptoms were shown to decrease the likelihood of best-friendship reciprocation and decrease the count of incoming peer nominations for boys, 2) ADHD is associated with increased peer delinquency indirectly through poorer school grades and increased delinquency, 3) the association between ADHD and delinquent behavior is not mediated by peer delinquency but is instead moderated by it and 4) ADHD is not explained away by related criminological concepts as measured in recent studies. Ten years ago, Unnever, Cullen, and Pratt found that ADHD may serve as an alternate predictor of delinquency for criminologists, though little progress has been made since that time. Given the recent public interest in ADHD, criminologists have the opportunity to test and expand theories in a highly relevant area by integrating it into the field.

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APPENDIX. ADHD SYMPTOM SURVEY QUESTIONS FROM ADD HEALTH

Prompt:

Think back to when you were between 5 and 12 years of age. For each of the following statements, which answer best describes your behavior when you were that age?

Questions:

1. When you were between 5 and 12, you failed to pay close attention to details or made careless mistakes in your work.
2. You fidgeted with your hands or feet or squirmed in your seat.
3. When you were between 5 and 12, you had difficulty sustaining your attention in tasks or fun activities.
4. You left your seat in the classroom or in other situations when being seated was expected.
5. When you were between 5 and 12, you didn't listen when spoken to directly.
6. You felt restless.
7. When you were between 5 and 12, you didn't follow through on instructions and failed to finish work.
8. You had difficulty doing things quietly.
9. When you were between 5 and 12, you had difficulty organizing tasks and activities.
10. You felt "on the go" or "driven by a motor."
11. When you were between 5 and 12, you avoided, disliked, or were reluctant to engage in work requiring sustained mental effort.
12. You talked too much.
13. When you were between 5 and 12, you lost things that were necessary for tasks or activities.
14. You blurted out answers before the questions had been completed.
15. When you were between 5 and 12, you were easily distracted.
16. You had difficulty waiting your turn.
17. When you were between 5 and 12, you were forgetful.