Conduct Disorder and Decision-making in Adolescent Girls

A Senior Honors Thesis

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by

Rowan Karaman

The Ohio State University
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Project Advisors: Professor William Gardner, Department of Psychology
Professor Kathleen Pajer, College of Medicine and Public Health

Abstract

Thirty females, aged 15 to 18 years, 16 of whom had conduct disorder and 14 of whom were normal controls, completed the Iowa Gambling Task, a card game that replicates real-life decision-making. The task involved selecting cards over trials from four decks: two advantageous and two disadvantageous. The hypotheses were that the controls would have better performance on the task, which is indicated by a higher final score, choosing more cards from the advantageous decks and improving along trial blocks. A final questionnaire asked the girls whether they had discovered the strategy to the game. Inconsistent with data about disorders of social conduct and its deleterious effect on decision-making, participants with conduct disorder did not have significantly lower scores, greater picks of advantageous cards, improvement over blocks of trials, or a greater understanding of strategy.

Introduction

Antisocial Behavior

Adolescent girls with antisocial behavior are classified as either delinquent or having conduct disorder. The two terms describe similar populations of girls, but there are some major differences. Criminal acts for both delinquency and conduct disorder include aggression to people and animals, destruction of property, deceitfulness or theft, and serious violations of rules. Girls found to be delinquent have committed criminal or status offenses (e.g., truancy or running away), all of which are included in the criteria for conduct disorder. The criteria for conduct disorder are broader than those for delinquency (see Table 1) so that they include legal behaviors, such as bullying or lying. A girl diagnosed with conduct disorder must display a persistent and repeated pattern of several antisocial behaviors, while a girl who is delinquent may have committed just one act. This study focused on conduct disorder, since it is the more severe of the two and has a worse prognosis.

Female antisocial behavior

Past research on antisocial behavior has historically focused on males, primarily because females were thought to rarely exhibit behavior against social norms and that when they did, it was relegated to the real of premarital sex or promiscuity (Cohen, 1955; Kunzel, 1993; Merton, 1957; L. S. Smith, 1978; Thomas, 1937). Females were also excluded from longitudinal studies because they were less likely than males to be involved in criminal activities (Cloward & Ohlin, 1960; Cowie, Cowie, & Slater, 1968; Glueck & Glueck, 1934; Morris, 1964). These misconceptions and the subsequent lack of data on antisocial behavior in women led to the mistaken assumption that all women, even the ones who had shown some criminal behavior, would find the same outcomes in adulthood.

Contrary to these conventional beliefs, data acquired recently indicates that antisocial behavior among females is widespread and rising for both conduct disorder (CD) and delinquency. Between 1980 and 2003, the arrest rate for assaults by girls increased 269%. In 2003, girls accounted for 24% of the arrests for aggravated assault, 35% of the forgery arrests, and 40% of the embezzlement charges for delinquents (Office of Juvenile Justice and Delinquency Prevention, 2005). CD is the second most common diagnosis given to adolescent female patients (Zoccolillo, 1993) and one-third of adolescent female psychiatric patients meet the criteria for the disorder (Rutter, Tizard, & Whilmore, 1970). In the general population, almost 10% of 15-17-year-old girls meet the criteria for CD (Fergusson, Horwood, & Lynskey, 1993; Kashani, Orvaschel, Rosenberg, & Reid, 1989). Even more alarming is that aggressive antisocial behavior in girls is increasing (Litt, 1995; Loper & Cornell, 1996; Parks, 1998; L. Smith, 1995). During the last two decades, the delinquency rate for adolescent girls has increased dramatically and the proportion of arrests for violent crimes has also risen (Department of Juvenile Justice, 1998; Office of Juvenile Justice and Delinquency Prevention, 1996; United States Government, 1997). In the past decade, arrest rates for female juveniles have increased 7.4% while arrest rates for males decreased 18.9% (National Center on Addiction and Substance Abuse, 2004). The behavior of antisocial females is usually targeted at friends and family, not strangers (Ben-David, 1993).

Antisocial behavior is a costly burden on our society. One study found that by age 28, individuals who had CD cost society ten times more than those with no psychiatric disorder (Scott, Knapp, Henderson, & Maughn, 2001). Moreover, the consequences for the girls themselves are dismal, in part because they do not respond well to the traditional treatments for boys, such as “boot camps” (Acoca, 1999). Treatment providers report that antisocial girls are

much more difficult to work with than boys (Baines & Alder, 1996). As antisocial girls mature into women, they have problems in all facets of their lives (Pajer, 1998). Their antisocial behavior is associated with a 40 fold increase in adult criminality, an increased rate of early mortality, depression and substance use, poor physical health, and a high rate of intergenerational transmission of antisocial behavior (Pajer, 1998). Adult psychopathology is also high; 14%-60% of girls with antisocial behavior develop adult psychiatric disorders, compared to 0%-40% of normal girls (Bardone, Moffitt, Caspi, Dickson, & Silva, 1996; Robins, 1966; Zoccolillo, Pickles, Quinton, & Rutter, 1992). Up to 70% of these girls develop adult substance abuse (Lewis et al., 1991; Robins, 1966; Storm-Mathisen & Vaglum, 1994; Zoccolillo & Rogers, 1991). In light of this information, finding the causes for antisocial behavior in girls is becoming even more important so proper treatment can be administered.

Decision-Making and Antisocial Behavior

Adolescents often display poor decision-making, favoring short-term gains despite negative long-term consequences (Spear, 2000; Steinberg, 2004). Adolescents who engage in antisocial behaviors (e.g. lying, stealing, aggression, truancy) have even poorer decision-making skills than adolescents without antisocial behavior and thus experience higher rates of mortality, pregnancy, arrest, and school drop-out. Adolescents with antisocial behavior were more likely to have had risky sexual intercourse, contracted sexually transmitted diseases, and have had sexual intercourse before 16 years of age than those without antisocial behavior (Ramrakha, 2000). When given a task that consisted of risky and non-risky response options, adolescents with antisocial behavior more often chose the risky options (low probability of a high monetary reward and high probability of smaller losses), made less money, and were less likely to learn from their mistakes than normal controls (Lane, 2001). On a task that manipulated immediate

rewards and long-term punishments, young adults with antisocial personality disorder favored larger immediate rewards even with long-term losses but were able to choose more advantageously as the task progressed (Mazas, 2000). A better understanding of decision-making processes will assist with the development of more effective methods to overcome these deficits.

The mechanisms principal to the development and maintenance of poor decision-making are not well-understood. An 11% reduction in prefrontal gray matter volume has been found in individuals with antisocial personality disorder and no brain lesions (Raine, 2000). These individuals also showed reduced autonomic activity during the stress task, a videotaped speech. Thus, there is some implication of deficits in the functioning of the central nervous system. In an effort to explain these deficits and how they impact decision-making, the somatic marker hypothesis states that the sympathoadrenal portion of the stress response system is generally activated when people encounter the negative consequence of a choice they have made. When this system is not activated, the individual is less aware of the poor choice that was made. Men and boys with antisocial behavior do not display this activation (van Honk, 2002) and do have poor decision-making skills. There are no data on females with antisocial behavior. The somatic marker hypothesis may also be applicable to their poor performance on the IGT due to this prefrontal cortex deficit.

The Iowa Gambling Task

The Iowa Gambling Task (IGT) measures decision-making and replicates how a participant makes real-life decisions. Variations on the IGT exist, but one design element remains constant: four decks of cards are always placed in front of a participant. Two of these decks are advantageous; that is, they provide an eventual net gain, and the other two decks are disadvantageous, meaning that they lead to a net loss. Each card from all four decks provides a

reward of varying size, but the gains from the advantageous decks are smaller than those from the disadvantageous decks. Punishments of varying magnitude and frequency are drawn with some, but not all, cards. Punishments in the advantageous decks are smaller than those in the disadvantageous decks. The disadvantageous decks have net punishments that are greater than the net rewards when the trials are averaged, leading to a net loss. The advantageous decks have net rewards greater than net punishments, leading to a net gain. The game consists of 100 card picks (trials) where the participant is to select from any of the four decks. The object of the game is to determine which of the decks are giving money over time and which of the decks are taking away money over time. Performance is measured by the final score and the number of cards selected from the advantageous decks; more advantageous cards selected show better performance. Participants were told that goal of the game is to win as much money as possible and avoid losing as much money as possible. They were encouraged to avoid the disadvantageous decks, but not told which decks those were, how many trials were in the game, or any game strategies. In normal controls, performance was expected to increase as more cards were drawn and the participant gained a greater understanding of how to win money. Since each card from the disadvantageous deck provides a greater reward than each card from the advantageous decks, individuals who pick a disproportionate number of cards from the disadvantageous decks show behavior characterized by seeking immediate rewards and discounting delayed punishment (Bechara, 2001).

Certain groups have been shown to fare poorly on the IGT compared to normal controls. These groups include violent and nonviolent suicide attempters (Jollant et al., 2005), patients with ventromedial prefrontal cortex damage (Bechara, 2004; Bechara, Damasio, Damasio, & Lee, 1999; Fellows and Farah, 2005), schizophrenic patients (Shurman, Horan, & Nuechterlein,

2005), cocaine abusers (Bolla et al., 2003), gamblers (Goudriaan, Oosterlaan, de Buers, van den Brink, 2005), alcohol dependents (Goudriaan, Oosterlaan, de Buers, van den Brink, 2005), patients with amygdala damage (Bechara, Damasio, & Damasio, 2003), and patients with dorsolateral frontal lobe damage (Fellows, 2005). Psychopathic adults, who are generally believed to have impaired dorsolateral prefrontal and orbitofrontal cortex functioning, chose significantly more from the disadvantageous decks and did not learn from their mistakes on the IGT (Mitchell, 2002). Some of the participants with deficits on the IGT do realize which decks are disadvantageous and that they should stop selecting cards from those decks, but despite that conscious recognition of the strategy, they continue selecting from the disadvantageous decks. Besides their poor performance on the IGT, individuals in these groups also have difficulty making appropriate decisions in real-life situations. They continue making decisions that have negative consequences and do not seem to learn from their previous mistakes. For instance, some make financial investments that continuously lead to losses, but they repeatedly pursue those same actions.

One of the major theories about the mechanism underlying the dysfunction of the brain-damaged patience in IGT performance is the Bechara and Damasio's Somatic Marker Hypothesis (Bechara, 2004; Bechara, Tranel, and Damasio, 2000; Damasio, Tranel, and Damasio, 1990). This hypothesis states that the emotions experienced when making a particular choice activate particular bodily changes (somatic markers) through the orbitofrontal cortex, amygdala, somatosensory/insular cortices, and peripheral nervous system. These markers are linked with the punishment and reward of experiences that the individual had previously encountered and are activated when confronted with the same type of situation. The somatic markers are reactions in the body of which an individual is unaware that drive the individual to

subsequently perform or refrain from doing a carrying out a certain action, even before a rational and conscious reason for making that choice is defined. Inability to activate these markers would result in the absence of a signal to alert the individual of the negative consequences of some actions. A functioning somatic marker unconsciously warns the individual about future negative consequences and also unconsciously inhibits the response systems that would lead to those consequences. Bechara found that patients with ventromedial prefrontal cortex damage did not show increases in their autonomic responses before selecting cards from disadvantageous decks, but normal controls did. Because the patients with ventromedial prefrontal cortex damage chose more cards from the disadvantageous decks than normal controls, Bechara hypothesized that their somatic markers did not function properly. Thus, decision-making on the IGT both in choosing more cards from the disadvantageous decks and failing to learn from past mistakes is influenced by markers that react to emotional situations. As previously discussed in the decision-making and antisocial behavior section, this theory may explain why adolescents with antisocial behavior, because of their prefrontal cortex deficits, have poor performance on the IGT.

Sex differences have been shown in previous studies using the IGT. Men do better on the task in terms of choosing more cards from the advantageous decks and discovering the rules of the game earlier and more often than women (Reavis & Overman, 2001). Women seem to be guided by the number of pluses and minuses in each deck as opposed to the net monetary outcome that seems to guide men (Overman, 2004). They appear to be more actively avoiding the decks with frequent punishments (on the IGT, one advantageous deck and one disadvantageous deck have frequent punishments). Women may be responding more than males to the disadvantageous deck that, over the average of 10 cards, consists of 10 gains (pluses) and only one loss (minus). In attempting to avoid frequent punishment, women encounter larger (yet

less frequent) punishment (Overman, 2004). In this study, males outperformed females during childhood, adolescence, and adulthood. Differences in neuroanatomy may also explain the disparities on IGT performance. During the task, men activated regions of the right lateral orbitofrontal cortex and right dorsolateral prefrontal cortex, while women activated the left medial orbitofrontal cortex (Bolla, Eldreth, Matochik, and Cadet, 2004). Men also had significant increases from the first to the second trial of the IGT, while women did not. The right lateral orbitofrontal cortex is thought to have the most effect on the greater performance of men, as it is important in the processing of punishment.

Adolescents are another group who do not perform as well as normal adult controls on the IGT. In one study, adolescent males picked more cards from the advantageous decks than females, and more males gained an understanding of the rules and discovered them earlier than females did (Overman et al., 2004). In addition, younger participants in general did worse than their older counterparts. Another study showed that when separated into age groups, the 14-17-year-old group of adolescent males and females significantly outperformed the 9-10-year-old age group, but the 11-13-year-old age group was not significantly different than the other groups (Hooper, Luciana, Conklin, and Yarger, 2004). Males and females displayed different responses to immediate gain and loss; females tended to choose from the decks with infrequent punishments more often than males (Hooper, Luciana, Conklin, and Yarger, 2004). This study did not indicate any significant differences between males and females in the number of cards picked from the advantageous decks.

Of the four studies completed on adolescents and the IGT, there were 366 males and 306 females, of which 30 males and 3 females had behavior disorders and an additional 20 males had psychopathic tendencies (Ernst, 2003; Hooper, 2004; Overman, 2004; Blair, 2001). Adolescents

with behavior disorders did more poorly than healthy adolescents on the second week of the IGT, but performance was not significantly different in the first week. The healthy adolescents learned the task better than those with behavior disorders (Ernst et al., 2003). Differences were not found among adolescents with ADHD, conduct disorder, and comorbid ADHD and mood disorder. Boys with psychopathic tendencies chose from the disadvantageous decks more than normal controls (Blair, 2001). They also failed to improve as the task continued, while the control group did improve. Findings indicate that adolescents with behavior disorders, in general, use less efficient decision-making processes than healthy adolescents. If adolescent girls with antisocial behavior display abnormalities on decision-making, this may indicate that they have abnormalities in the orbitofrontal cortex and hypoarousal of the autonomic nervous system, as Raine (2000) found with antisocial adults. If girls with conduct disorder do repeatedly make poor decisions and do not have adequate levels of arousal, this could have important treatment implications.

In previous studies, there were not enough females with antisocial behavior to conduct analyses on their performance as opposed to controls. As the first to do so, this pilot study was to show if there are any differences on the IGT between adolescent females with conduct disorder and normal adolescent females. Although generalizability is limited due to the small sample size, this study can function as a starting-point for further, larger studies on the performance of female adolescents with conduct disorders. Gaining a greater understanding of how cognitive processes work in those with conduct disorders will help with the formulation of intervention plans to help improve their decision-making skills.

Because of previous studies showing that those who make bad decisions in real-life situations also fare poorly on the IGT, the primary hypothesis was that the female adolescents

with conduct disorders would perform significantly worse on the IGT than normal female adolescents by picking fewer cards from the advantageous decks and more cards from the disadvantageous decks. Their net score of choosing advantageous cards over disadvantageous cards would be significantly lower compared to the controls. They would also not improve along the blocks of trials, while the normal controls would. In a small questionnaire to be distributed at the end of the session, the girls answered if they understood the strategy of the game. The girls with conduct disorder would not have understood the strategy, while the normal controls would have reported doing so by the end of the session. Decision-making in girls with conduct disorder is impaired in their daily lives and that impairment was expected to be exhibited through the IGT because of flawed cognitive processes due to orbitofrontal cortex deficiencies.

Using a natural groups design, the independent variable relates to the social conduct of the girls. This social conduct variable is divided into two levels: those with conduct disorder (disordered level) and the normal controls without conduct disorder (ordered level). The dependent variables are the scores that the girls receive on the IGT and their abilities to discover the strategy of the IGT. As indicated above, we have selected conduct disorder as the primary independent variable because it is a more persistent, severe, and pervasive problem with a poor outcome in life decisions. It has also been associated with decreased performance on the IGT in males. The IGT (score and improvement along blocks) has been chosen as the dependent variable because it has been demonstrated repeatedly to replicate real-life decision-making skills.

Method

Subjects/Recruitment

The subjects were 30 girls between the ages of 15-18. Sixteen had conduct disorder and

fourteen were normal controls. They were drawn from a larger study of HPA axis function in girls with antisocial behavior and had already undergone evaluations of their psychopathologies. Invitation letters with the study protocol were sent to these girls and their parents. If they were interested in participating, they contacted us via phone and received further information regarding the study. Parents or guardians were required to sign a consent form prior to their child's participation in the study and the girls signed assent forms.

Design

This study is not fully experimental, as status of conduct disorder is not randomly assigned. The ordered group was the girls with no psychiatric disorders, and the disordered group was the girls with conduct disorder as diagnosed by previous testing. The group, final scores, and picks from advantageous decks were between-subjects factors and the blocks of card trials was a within-subjects factor.

Apparatus/Materials

Lifetime and current psychiatric diagnoses have already been determined by a previous study (from which I will draw the participants) with the computerized version of the Diagnostic Interview Schedule for Children and Adolescents-IV (DISC-IV), Parent and Youth Versions. The DISC is a structured psychiatric interview, organized into six Axis I diagnostic sections: Anxiety Disorders, Mood Disorders, Disruptive Disorders, Substance-Use Disorders, Schizophrenia, and Miscellaneous Disorders (e.g., Eating Disorders) (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Three reference times are used in the interview: the previous month, the previous year, and the participant's entire life.

Test-retest reliabilities of the parent version of the instrument in a clinical sample, as measured by the kappa statistic, was fair to good (Fisher et al, 1997). For the youth reports, the

kappa values were fair. The combination of Parent and Youth data increased test-retest reliability, with most of the values in the .55-.65 range, which is good. The reliability of the CD diagnosis was good with a value of .65 for the Youth and .45 for the Parent.

Validity data on the DISC-IV are not available yet, but the validity of the previous version was tested (Schwab-Stone et al., 1996). CD had the highest validity of the Parent-reported diagnoses (.77) and the second to highest validity score on the Youth report (.72). The DISC diagnoses at baseline and 12 months later were compared with the daily incident reports on 222 boys and 147 girls, ages 9-17. The validity of the DISC diagnoses in comparison to the daily behavior ratings of the youths was excellent (Friman et al., 2000).

A girl in the original HPA axis study received a diagnosis of CD if she met criteria from the youth or parent DISC. To be placed in the NCD group, the girls must not have met criteria for any psychiatric disorder in their lifetimes. No girl was put in the NCD group if she had displayed antisocial behaviors at any time in her life.

A computerized version of the Iowa Gambling Task will be used. This game has been widely used to evaluate decision-making in normal and clinical populations, including adolescents. It has been validated repeatedly and is widely used (Bechara, 1999; Bechara 2000; Bechara 2001; Hooper, 2004).

Procedure

A number of girls from the HPA axis study were selected as possible participants in this study. Recruitment letters (see Appendix A) with a brief description of the protocol were sent inviting them to participate. Girls and parents that were interested called our office and were given more information about the study. An appointment was scheduled if the girl was still interested and the parent had been told the details of the study.

The procedure for this study followed that of Bechara (1999). When the subject was seated at the computer with the IGT program running, she saw four decks of cards on the screen, labeled A, B, C, and D. After her selection of a card from one of the decks, the reward amount and punishment amount (if present) were shown on the screen. Either a happy face or a sad face appeared, depending on whether there was a net gain or net loss with the card, respectively. A green bar indicating gains at the top of the screen increased in length if money was gained or decreased if money was lost. A red bar indicated how much money is borrowed if the subject lost more than the $2000 credit she was initially given.

Each deck contained 40 cards. In deck A, every 10 cards, on average, had a gain of $1000 with five unpredictable punishments from $150 to $350. The total loss was $1250 with this deck. In deck B, every 10 cards gained $1000, but there was one large punishment of $1250. In deck C, every 10 cards gained $500 but only lost $250 with losses ranging from $25 to $75. In deck D, every 10 cards also gained $500 and lost $250 in one punishment. Rewards from each deck ranged from $80 to $150 for the disadvantageous decks A and B and from $40 to $80 for the advantageous decks C and D. The net gain or loss of the deck varied according to the punishments provided in each card. Not every card will contained a punishment. Decks A and B are disadvantageous because they had a net loss, and decks C and D are advantageous because they had a net gain.

Participants were instructed to select a card from the deck of their choosing. They were told that the goal of the game is to win as much money as possible and avoid losing as much money as possible when selecting cards. The only hint given was that some of the decks are worse than others and that the participant should avoid those bad decks. She was reassured that if she found herself losing, there was still a possibility of winning the game by staying away from

the bad decks. Participants were also told that the computer does not change the order of the cards once the game has started, so it will not deliberately force them to lose. A complete listing of the instructions given to the girls before starting the task is given in Appendix B.

After the 100 trials were completed, the girls were paid 1% of their winnings on the IGT and a $15 reimbursement for participating in the study. This gave them motivation for doing well on the game and also reduced negative feelings if they did not win any money during the session. At the end of the game, they were given a small questionnaire that asked them if and when they realized what the proper strategy was (see Appendix C).

Results

A sample size of 30 (16 with conduct disorder and 14 controls) had a power of 0.38 (one-tailed and $\alpha = 0.05$). The final scores on the IGT for the girls with conduct disorder (M=-1219, SD=856) were not significantly different than those of the controls (M=-745, SD=1243), $t(28)=-1.230$, $p \leq .11$, one-tailed. The number of cards picked from the advantageous decks by the girls with conduct disorder (M=51.75, SD=6.93) were not significantly different than those picked by the controls (M=53.36, SD=13.11), $t(28)=-.427$, ns. The 100 card draws were divided into 5 blocks of 20 cards each to detect any improvement in performance and if the groups differed in that performance. A 2 (group) x 5 (block) factorial ANOVA showed no such difference between groups either in the average score of each block ($F(4, 112)=1.456$, $p \leq .11$). A 2 (group) x 2 (picks from advantageous deck v picks from disadvantageous deck) x 5 (block) mixed factorial ANOVA also showed no difference between the groups ($F(1, 28)=.938$, $p \leq .17$). No significant differences were found for positive responses to the questionnaires asking if the participants had found a strategy to win the game; 10 girls with conduct disorder said they had and 5 said they had not, while 8 of the control girls said they had and 6 replied they had not. The sample size

was too small to analyze when they had figured out that strategy.

Discussion

Performance of the girls with conduct disorder and the controls was not significant on the IGT, either in the number of disadvantageous cards picked, final score, improvement along blocks of cards, or affirmative responses to having discovered a strategy to win. The primary reason for this lack of significance was the small sample size. The direction of the final scores was in the expected direction, however. The girls with conduct disorder had a mean score 474 points lower than that of the controls. This does show a medium effect size ($d = 0.474$), but the variability of the scores was too high and the sample size too small to detect the effect.

The girls with conduct disorder were expected to do worse on the IGT than the controls because brain imaging studies have shown that individuals with antisocial behavior have functional deficits and impairments in the prefrontal cortex (Raine, 2002). Bechara's somatic marker hypothesis implicates the prefrontal cortex as the most important area contributing to the executive functions necessary for performing well on the IGT (Bechara, 2001). The prefrontal cortex is the location where exteroceptive information from environmental stimuli is combined with the interoceptive information of emotional and somatic states. These emotional and somatic states that had previously been experienced in relation to the environmental stimuli then unconsciously alert the participant when a poor choice is about to be made. Since the prefrontal cortex of girls with conduct disorder is believed to be impaired, this alert system was thought to have been compromised. In previous studies where individuals with prefrontal cortex deficits were compared to normal controls, 100 card trials were enough to show these differences and provide evidence for the somatic marker hypothesis (Bechara, 2004; Bechara, Damasio,

Damasio, & Lee, 1999; Fellows and Farah, 2005; Goudriaan, Oosterlaan, de Buers, van den Brink, 2005; Shurman, Horan, & Nuechterlein, 2005).

However, one study on adolescents suggests that the controls may have needed more time to increase their performance on the task (Ernst et al., 2003). This study had 33 adolescents (30 males and 3 females) with antisocial behavior and 30 control adolescents, all between the ages of 12 and 14 years. Participants completed the IGT on two occasions, week 1 and week 2. During the first week, there were no significant differences in disadvantageous versus advantageous card picks between the two groups. The second time the IGT was played, the controls significantly improved while the scores of the participants with antisocial behavior did not change, leading to a significant difference between the two groups. If the number of our participants had been doubled and they had been brought in for another attempt at the IGT, we may have also seen a significant difference between the groups. One study with contradictory findings (although not specifically for diagnosed antisocial behavior) does exist, however. Blair, Colledge, and Mitchell (2001) found that the performance on the IGT of 20 adolescent boys with psychopathic tendencies was significantly worse than that of 23 control adolescents over 100 card trials and there was also a significant block x group interaction, with the controls improving along blocks of cards.

An additional consideration is that of gender differences on the IGT. Overman (2004) tested 210 adolescent males and 210 adolescent females and found that the males chose significantly more advantageous cards than the females, possibly as a result of females being more sensitive to minus signs (losses) than males. In that case, the adolescent male controls in both the Ernst and Blair studies could have been performing at better levels on the IGT than the adolescent female controls in this study, leading to wider differences between the controls and

those with psychiatric disorders. The difficulty with this explanation is that if the female controls do worse than male controls, then the females with antisocial behavior should also do worse than males with antisocial behavior, which would not influence the gap between the controls and those with antisocial behavior. More research will be necessary to explore whether such gender gaps do exist for females and males with antisocial behavior.

The results for the questionnaire asking whether the participant had discovered a strategy were also equal in "Yes" and "No" for both groups. Several studies have shown that children who are overly aggressive tend to exhibit overestimations of their social, behavioral, and academic capabilities as compared to responses given by their teachers and peers (David & Kistner, 2000; Edens, Cavell, and Hughes, 1999; Hughes, Cavell, & Grossman, 1997). Although only 2 girls with conduct disorder had positive scores on the IGT, 10 still answered that they had discovered a strategy. Their replies may be a result of their of their overly positive self-perception regardless of the reality of the situation. This data is consistent with previous studies linking conduct disorder and poor decision-making skills. If these girls truly believe that they are not making bad decisions, then they will persist at the same activities even though the consequences may be dire. If they do know that they are making bad decisions but are trying to hide it to prevent embarrassment and humiliation, similarly disastrous costs may be incurred.

Future extensions of this study should at least double the sample size to be able to detect the effect that conduct disorder has on decision-making as well as provide a second card trial to detect the learning effect that should appear in the controls but not in the girls with conduct disorder. These adaptations are similar to those used by Ernst et al. (2003) and would provide a basis of comparison for a study on antisocial behavior in boys. If there is still no significant difference between the groups, then selecting a game that replicates real-life decision-making but

does not inherently contain biases that may affect the performance of females is an option. The ability to generalize these results for both males and females with conduct disorder will assist in formulating more effective treatments, such as the incorporation of rewards for positive, norm-abiding behavior.

References

Acoca, L. (1999). Investing in girls: a 21st century strategy. *Juvenile Justice, VI*(1), 3-13.

Andrews, V. C., Garrison, C. Z., Jackson, K. L., & Addy, C. L., et al. (1993). Mother-adolescent agreement on the symptoms and diagnoses of adolescent depression and conduct disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 32*(4), 869-877.

Baines, M., & Alder, C. (1996). Are girls more difficult to work with? Youth workers' perspectives in juvenile justice and related areas. *Crime and Delinquency, 42*, 476-485.

Bardone, A., Moffitt, T., Caspi, A., Dickson, N., & Silva, P. (1996). Adult mental health and social outcomes of adolescent girls with depression and conduct disorder. *Development and Psychopathology, 8*, 811-829.

Bassarath, L. (2001). "Conduct disorder: a biopsychosocial review." *Canadian journal of psychiatry. Revue canadienne de psychiatrie, 46,* 609-16.

Bechara, A., Damasio, H., Damasio, A.R., Lee, G.P. (1999). Different contributions of the human amygdale and ventromedial prefrontal cortex to decision-making. *The Journal of Neuroscience, 19,* 5473-5481.

Bechara, A., Tranel, D., Damasio, H. (2000). Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. *Brain, 123,* 2189-2202.

Bechara, A. (2001). Neurobiology of decision-making: Risk and reward. *Seminars in Clinical Neuropsychiatry, 6,* 205-216.

Bechara, A., Damasio, H., Damasio, A.R. (2003). Role of the amygdala in decision-making. *Annals New York Academy of Sciences, 985,* 356-369.

Bechara, A. (2004). The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition, 55,* 30-40.

Ben-David, S. (1993). The two facets of female violence: the public and the domestic domains. *Journal of Family Violence., 8*(4), 345-359.

Blair, R.J.R. (2001). Somatic markers and response reversal: Is there orbitofrontal cortex dysfunction in boys with psychopathic tendencies? *Journal of Abnormal Child Psychology, 29,* 499-511.

Bolla et al. (2003). Orbitofrontal cortex dysfunction in abstinent cocaine abusers performing a decision-making task. *NeuroImage, 19,* 1085-1094.

Bolla, K.I., Eldreth, D.A., Matochik, J.A., Cadet, J.L. (2004). Sex-related differences in a gambling task and its neurological correlates. *Cerebral Cortex, 14,* 1226-1232.

Cloward, R., & Ohlin, L. E. (1960). *Delinquency and opportunity.* New York: Free Press.

Cohen, A. (1955). Delinquent boys. In. Glencoe, IL: Free Press.

Cowie, J., Cowie, V., & Slater, E. (1968). *Delinquency in girls*. London: Macmillan & Co.

Damasio, A.R., Tranel, D., Damasio, H. (1990). Individuals with sociopathic behavior caused by frontal damage fail to respond autonomically to social stimuli. *Behavioural Brain Research, 41,* 81-94.

David, C.F., & Kistner, J.A. (2000). Do positive self-perceptions have a "dark side"? Examination of the link between perceptual bias and aggression. *Journal of Abnormal Child Psychology, 28,* 327-338.

Department of Juvenile Justice. (1998). *Juvenile justice bulletin.*

Edens, J.F., Cavell, T.A., & Hughes, J.N. (1999). The self-systems of aggressive children: A cluster-analytic investigation. *Journal of Child Psychology and Psychiatry, 40,* 441-454.

Ernst, M., Grant, S.J., London, E.D., Contoreggi, C.S., Kimes, A.S., Spurgeon, L. (2003). Decision-making in adolescents with behavior disorders and adults with substanceabuse. *American Journal of Psychiatry, 160,* 33-40.

Fellows, L.K. and Farah, M.J. (2005). Different underlying impairments in decision-making following ventromedial and dorsolateral frontal lobe damage in humans. *Cerebral Cortex, 15*, 58-63.

Fergusson, D. M., Horwood, J., & Lynskey, M. T. (1993). Prevalence and comorbidity of DSM III-R diagnoses in a birth cohort of 15 year olds. *Journal of American Academy on Child & Adolescent Psychiatry, 32*(6), 1127-1134.

Fisher, P., Lucas, C., Shaffer, D., Schwab-Stone, M., Graae, F., Lichtman, J., et al. (1997). Diagnostic interview for children, version IV(DISC-IV): test-retest reliability in a clinical sample. Paper presented at the American Academy of Child and Adolescent Psychiatry, Toronto.

Friman, P., Handwerk, M., Smith, G., Larzelere, R., Lucas, C., & Shaffer, D. (2000). External validity of conduct and oppositional defiant disorders determined by the NIMH Diagnostic Interview Schedule for Children. *Journal of Abnormal Child Psychology, 28*, 277-286.

Glueck, S., & Glueck, E. T. (1934). *Five Hundred Delinquent Women*. New York: Alfred A. Knopf.

Goudriaan, A.E., Oosterlaan, J., de Beurs, E., van den Brink, W. (2005). Decision-making in pathological gambling: A comparison between pathological gamblers, alcohol dependents, persons with Tourette syndrome, and normal controls. *Cognitive Brain Research, 23,* 137-151.

Hooper, C.J., Luciana, M., Conklin, H.M, Yarger, R.S. (2004). Adolescents' performance on the Iowa Gambling Task: Implications for the development of decision-making and ventromedial prefrontal cortex. *Developmental Psychology, 40,* 1148-1158.

Hughes, J.N., Cavell, T.A., & Grossman, P.B. (1997). A positive view of self: Risk or protection for aggressive children? *Development and Psychopathology, 9*, 75-94.

Jollant, F. (2005). Impaired decision-making in suicide attempters. *American Journal of Psychiatry, 162,* 304-310.

Kashani, J. H., Orvaschel, H., Rosenberg, T. K., & Reid, J. C. (1989). Psychopathology in a community sample of children and adolescents: a developmental perspective. *Journal of American Academy of Children and Adolescent Psychiatry, 28*(5), 701-706.

Kunzel, R. G. (1993). *Problem girls: Unmarried mothers and the professionalization of social work, 1890-1945.* New Haven, Conn.: Yale University Press.

Lane, S., Cherek, D. (2001). "Risk taking by adolescents with maladaptive behavior histories." *Experimental and Clinical Psychopharmacology*, *9,* 74-82.

Lavan, H., Johnson, J. (2002). "The association between axis I and II psychiatric symptoms and high-risk sexual behavior during adolescence." *Journal of Personality Disorders*, *16,* 73 94.Lewis, D. O., Yeager, C. A., Cobham-Portorreal, C. S., Klein, N., Showalter, C., &

Anthony, A. (1991). A follow-up of female delinquents: maternal contributions to the perpetuation of deviance. *Journal of American Child and Adolescent Psychiatry, 30*, 197 201.

Litt, I. F. (1995). Violence among adolescents: don't overlook the girls. *Journal of Adolescent Health., 17*, 333.

Loper, A., & Cornell, D. (1996). Homicide by juvenile girls. *Journal of Child and Family*

Studies., 5, 323-336.
Mazas, C., Finn, P.,Steinmetz, J. (2000) "Decision-making biases, antisocial personality, and early-onset alcoholism." *Alcoholism: Clinical and Experimental Research*, *24,* 1036-40.
Merton, R. (1957). *Social Theory and Social Structure*. Chicago: The Free Press of Glencoe Illinois.
Mitchell, D., Colledge, E., Leonard, A., Blair, R. (2002). "Risky decisions and response reversal:is there evidence of orbitofrontal cortex dysfunction in psychopathic individuals?." *Neuropsychologia*, *40,* 2013-22.
Morris, R. R. (1964). Female delinquency and relational problems. *Social Forces, 43*(1), 82-89.
National Center on Addiction and Substance Abuse. (2004). Criminal Neglect: Substance abuse, juvenile justice, and the children left behind. http://www.casacolumbia.org/Absolutenm/articlefiles/JJreport.pdf
Office of Juvenile Justice and Delinquency Prevention. (1996). *Female offenders in the juvenile justice system*. Pittsburgh, PA: National Center for Juvenile Justice.
Office of Juvenile Justice and Delinquency Prevention. (2005). *Juvenile Justice Bulletin: Juvenile Arrests 2003*. Washington, D.C.: U.S. Department of Justice.
Overman, W.H., Frassrand, K., Ansel, S., Trawalter, S., Bies, B., Redmond, A. (2004). Performance on the IOWA card task by adolescents and adults. *Neuropsychologia, 42,* 1838-1851.
Overman, W.H. (2004). Sex differences in early childhood, adolescence, and adulthood on cognitive tasks that rely on orbital prefrontal cortex. *Brain and Cognition, 55,* 134-147.
Pajer, K. (1998). What happens to "bad" girls? A review of the adult outcomes of antisocial adolescent girls. *American Journal of Psychiatry, 155*, 862-870.
Parks, S. (1998, 11/1/98). NM killing reflects trend of rising violence in girls. *Dallas Morning News,* pp. 45A, 49A.
Raine, A., Lencz, T., Bihrle, S., LaCasse, L., Colletti, P. (2000) "Reduced prefrontal gray matter volume and reduced autonomic activity in antisocial personality disorder." *Archives of General Psychiatry*, 57, 119-129.
Raine, A. (2002). Annotation: The role of prefrontal deficits, low autonomic arousal, and early health factors in the development of antisocial and aggressive behavior in children. *Journal of Child Psychology and Psychiatry, 43,* 417-434.
Ramrakha, S., Caspi, A., Dickson, N., Moffitt, T.E, Paul, C. (2000). "Psychiatric disorders and risky sexual behaviour in young adulthood: cross sectional study in birth cohort." *British Medical Journal*, *32*1, 263-6.
Reavis, R. and Overman, W.H. (2001). Adult sex differences on a decision-making task previously shown to depend on the orbital prefrontal cortex. *Behavioral Neuroscience, 115,* 196-206.
Robins, L. (1966). *Deviant children grown up: a sociological and psychiatric study of sociopathic personality*. Baltimore: Williams & Wilkins.
Rutter, M., Tizard, J., & Whilmore, K. (1970). *Education, health, and behavior.* London: Longeman.
Schwab-Stone, M., D, S., MK, D., PS, J., P, F., HR., B., et al. (1996). Criterion validity of the NIMH Diagnostic Interview Schedule for Children Version 2.3 (DISC-2.3). *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 865-877.
Scott, S., Knapp, M., Henderson, J., & Maughn, B. (2001). Financial cost of social exclusion: follow up study of children into adulthood. *British Medical Journal, 323*, 191-198.

Shaffer, D., Fisher, P., Lucas, C.P., Dulcan, M.K., Schwab-Stone, M.E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry, 39,* 28-38.

Shurman, B., Horan, W.P., Nuechterlein, K.H. (2005). Schizophrenia patients demonstrate a distinctive pattern of decision-making impairment on the Iowa Gambling Task. *Schizophrenia Research, 72*, 215-224.

Smith, L. (1995). In suburbs, concern grows over girls' criminal activity. In (pp. A1): Washington Post.

Smith, L. S. (1978). Sexist assumptions and female delinquency. An empirical investigation. In C. Smart & B. Smart (Eds.), *Women, sexuality and social control.* (pp. 72-88). London: Routledge & Kagen Paul.

Spear, L. P. (2000). The adolescent brain and brain-related behavioral manifestations. *Neuroscience and Biobehavioral Reviews, 24*, 417-463.

Steinberg, L. (2004). Risk taking in adolescence. What changes, and why? *Ann NY Acad Sci, 1021*, 51-58.

Storm-Mathisen, A., & Vaglum, P. (1994). Conduct disorder patients 20 years later: a personal follow-up study. *Acta Psychiatrica Scandinavica, 89*, 416-420.

Thomas, W. (1937). *The Unadjusted Girl*. Boston: Little, Brown and Company.

van Honk, J., Hermans, E.J., Putman, P., Montagne, B., Schutter, D.J. "Defective somatic markers in sub-clinical psychopathy." (2002). *NeuroReport*, *13,* 1025-7.

United States Government. (1997). *Crime in the United States*. Washington, D.C.: U.S. Government Printing Office.

Zoccolillo, M. (1993). Gender and the development of conduct disorder. *Developmental Psychopathology, 5*, 65-78.

Zoccolillo, M., Pickles, A., Quinton, D., & Rutter, M. (1992). The outcome of childhood conduct disorder: implications for defining adult personality disorder and conduct disorder. *Psychological Medicine, 22*, 971-986.

Zoccolillo, M., & Rogers, K. (1991). Characteristics and outcome of hospitalized adolescent girls with conduct disorder. *Journal of American Academy of Child and Adolescent Pyschiatry, 30*(6), 973-981.

Table 1
DSM-IV Diagnostic Criteria for Conduct Disorder

A. A repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate societal norms or rules are violated, as manifested by the presence of three (or more) of the following criteria in the past 12 months, with at least one criterion present in the past six months:

Aggression to people and animals

1. Often bullies, threatens, or intimidates others.
2. Often initiates physical fights.
3. Has used a weapon that can cause serious physical harm to others.
4. Has been physically cruel to people.
5. Has been physically cruel to animals.
6. Has stolen while confronting a victim.
7. Has forced someone into sexual activity,

Destruction of property

8. Has deliberately engaged in fire setting with the intention of causing serious damage.
9. Has deliberately destroyed others' property.

Deceitfulness or theft

10. Has broken into someone else's house, building, or car.
11. Often lies to obtain goods or favors to avoid obligations.
12. Has stolen items of nontrivial value without confronting a victim.

Serious violations of rules

13. Often stays out at night despite parental prohibitions, beginning before age 13 years.
14. Has run away from home overnight at least twice while living in parental or parental surrogate home.
15. Is often truant from school, beginning before age 13 years.

B. The disturbance in behavior causes clinically significant impairment in social, academic, or occupational functioning.

***Code* type based on age at onset**

Conduct disorder Childhood-Onset Type: Onset of at least one criterion characteristic of Conduct Disorder prior to age 10 years.

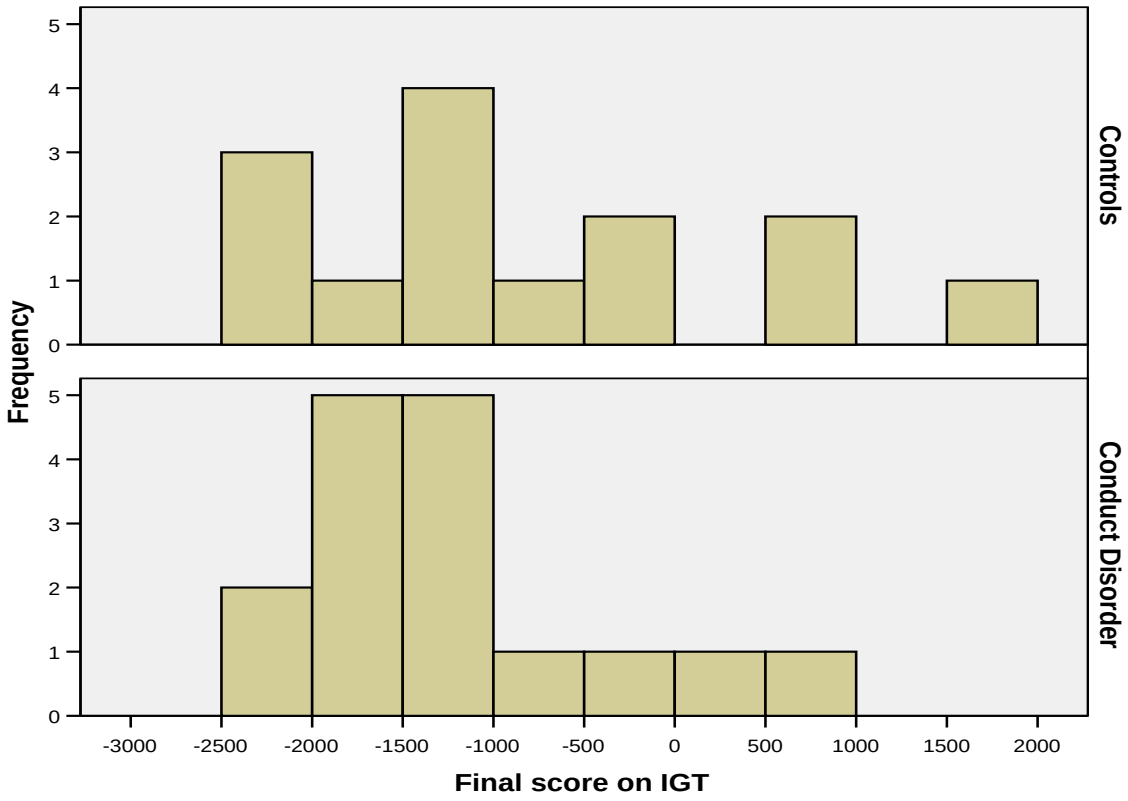
Conduct disorder Adolescent-Onset Type: Absence of any criteria characteristic of Conduct Disorder prior to age 10 years.

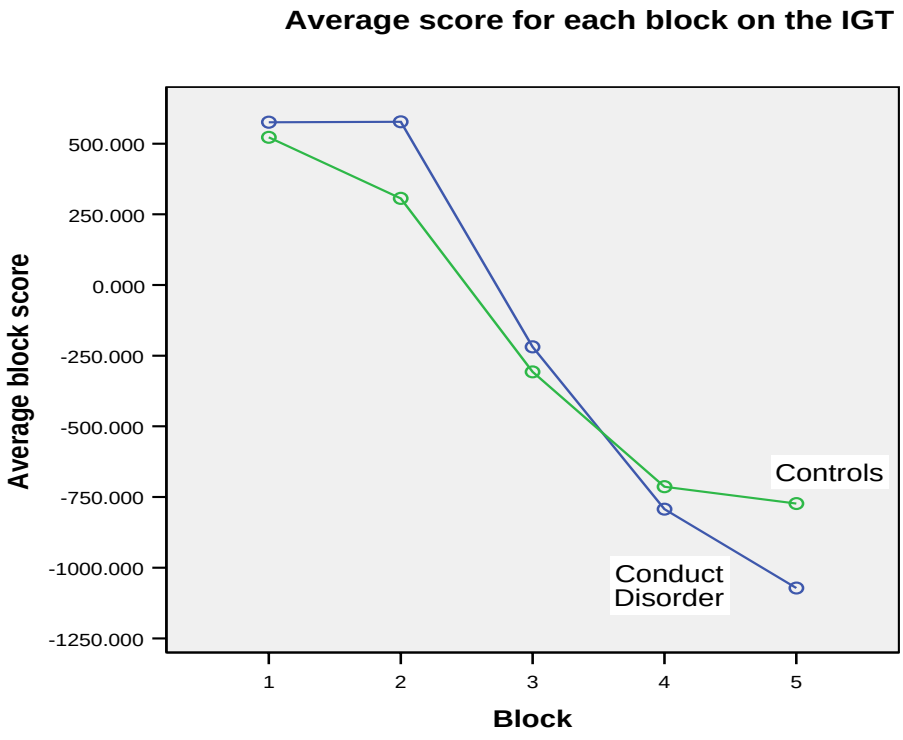
Figure Captions

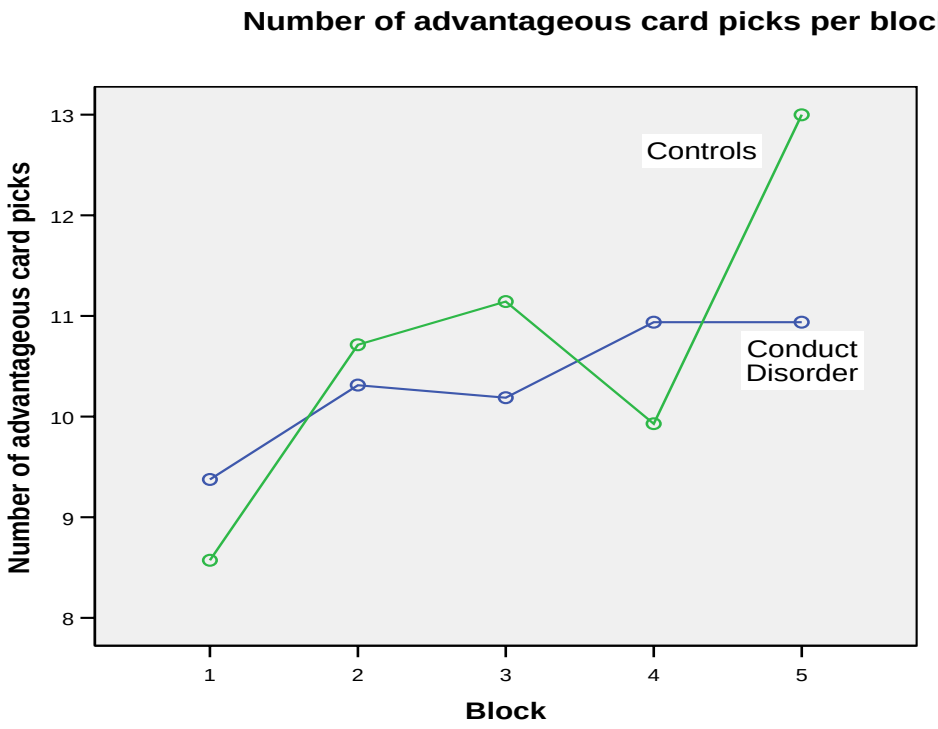
Figure 1. The frequency distribution of final scores on the IGT, for girls with and without conduct disorder.

Figure 2. The average scores of card picks per block over 5 blocks of 20 card trials each, for girls with and without conduct disorder.

Figure 3. The number of advantageous card picks per block over 5 blocks of 20 card trials each, for girls with and without conduct disorder.


Frequency
Controls
Conduct Disorder
0
1
2
3
4
5
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Final score on IGT


Average score for each block on the IGT
Average block score
500.000
250.000
0.000
-250.000
-500.000
-750.000
-1000.000
-1250.000
Controls
Conduct Disorder
1
2
3
4
5
Block


Number of advantageous card picks per block
Number of advantageous card picks
13
12
11
10
9
8
Controls
Conduct Disorder
1
2
3
4
5
Block

Appendix A Recruitment Letter

Dear _____:

I really appreciate your help in the Girls Coping with Stress Study and I'm sending letters to some of the girls who are in that study. I am writing to find out if you are interested in participating in a brief study over the next few months. Participating is completely voluntary; it won't affect anything about participating in the Girls Coping with Stress project.

The study is about how girls think about decisions and make choices about health. If you decided to join this study, you would come into our study office at Children's Hospital one afternoon at 3 PM. You and your parent would sign permission forms (consent), but your parent doesn't have to stay for the study if he or she doesn't want to. Than I will ask you to fill out two questionnaires about health and how you think about decisions. After that, I will have you play a computer card game. Before you play the game, once during it, and once after it, I will have you put the cotton roll in your mouth for saliva, exactly the way you've done before. I will also do a new measurement of the sweat content in your hand. For this, I will wrap two small straps around two fingers of the hand you don't write with and measure the change in sweat in your skin while you're doing the game. Then the study is over; you should be done by 5:30 PM.

I know this will take up your time and I will pay you $15 for the time and effort. I will also pay for parking or busfare. In addition, you may be able to win a small amount of money in the computer game (ranging from $0 to $2.50).

If you are interested in participating, please call me at **614-722-3190**. If I am not there, you can leave a voice mail message. Thank you again for all your help in this work.

Sincerely,

Kathleen Pajer, M.D.,M.P.H.

Appendix B IGT Instructions to Participants

The following verbal instructions are given to the girls before they begin the game:

1. In front of you on the screen, there are 4 decks of cards: A, B, C, and D.
2. When we begin the game, I want you to select one card at a time by clicking on a card from any deck you choose.
3. Each time you select a card, the computer will tell you that you won some money. I don't know how much money you will win. You will find out as we go along. Every time you win, the green bar gets bigger.
4. Every so often, when you click on a card, the computer will tell you that you won some money as usual, but then it will say that you lost some money as well. I don't know when you will lose or how much. You will find out as we go along. Every time you lose, the green bar gets smaller.
5. You are absolutely free to switch from one deck to the other at any time, and as often as you wish.
6. The goal of the game is to win as much money as possible and avoid losing as much money as possible.
7. You won't know when the game will end. Simply keep on playing until the computer stops.
8. I am going to give you $2000 of credit, the green bar, to start the game. The red bar is a reminder of how much money you borrowed to play the game, and how much money you have to pay back before we see whether you won or lost.
9. The only hint I can give you, and the most important thing to note is this:
   Out of these four decks of cards, there are some that are worse than others, and to win you should try to stay away from bad decks. No matter how much you find yourself losing, you can still win the game if you avoid the worst decks.
10. Also note that the computer does not change the order of the cards once the game begins. It does not make you lose at random, or make you lose money based on the last card you picked.

Appendix C Post-IGT Questionnaire

1. By the end of the game, did you feel like you had figured out the strategy of how to win more money?

□ Yes

□ No

2. If your answer to Question 1 was "yes," at which point of the game did you figure it out?

□ Around the beginning of the game

□ Around the middle of the game

□ Around the end of the game