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Planned versus unplanned risks: Neurocognitive predictors of subtypes of adolescents’ risk behavior

Julie Maslowsky,1 Daniel P. Keating,1 Christopher S. Monk,1 and John Schulenberg1

Abstract
Risk behavior contributes to substantial morbidity and mortality during adolescence. This study examined neurocognitive predictors of proposed subtypes of adolescent risk behavior: planned (premeditated) versus unplanned (spontaneous). Adolescents (N = 69, 49% male, M = 15.1 [1.0] years) completed neurocognitive tasks (Iowa Gambling Task [IGT], and Game of Dice Task [GDT]) and a self-report measure indicating whether past-year risk behaviors were planned or unplanned. As hypothesized, identifying more beneficial choices on the neurocognitive tasks and perceiving benefits of risk behavior to outweigh costs predicted engagement in planned versus unplanned risk behavior. This study is the first to use neurocognitive assessments to differentiate planned and unplanned subtypes of risk behavior. Understanding mechanisms underlying these subtypes may inform prevention programs targeting specific contributors to adolescent risk behavior.

Keywords
adolescent development, decision-making, individual differences, risk-taking behavior

Risk behavior during adolescence contributes to the leading causes of morbidity and mortality during this developmental period (Sells & Blum, 1996). Risk behavior includes any behavior that jeopardizes health or well-being of the self or another, either through immediate risk of physical harm or by violating rules or norms established to prevent this harm. Seventy-one percent of deaths among 10- to 24-year-olds are due to risk-related events such as motor vehicle crashes, accidental injury, homicide, and suicide (National Center for Chronic Disease Prevention and Health Promotion, 2006). Research to date has often treated risk behavior as a singular construct (e.g., Jessor, 1991). However, given that the term “risk behavior” can include any number of behaviors, and considering the heterogeneity of the adolescent experience, it is likely that risk behavior is a multidimensional construct (Gibbons, Gerrard, Blanton, & Russell, 1998; Reyna & Farley, 2006). For example, some risk behavior may be premeditated and other behavior may be spontaneous. Therefore, the current study proposes and tests a distinction between risk behavior that is planned and that which is unplanned by examining individual differences in the neurocognitive task performance of adolescents who differ in their propensities to undertake each of these types of risk.

Gerrard and colleagues (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2007) have developed a dual-processing perspective on adolescent risk behavior. They argue that traditional models of health behavior, which describe health behavior as the result of a deliberative decision-making process, are not appropriate for adolescent risk behavior. Instead, models of adolescent risk behavior should account for dual levels of processing: heuristic and deliberative (Gibbons, Houlihan, & Gerrard, 2009). Heuristic processing is thought to result in behaviors that are less reasoned and premeditated than those portrayed by models based solely on a deliberative, expectancy-value perspective. Similarly, Reyna & Farley (2006) proposed that adolescent risk behavior can be described by two subtypes. The first type, which they termed reasoned risk, is described as the product of deliberately trading off risks and benefits, with benefits given greater weight than risks in decision making. This type of risk behavior is thought to consist of purposeful choice of behaviors known to be risky in order to earn benefits that may be associated with the behavior. The second type, termed reactive risk, is described as a non-deliberative reaction to the situational and emotional aspects of the immediate environment. This type of risk behavior is proposed to occur as an in-the-moment reaction when one did not seek out the opportunity beforehand. A key distinction between these two subtypes is whether the risk behavior was planned. Thus, in the current study, reasoned risk behavior is defined as that which is planned, and reactive risk as that which is unplanned. The mechanisms underlying each subtype and the possible sequelae of these subtypes of risk appear to be distinct, but no known study has attempted to empirically differentiate these two subtypes of risk behavior.

Identifying the predictors of subtypes of risk behavior has both theoretical and practical importance. Theoretically, this distinction expands the scope of research to consider meaningful subtypes of risk behavior in order to increase the precision of current theories of its origins, correlates, and, potentially, its consequences and their prevention. Practically, it is important because different subtypes

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may respond to distinct prevention approaches if they are indeed driven by different underlying mechanisms as predicted.

The current study utilized a multimodal assessment technique, including IQ interviews and self-report measures, in addition to the primary assessment tool, neurocognitive tasks. Previous research has demonstrated the utility of neurocognitive tasks in studying adolescent risk behavior. Decision making in such tasks, in which participants choose among various risky and non-risky alternatives to earn a reward, has been found to predict real-life risk behavior. One task commonly used to assess risk preference and decision making is the Iowa Gambling Task (IGT). The IGT involves choosing between low and high risk decks of cards to gain monetary reward. Developed originally to measure the integrity of prefrontal neural systems believed to be central to judgment, this task measures the participant’s ability to analyze costs and benefits and defer immediate gratification for long-term gain (Bechara, Damasio, Damasio, & Anderson, 1994). In adults, preference for high risk decks is correlated with risk behavior in day-to-day life, including substance use and abuse (Bechara & Damasio, 2002) and pathological gambling (Cavedini, Riboldi, Keller, D’Annuzi, & Bellodi, 2002). The IGT has also been used as a measure of risk preference and sensitivity to probability of reward versus punishment in adolescents. Although there is an overall developmental trend of improved performance with age on this task (Crone & van der Molen, 2004), there is also substantial within-age variability that is not explained by other cognitive measures such as working memory and IQ (Hoppe, Luciana, Conklin, & Yarger, 2004). Such variability in individual neurocognitive characteristics may manifest as individual differences in risk behavior, such as alcohol use (Spear, 2000).

Because planned risk behavior is hypothesized to be driven by a search for rewards, we expected that those adolescents who were better at identifying potential rewards in neurocognitive tasks would be more likely to engage in planned risk behavior.

Adolescents’ perceptions of the relative costs and benefits of risk behavior can also be measured via self-report. Although some research has suggested that high rates of risk behavior are due in part to adolescents’ underestimation of the risks associated with these behaviors (Arnett, 2000; Romer & Jamieson, 2001), several studies have demonstrated that adolescents judge the risks of their behavior relatively accurately (Ellen, Boyer, Tschan, & Shafer, 1996; Johnson, McCaul, & Klein, 2002; Parsons, Halkitis, Bimbi, & Borkowski, 2000). Importantly, those adolescents who are most involved in risk behavior rate their likelihood of negative consequences highest, indicating an appreciation of the relative risks involved (Ellen et al., 1996; Fromme, Katz, & Rivet, 1997).

An important consideration, then, is not whether adolescents can identify risks and benefits, but how they weigh risks and benefits against each other and how each of these constructs may individually relate to their actual risk behavior. For example, several studies have found that perceived benefits of a behavior are more reliably associated with engagement in that risk behavior than is perceived riskiness. In a sample of college students, having unprotected sex was predicted only by its perceived benefits, not by its perceived risks (Parsons et al., 2000). In a short-term longitudinal study, the perceived benefits of risk behaviors, including substance use, unprotected sexual behavior, and other dangerous activities, predicted whether adolescent participants had engaged in those same behaviors three months later (Parsons, Siegl, & Cousins, 1997). Thus, in adolescence, it appears that the extent to which behaviors are perceived as beneficial is more predictive of the likelihood of engaging in the behavior than the risks perceived to be involved. We expected that perceived benefits of a behavior would relate to planned risk behavior because it is, by definition, driven by a search for benefits.

In much of the extant literature on adolescent risk behavior, the dependent variable is frequency of risk behavior, with an implication that risk behavior is a unitary phenomenon. As suggested above, this unitary conceptualization of risk behavior may not be warranted given the wide range of behaviors, circumstances, motivations, and individual differences that can be subsumed under the term “risk behavior.” The current study extends the extant literature by differentiating between risk behavior that entailed prior planning versus that which was unplanned. The primary research question addressed is: ‘To what extent are differences in the planfulness of adolescents’ risk behavior validated as a meaningful construct by their theoretically predicted associations with neurocognitive task performance?’ Of particular importance, we employed a multi-modal approach to assessing the predictors of risk behavior, important for guarding against self-report measurement bias and covariation as well as for providing a more comprehensive picture of the net of influences surrounding risk behaviors. Our choice of this multi-modal approach was based on previous literature demonstrating that differential aspects of behavior and personality constructs are captured by self-report measures and behavioral tasks, and that information from both methods adds to the prediction of risk behavior (Dom, D’haene, Hulsjin, & Sabbe, 2006; Meda et al., 2009; Muntaner et al., 1990).

We identified two groups of adolescents who differed in their propensities to describe their self-reported risk behavior as planned versus unplanned, and contrasted their neurocognitive and personality profiles. Planned risk behavior is defined as the product of deliberately trading off risks and benefits, with benefits given greater weight than risks in decision-making. Thus our two hypotheses concern the participants’ ability to accurately identify sources of benefits within a risky task, and their perceptions of the benefits of risk behavior. First, we hypothesized that more accurate identification of risk probability and more advantageous performance on neurocognitive tasks would be associated with increased odds of membership in the planned risk behavior group. Logically, planning one’s risk behavior necessitates an ability to identify risky versus non risky behavioral choices Second, we hypothesized that weighing the benefits of risk behavior more heavily than its potential harm would be related to increased odds of membership in the planned risk group. This hypothesis is rooted in an expectation that those who rate risk behavior as more beneficial are likely to plan on doing it more often than engaging in it spontaneously.

Method

Sample and procedure

Adolescent participants were recruited using newspaper advertisements and flyers posted in community settings. Informed consent to participate in the study was obtained from a parent or guardian, and assent was obtained from all participants. Participants were paid $30 for their participation in one three-hour session in the laboratory. In addition, they were able to earn up to $10 in bonuses on each of two neurocognitive tasks. A total of 69 adolescents participated in the study. Table 1 summarizes the sample characteristics.

Measures

The measures used in this study are described below. All neurocognitive tasks and self-report measures were administered on a...
Table 1. Sample characteristics

<table>
<thead>
<tr>
<th></th>
<th>Full sample ($N = 69$)</th>
<th>Analysis sample ($N = 55$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>15.6 (1.0)</td>
<td>15.6 (1.0)</td>
</tr>
<tr>
<td>IQ</td>
<td>112 (12.3)</td>
<td>112 (11.5)</td>
</tr>
<tr>
<td>N (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender Male</td>
<td>34 (49.3)</td>
<td>28 (50.9)</td>
</tr>
<tr>
<td>Female</td>
<td>35 (50.7)</td>
<td>27 (49.1)</td>
</tr>
<tr>
<td>Race White</td>
<td>44 (63.8)</td>
<td>38 (69.1)</td>
</tr>
<tr>
<td>Black</td>
<td>13 (18.8)</td>
<td>9 (16.4)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3 (4.3)</td>
<td>3 (5.4)</td>
</tr>
<tr>
<td>Asian-American</td>
<td>3 (4.3)</td>
<td>2 (3.6)</td>
</tr>
<tr>
<td>Native American</td>
<td>2 (2.9)</td>
<td>2 (3.6)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (5.7)</td>
<td>1 (1.8)</td>
</tr>
<tr>
<td>Mother education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>6 (8.7)</td>
<td>6 (10.9)</td>
</tr>
<tr>
<td>Some college</td>
<td>19 (27.5)</td>
<td>14 (25.5)</td>
</tr>
<tr>
<td>Four years college and beyond</td>
<td>38 (55.1)</td>
<td>31 (56.3)</td>
</tr>
<tr>
<td>Not reported</td>
<td>6 (8.7)</td>
<td>4 (7.3)</td>
</tr>
<tr>
<td>Father education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>12 (17.4)</td>
<td>9 (16.3)</td>
</tr>
<tr>
<td>Some college</td>
<td>12 (17.4)</td>
<td>11 (20.0)</td>
</tr>
<tr>
<td>Four years college and beyond</td>
<td>39 (56.5)</td>
<td>31 (56.4)</td>
</tr>
<tr>
<td>Not reported</td>
<td>6 (8.7)</td>
<td>4 (7.3)</td>
</tr>
</tbody>
</table>

Risk behavior. Participants reported how many times in the past year they had engaged in each of nine risk behaviors: smoking cigarettes, drinking alcohol, using marijuana, using drugs besides marijuana, physical fighting, skipping school, stealing, risking serious injury to self, and having unprotected sex. These items were adapted from the Monitoring the Future study (Johnston, O’Malley, Bachman, & Schulenberg, 2009) where they have been used for several decades in annual, national surveys of adolescent substance use and related behaviors. Responses were given on an 11 point scale with 0 = ‘0’, 1 = ‘1–2’, 3 = ‘3–5’ through 10 = ‘70+’ occasions in the past 12 months. Frequency of risk behavior was calculated by averaging the responses to each of the nine behaviors in which each adolescent had participated. This scale showed good internal reliability, $\alpha = .78$.

Percentage planned risk behavior. For each risk behavior in which participants had engaged at least once in the past year, they were asked, “When you have [done behavior], what proportion of the time did you plan on doing it beforehand, and what proportion of the time was it unplanned?” This item was devised for the purpose of this study and was based on Reyna and Farley’s (2006) distinction between reasoned and reactive risk behaviors, which emphasizes whether the behavior was planned as a key difference between these proposed subtypes of behavior. This item shows face validity in representing the proportion of risk behavior that was planned. Additionally, although participants were permitted to ask for clarification on items if needed, no participant expressed difficulty understanding the content or intention of this item. The value corresponding to percentage planned was extracted from the item response. For example, if a participant indicated that on the occasions when he had smoked cigarettes in the past year, the behavior was planned 75% of the time and unplanned 25% of the time, the value of 0.75 was assigned to that behavior. Overall percentage planned was calculated as the average percentage planned for all behaviors in which each participant had engaged in the past year. Because planned/unplanned items were only answered if the subject engaged in a given risk behavior, there were numerous “N/A” responses, making coefficient alpha inappropriate.

IQ. The Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) was used to assess IQ. This brief measure of intelligence estimates full scale IQ and has been normed for ages 6 through 89. The two-subtest format of Vocabulary and Matrix Reasoning was administered. This format correlates .81 and .87 respectively with the Wechsler Intelligence Scale for Children-III and Wechsler Adult Intelligence Scale-III full scale IQs (Wechsler, 1999). Because IQ has been found to correlate positively with performance on neurocognitive tasks, including the Iowa Gambling Task (Caffmian et al., 2010), it was included as a covariate in the multivariate analysis.

Benefits versus risks. The benefits versus risks subscale of the Benthin Risk Perception Measure (Benthin, Slovic, & Severson, 1993) was used to measure participants’ perceptions of the relative benefits and risks associated with each behavior. In previous studies, this subscale showed good internal reliability and strong positive relationships to risk behavior (Gardner & Steinberg, 2005; Magar, Phillips, & Hosie, 2008). For each of the nine risk behaviors, participants were asked, “How much do the benefits or pleasures of [behavior] outweigh the risks of doing it?” The mean of the nine responses was used in analysis. Internal reliability in the current study was moderate ($\alpha = .67$).

Iowa Gambling Task. The Iowa Gambling Task (IGT; Bechara et al., 1994) was used to measure risk preference and risk identification (see Figure 1). In the IGT, a participant attempts to earn money by selectively playing from four decks of cards associated with probabilities of win or loss that are unknown to the participant. Two decks are programmed to be disadvantageous, yielding large short-term gains but long-term losses if played consistently. The other two decks are advantageous, yielding small short-term gains that add up to long-term gains when played consistently. Favoring disadvantageous decks is interpreted as preferential attention to immediate gains over long-term losses (Bechara, 2003).

In the IGT, the participant is presented with four decks of cards on the computer screen. Participants were told that some decks are “good” decks, meaning they will make money in the long run by playing from those decks, and that some decks are “bad” decks, meaning they will lose money in the long run by playing them. Participants were instructed to try to maximize their winnings by playing more from the good than the bad decks. However, participants were not told which decks were good and which were bad. Instead, they were instructed that they should try to figure out which were the good and bad decks as they played.

All four decks were present on the screen at all times during the task. On each trial, a preselected deck was highlighted and the
participant was given the opportunity to play or pass on that deck (Figure 1a). If the participant chose to play, he or she received feedback regarding how much money was won or lost before moving on to the next trial (Figure 1b). If the participant chose to pass, no feedback was given. In addition, at three points during the task, participants were asked to rate each of the four decks as good or bad, indicating whether each participant felt he or she won or lost money overall when playing it (Figure 1c). Thus, this version of the task gathers two types of information: an indicator of the participant’s ability to judge the relative probabilities of benefit or loss associated with each deck (Figure 1c), and his or her behavioral choice under conditions of uncertainty and risk evaluation (Figures 1a and 1b).

This version of the task was modified slightly from the original in order to increase its developmental appropriateness for use with adolescents (Cauffman et al., 2010). There are two major modifications in this version of the IGT. The first modification is the addition of the knowledge component, in which participants indicate whether they think each deck is good, bad, or they do not know. The second modification is that decks were presented for play in a pseudorandom order, rather than giving the participant the option to play from any deck on each turn, as in the original IGT. This method of presentation eliminates differential search strategy as a confounding variable in task performance. Additional explanation of the procedures in this modified IGT can be found in Cauffman et al. (2010).

The task was presented using Eprime software (Psychological Software Tools, Pittsburgh, PA). It consisted of 120 trials divided into three blocks of 40 trials each. The number of decks correctly identified as good or bad and the number of plays from the objectively good (advantageous) decks were computed. In order to increase their motivation to perform well, participants were instructed that the amount of money won on each neurocognitive task would determine the amount of the cash bonus they received at the end of the study.

**Game of Dice Task.** The Game of Dice Task (GDT; Brand et al., 2005) was used to measure risk preference when probability of gain or loss is explicitly presented. As in the IGT, participants were instructed to try to maximize their winnings. Unlike the IGT, the probability of winning and the amount to be won or lost that is associated with each choice were presented explicitly throughout the GDT (see Figure 2). The GDT has shown convergent validity with other neuropsychological assessments of decision-making such as the Wisconsin Card Sorting Task (Brand et al., 2005). Performance on the GDT is positively correlated with performance on the later trials of the IGT, in which the probabilities of gain and loss have become known to the participant, as they are known throughout the GDT (Brand, Recknor, Grabenhorst, & Bechara, 2007). To date, the GDT has been used most often to study adult clinical samples. However, at least one previous study has successfully employed the GDT in a young (preadolescent) sample (Drechsler, Rizzo, & Steinhausen, 2008).

Figure 2 shows the Game of Dice Task as it was presented on the computer screen. A single die and a shaker were presented, and participants were informed that they would have 18 throws of the die. Before each throw, participants chose a combination of one to four digits between one and six, representing the six faces of the die. If the number rolled matched one of the numbers chosen, participants won the amount of money associated with the chosen number of digits. If the number did not match, participants lost that amount. Both the probability of winning or losing and the amount of money that could be won or lost were presented on the screen throughout the task. The amount of potential gain or loss was inversely related to the probability of winning, with highest gain/loss associated with lowest probability of winning. Playing one or two digits (which are associated with less than 50% probability of winning and high gains/high losses) was coded as a risky play; playing three or four digits was coded as a safe play.
as a safe play, following previous research (Brand et al., 2005). The results of the throws were pseudorandomized, with each of the six possible numbers occurring three times during the task. The variable used in the analysis was the number of safe plays out of 18 that were made.

Although the GDT is similar in some ways to the IGT, the primary difference between the two is that the probability of win/loss is explicitly presented throughout the GDT, while the probabilities are implicit in the IGT until the participant can deduce them through trial and error during the task. Thus the response measure obtained from the IGT, total good decks played, is a measure of risk taking under conditions of implicit risk. The response measure obtained from the GDT, total safe plays, is a measure of risk taking under conditions of explicit risk. In addition, we included a variable from the IGT, total decks correctly identified, which indicates how well the participant was able to deduce the implicit probabilities of win and loss, that is the number of “good” and “bad” decks correctly identified.

### Results

Data were analyzed using logistic regression to predict membership in dichotomous outcome categories of planned versus unplanned risk behavior. To account for different scales of measurement, all continuous independent variables were standardized ($M = 0, SD = 1$). Table 2 presents the correlations among all variables.

The participants included in the analysis were those who reported that they had engaged in at least one of the measured risk behaviors in the past 12 months ($N = 55$). Those participants who reported that they had not engaged in any risk behavior were excluded because they did not provide any data for the follow-up item regarding how often their risk behavior was planned versus unplanned. Excluded participants did not differ from those in the analysis sample in regards to gender, $\chi^2(1) = 0.29 (p > .05)$, age, t(67) = −0.36 ($p > .05$), race, $\chi^2(5) = 11.08 (p > .05)$, IQ, t(67) = −0.49 ($p > .05$), or parental education level (father’s education level: $\chi^2(3) = 1.86, p > .05$; mother’s education level: $\chi^2(3) = 2.67, p > .05$). However, our power to detect significant differences between the included and excluded participants may have been limited by the small number of excluded participants ($n = 14$).

The mean sum of responses to the nine risk behaviors was approximately 9, meaning the average response to each of the nine items was “1,” which on our scale indicated 1–2 occasions of risk behavior. On average, participants reported engaging in 9–18 occasions of risk behavior in the past 12 months. Percentage planned was calculated as the mean percentage planned of all risk behaviors in which the participant had participated in the past year. On average, participants reported that their engagement in risk behavior was planned 34% of the time ($M = 0.34, SD = 0.24$, median = 0.33).

To form dichotomous outcome groups of planned versus unplanned risk behavior, a median split was performed. Those at or above the median for percentage planned risk behavior were placed in the planned risk behavior group, and those below the median were placed in the unplanned risk behavior group. We chose to split groups at the median rather than at an a priori level of planfulness or frequency due to the preliminary nature of the study and the size of the sample. The aim of the study was to perform an initial validation of the construct. As no prior information was available to guide an a priori hypothesized level at which planfulness would be associated with different personality and neurocognitive profiles, we chose the median as an initial level for splitting the groups.

Although dichotomization of continuous variables has been criticized, these criticisms generally refer to dichotomization of independent variables (e.g., MacCallum, Zhang, Preacher, & Rucker,
Table 2. Correlations of independent and dependent variables (N = 55)

<table>
<thead>
<tr>
<th>1. Planned Risk Behavior Group</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.02</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Age</td>
<td>0.16</td>
<td>0.26</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Frequency of risk behavior</td>
<td>0.25</td>
<td>0.04</td>
<td>0.18</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>IQ</td>
<td>0.13</td>
<td>0.057</td>
<td>-0.08</td>
<td>-0.08</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Benefits versus risks</td>
<td>0.40*</td>
<td>0.005</td>
<td>-0.07</td>
<td>0.334*</td>
<td>0.059</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Gambling tasks—decks correct</td>
<td>0.28*</td>
<td>-0.07</td>
<td>0.165</td>
<td>0.089</td>
<td>0.538*</td>
<td>0.106</td>
<td>---</td>
<td>---</td>
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<tr>
<td>Gambling task—good decks played</td>
<td>0.05</td>
<td>-0.04</td>
<td>0.164</td>
<td>0.072</td>
<td>-0.06</td>
<td>-0.17*</td>
<td>-0.29*</td>
<td>---</td>
</tr>
<tr>
<td>Dice task—safe choices</td>
<td>0.29*</td>
<td>-0.07</td>
<td>0.105</td>
<td>-0.20</td>
<td>-0.06</td>
<td>-0.16</td>
<td>0.022</td>
<td>-0.09</td>
</tr>
</tbody>
</table>


Table 3. Logistic regression: Planned versus unplanned risk behavior (N = 55)

<table>
<thead>
<tr>
<th></th>
<th>Bivariate</th>
<th></th>
<th>Multivariate</th>
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</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.93</td>
<td>0.32–2.69</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Age</td>
<td>1.41</td>
<td>0.80–2.46</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Frequency of risk behavior</td>
<td>1.83</td>
<td>0.92–3.63</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>IQ</td>
<td>1.32</td>
<td>0.73–2.36</td>
<td>0.75</td>
<td>0.28–1.99</td>
</tr>
<tr>
<td>Benefits versus risks</td>
<td>3.00*</td>
<td>1.38–5.64</td>
<td>7.15*</td>
<td>2.17–23.55</td>
</tr>
<tr>
<td>Gambling task—total decks correct</td>
<td>1.85*</td>
<td>1.01–3.37</td>
<td>3.87*</td>
<td>1.21–12.39</td>
</tr>
<tr>
<td>Gambling task—total good decks played</td>
<td>1.10</td>
<td>0.65–1.87</td>
<td>2.75*</td>
<td>1.09–6.95</td>
</tr>
<tr>
<td>Dice task—total safe choices</td>
<td>1.87*</td>
<td>1.02–3.44</td>
<td>3.96*</td>
<td>1.53–10.29</td>
</tr>
</tbody>
</table>

Note. Dependent variable: Unplanned Risk Group = 1 (Reference category); Planned Risk Group = 2. Gender: 1 = Male; 2 = Female. Multivariate model Nagelkerke $R^2 = .54$. *p < .05.

2002). Farrington & Loeber (2000) described the associated benefits of dichotomization of dependent variables, particularly in psychiatric and criminological research, where the results have clear implications for practice. They demonstrated that logistic and OLS regression analyses led to comparable conclusions about the relationship of independent variables to the outcome of interest. In addition, dichotomous dependent variables produce results that are easily understandable to a wide audience. Finally, as stated above, in this initial validation study, we predicted that adolescents with different propensities to engage in planned risk behavior would differ in their neurocognitive and personality characteristics. For these reasons, we chose to describe the dependent variable as dichotomous categories.

Planned versus unplanned risk behavior

Results of all analyses are presented in Table 3. Bivariate analyses were conducted first to determine the individual relationships between each independent variable and membership in the planned versus unplanned risk group. The bivariate relationships of gender, age, IQ, and frequency of engaging in risk behavior to planned versus unplanned risk behavior group membership were not significant. Perceived benefits versus risks of the behavior, more decks correctly identified as good or bad in the IGT, and more advantageous choices made in the GDT were each associated with greater likelihood of membership in the planned versus unplanned risk behavior group.

The multivariate analysis was conducted with a reduced set of independent variables. Due to the relatively small sample size, only the hypothesized variables and key covariates were included in this model. Gender, age, and frequency of engaging in risk behavior were not included in the model due to their nonsignificant bivariate relationships with the outcome; IQ was retained to control for its relationship to the neurocognitive tasks.

In the multivariate model, the test of the overall model against a constant-only model was significant, $\chi^2(5) = 28.17, p < .001$, indicating that the predictors, as a set, reliably distinguished between the planned and unplanned risk behavior groups. Additionally, the amount of variance explained was relatively large, Nagelkerke $R^2 = .54$ (Nagelkerke, 1991). Consistent with our first hypothesis, correctly identifying more good and bad decks in the IGT, choosing to play more good decks in the IGT, and making more safe choices in the GDT were all associated with significantly higher odds of membership in the planned risk group. Also as hypothesized, rating the benefits of engaging in risk behaviors as outweighing the risks of those behaviors predicted higher odds of membership in the planned group than the unplanned group. Odds ratios for the neurocognitive task variables ranged from 2.75–3.96, indicating that for each 1-unit increase in performance on a task, participants were approximately three to four times more likely to be in the planned versus unplanned risk group. The odds ratio for perceptions of benefits versus risks was 7.15, indicating a sevenfold increase in likelihood of being in the planned versus unplanned risk group for every 1-point increase in rating benefits to outweigh risks. This
result should be interpreted with some caution because both benefits versus risks and planned versus unplanned risk behavior were self-report variables and, unlike the neurocognitive tasks, their relationship may be inflated to some degree by method covariance.

**Discussion**

This study examined the distinction between planned and unplanned risk behaviors as subtypes of risk behavior during adolescence. It extends previous research using neurocognitive tasks and perceptions of costs and benefits to predict adolescents’ engagement in risk behavior (e.g., Parsons et al., 1997; Verdejo-Garcia, Bechara, Recknor, & Perez-Garcia, 2006), with evidence that these predictors are differentially related to planned versus unplanned risk behavior.

The first hypothesis was supported; more advantageous performance on the neurocognitive tasks, as indicated by more decks correctly identified as risky or non-risky in the IGT and more advantageous plays made in both the IGT and the GDT, was associated with higher odds of membership in the planned risk group. We predicted that correctly identifying more decks in the IGT as advantageous or disadvantageous would relate to planned risk behavior because it may represent the participant’s ability to identify the most beneficial option in a risky situation. We hypothesized that planned risk behavior is largely driven by a search for rewards, and that those who engaged in more planned risk behavior would be better at identifying rewards within risky situations. The large positive relationship between number of decks correctly identified and membership in the planned risk group supported this hypothesis. Similarly, playing more from the good decks is consistent with attunement to the benefits of a situation and the ability to correctly identify beneficial options. Finally, making more safe choices in the GDT, in which the probabilities for gain and loss are explicit, was also predictive of membership in the planned risk group. It is important to note that all neurocognitive task performance variables were significant predictors after controlling for the effects of IQ in the multivariate analysis. Overall, the relationships of the neurocognitive tasks to planned versus unplanned risk behavior suggest that seeking benefits and the ability to choose a beneficial option within a risky situation are associated with a greater likelihood of participating in risk behavior that is planned versus unplanned.

The second hypothesis was also supported. Greater agreement that the benefits of risk behavior outweigh its risks was associated with higher odds of membership in the planned risk group. This is consistent with previous studies that have found perceived benefits to be better predictors of risk behavior than perceived risks (Fromme et al., 1997; Parsons et al., 1997). This result extends the literature on perceived benefits of risk behavior, with the result that attunement to benefits of behavior may be particularly related to planning one’s risk behavior.

The primary aim of this study was to use neurocognitive tasks to predict planned versus unplanned risk behavior. Given that this was the first study to empirically test the planned versus unplanned risk behavior distinction, it is important to consider whether the evidence generated herein supports this distinction. Both of our hypotheses were supported: weighing benefits more highly than risks and greater ability to identify beneficial options in risky neurocognitive tasks were related to greater propensity for planned risk behavior. The theoretical coherence of these results is also of note.

We found that cognitive performance variables reliably distinguished between those who engaged in planned versus unplanned risk behavior. This is consistent with previous work on the cognitive underpinnings of risk behavior, in which fuzzy-trace theory has been used to identify differential sources of risk decisions and their developmental changes (Reyna, Adam, Poirier, LeCray, & Brainerd, 2005; Reyna & Farley, 2006). The association of neurocognitive performance with planned versus unplanned risk behavior lends support to the theoretical claim of differential sources of risky decision making. Neurocognitive tasks are assessment tools that allow researchers to capture decision-making behavior in vivo rather than through the lens of self report. These tasks are meant to simulate a real-life risk situation by offering behavioral alternatives with various amounts of risk and benefit involved. The choices made by adolescents in these laboratory situations may yield insight into the choices they make in analogous real-life risk situations, without being subject to biases of self report.

In sum, this study was successful in identifying individual characteristics that predict a greater tendency toward engaging in planned versus unplanned risk behavior. It is the first study to provide empirical evidence regarding the validity of this distinction. Weighing benefits more highly than risks, and seeking and making choices that appear likely to yield benefits, are associated with higher odds of membership in the planned risk group compared to the unplanned risk group. Members of both groups engaged in risk behavior, but the cognitive processes underlying that behavior may differ. These results have important implications for future research in the area of adolescent risk behavior. Future studies may consider focusing not only on the quantitative aspects of risk behavior that are often studied, such as how frequently adolescents engage in risk behavior, but on typological distinctions as well, such as what type of behavior they engage in and for what reasons.

This study has several limitations, the first of which relates to the study’s sample. The primary limitation is the relatively small sample size, which limited both the type of analyses that could be performed and the power to detect possible small effects. This also precluded the examination of predictors of individual risk behaviors; instead, a composite of the nine risk behaviors was examined. It is worth noting, however, that the intensive multi-modal measurement used here, an important advantage of this work, made a larger sample cost prohibitive, reflecting the common trade-off between larger sample sizes and more in-depth measurement. The participants in this study were a relatively high SES sample; over half of participants’ parents had attended college. Further research that includes more diverse and representative participants is needed to determine whether the current results hold in other samples. Our participants reported engaging only in low to moderate levels of risk behavior; future studies of higher risk-taking samples are needed to determine whether the planned versus unplanned risk behavior distinction is replicated among those engaging in higher risk behavior.

A second set of limitations concerned measurement. We used a percentage scale to measure planned risk behavior, which could be difficult for adolescents to complete accurately. However, this concern is somewhat mitigated by work by Bruine de Bruin and colleagues, in which adolescents accurately used a percentage scale to predict likelihood of future events occurring to them (Bruine de Bruin, Parker, & Fischhoff, 2007). Also, because answering the question regarding planfulness of risk behavior was dependent on having engaged in a given risk behavior at least once in the past
12 months, there was too much missing data to allow for reliability to be computed. Finally, this study is also limited by its cross-sectional design. With this design, the stability of the individual differences in the independent variables and their relationships to planned and unplanned risk behavior could not be examined.

Despite its limitations, this study offers a promising first look at two distinct subtypes of risk behavior during adolescence, planned and unplanned risk behavior. It is a novel attempt to describe these subtypes and the individual characteristics that relate to them. More work is needed to further investigate the validity and significance of these subtypes. Future studies should use a longitudinal design to examine the stability of risk behavior subtypes and their predictors over time, as well as their potentially distinctive sequelae. For example, the current study highlighted the relationship of perceived benefits of risk behavior to planning to engage in those behaviors. However, this study did not involve measuring the specific benefits that adolescents believed to be associated with risk behavior. Future research should work to delineate the benefits adolescents hope to gain specifically from risk behavior that they plan in advance. A second, related question is to what extent planned and unplanned risk behavior may be adaptive depending on the behavior itself, and the costs and benefits that the adolescent perceives to be associated with that behavior. Reasoned risk behavior may not simply be a source of developmental risk for adolescents as Reyna and Farley (2006) suggest, but also an adaptive form of extracting benefits from the environment, though more research is needed to test this possibility. While both of these questions were beyond the scope of the current study, they represent important directions for future study in order to further understand the correlates and sequelae of planned versus unplanned risk behavior.

The results of this study, though preliminary, have important implications for prevention of adolescent risk behavior. If they are further validated in future research, planned and unplanned risk behavior may need to be approached with separate prevention strategies. Our results indicate that seeking benefits through risk behavior is highly related to planned risk behavior. In other words, those adolescents who evidence greater neurocognitive maturity through their ability to identify benefits in risky situations are more likely to plan their risk behavior. In this case, preventive interventions should focus on harm reduction via the provision of alternative strategies. Our results indicate that seeking benefits through risk behavior may need to be approached with separate prevention strategies. Our results indicate that seeking benefits through risk behavior is highly related to planned risk behavior. In other words, those adolescents who evidence greater neurocognitive maturity through their ability to identify benefits in risky situations are more likely to plan their risk behavior. In this case, preventive interventions should focus on harm reduction via the provision of alternative strategies. Our results indicate that seeking benefits through risk behavior is highly related to planned risk behavior. In other words, those adolescents who evidence greater neurocognitive maturity through their ability to identify benefits in risky situations are more likely to plan their risk behavior. In this case, preventive interventions should focus on harm reduction via the provision of alternative strategies.

Effective prevention in any arena rarely occurs in the absence of a thorough understanding of the underlying causal mechanisms. Adolescent risk behavior is no exception. Understanding the mechanisms of specific subtypes of risk behavior, planned and unplanned, and the characteristics of the individuals who engage in them is the first step toward improving and targeting prevention programs against the potential negative consequences of risk behavior during adolescence.

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**References**


