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Do risks matter? Variable and person-centered approaches to adolescents' problem behavior

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ABSTRACT

Two limitations in research examining adolescents' risk cognitions have been the absence of developmental age group comparisons on a breadth of cognitions and the need to better characterize how cognitions influence behavior. To address these limitations, this study compared adolescent ($n = 205$; 52% female) and young adult ($n = 274$; 58% female) risk cognitions (risk probability, risk identification, risk tolerance, risk salience, and risk preference) and used variable- and person-centered approaches to explore how cognitions affect problem behavior. Adolescents generally reported lower risk-related cognitions than young adults. Further, risk probability, the cognition typically assessed in research, did not exert an independent effect on behavior. Adolescents and young adults were characterized by two similar cognition profiles, but only adolescents were characterized by a third, maladaptive profile, *Low Identification/High Preference*, reflecting low risk identification and risk salience and high risk preference. Interventions should arguably target these three cognitions within at-risk youth.

Adolescence is widely recognized as a critical period for preventing problem behavior. High school-aged adolescents (grades 9–12) engage in high rates of behaviors that contribute to unintentional injuries, mortality, and social problems such as substance use, aggression, and delinquency (Centers for Disease Control & Prevention [CDCP], 2014). For instance, more than 20% of high school students report binge drinking in the last month and nearly 25% report involvement in a physical fight in the last year (CDCP, 2014). These behaviors, if established during adolescence, often extend into young adulthood, when they can escalate (Neinstein, Lu, Perez, & Tysinger, 2013). In the last 20 years, researchers have made exciting discoveries that can inform interventions by explaining why adolescents choose to engage in activities that threaten their health and long-term interests (e.g. Durston & Casey, 2006; Somerville, 2013; Steinberg, 2008). Much of this research has focused on adolescents' biologically-based reward-system, which impels them to pursue the social and emotional rewards of risky and antisocial choices. However, perceived rewards are only one piece of the decision making puzzle (Ernst et al., 2005; Fischhoff, 2008). Adolescents' cognitive control system, the decelerating-counterpart to their reward-drive, also contributes to their behavioral choices (Van Duijvenvoorde, Jansen, Bredman, & Huizenga, 2012).

In fact, dual system models of decision making point to a critical role for cognitive control in adolescents' problem behavior involvement. For instance, one prominent biological theory contends that adolescents' cognitive control system is underdeveloped relative to their reward-drive (Spear, 2013; Steinberg, 2008). This developmental-lag model implicates a maturation-mismatch between a mature excitatory system and an incipient cognitive system, suggesting that adolescents cannot exert behavioral control in risky and antisocial contexts (Casey, Jones, & Somerville, 2011; Somerville, Jones, & Casey, 2010). Research findings, however, are not unequivocally supportive of "developmental mismatch" theories (e.g. Romer, 2010). As a result, some scholars argue that the control system is no less mature than the affective system. Instead, connections among control systems are simply less networked or fine-tuned, so that this mechanism for regulating dangerous and problematic behavior does not function as rapidly or as regularly as the reward system (Crone & Dahl, 2012; Luciana, 2013). However, both of these viewpoints imply that reduced cognitive control capacities contribute to adolescents' affinity for problem behavior and that determining the effect of control cognitions on behavior requires a nuanced approach.

The current study focuses on risk cognitions as a marker of how the control system curbs adolescents' problematic choices, ranging from shoplifting to violent behavior. More specifically, I address two issues that could better explicate the role of risk cognitions in these types of behaviors. First, many studies have asserted that adolescents and adults are essentially equivalent in judging risks (e.g. Knoll, Magis-Weinberg, Speekenbrink, & Blakemore, 2015, comparing youth ages 12–14 and 15–18, with young adults 19–25 and adults 26–59; Cohn, Macfarlane, Yanez, & Imai, 1995, comparing adolescents ages 13–18 with their parents ages 28–62). However, previous studies have measured risk

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cognitions derived from a perspective in which *risk probability*, or adolescents' reported likelihood of possible risk, is fundamental to choice (Slovic, 1998; Slovic, Finucane, Peters, & MacGregor, 2004). Yet a review of cognitive, public health, and criminological literatures identifies several other influential risk cognitions that research has not yet adequately examined. As a result, we do not yet know whether adolescents are less capable than older age groups when anticipating aspects of risk other than risk probability. Second, previous research generally shows only weak linkage between adolescents' risk cognitions and their problematic choices (e.g. Baumgartner, Valkenburg, & Peter, 2010; Ben-Zur & Reshef-Kfir, 2003; Goldberg, Halpern-Felsher, & Millstein, 2002). However, researchers have based these conclusions on variable-centered methods such as regression, which have focused on whether one or two risk cognitions predict problem behavior. Scholars have not yet focused on alternative methodologies to characterize how cognitions might influence decisions. Namely, contemporary decision models suggest that choices to engage in problem behavior may draw on a general, intuitive impression of risk (Quartz, 2009). Methods that treat the adolescent, rather than the variable, as the unit of analysis may best capture these intuitive risk impressions. For instance, person-centered techniques such as latent profile analysis (LPA) can help to assess whether distinct groups of adolescents can be identified through their naturalistic groupings of risk cognitions, and can assess whether these cognition profiles differentiate adolescents who engage in especially high or low levels of problem behavior (Pears, Kim, & Fisher, 2008). As a result, LPA can complement the information regression affords, and together, person- and variable-centered methods can provide more comprehensive understanding of how risk cognitions influence adolescents' choices.

The current study addresses these two issues, which research has under-explored to date. First I compare mean-level differences between adolescents and young adults on five theoretically relevant risk cognitions (risk probability, risk identification, risk tolerance, risk salience, and risk preference). Importantly, use of a young adult sample as a comparison represents a conservative test of adolescents' developmental deficits in perceiving risk, because the pre-frontal system, which is responsible for cognitive control, continues to fine-tune throughout young adulthood (Luciana, 2013). Thus, although young adults are should be less risk-averse than adults (Modecki, 2009). Second, I explore the influence of risk cognitions on behavior using two complementary approaches, variable-centered (regression) and person-centered (LPA) methods (Bates, 2000). A traditional variable-centered approach assesses direct relations between risk cognitions and problem behavior and whether the magnitude of these relations differs for adolescents versus young adults. In corresponding analyses, I take a person-centered approach to identify meaningful cognition patterns among these different age groups and test whether individuals with certain cognition patterns are more or less problem behavior involved. As a result, this study informs understanding of developmental age-group differences in risk cognitions and also how these cognitions impact youthful choices.

Which risk cognitions matter?

Faced with antisocial opportunities in the real world, adolescents estimate the probability or likelihood of possible risks (*risk probability*). Before gauging probability, however, they must also identify possible risks (*risk identification*). Further, young people likely also draw on information about their own tolerance for negative consequences (*risk tolerance*) and intuitively assess how much they care about negative outcomes should they occur (*risk salience*). Finally, adolescents arguably gauge the relative importance of possible risks in relation to possible benefits of problem behavior (*risk preference*). As a result, all of these cognitions likely inform adolescent impressions of risk. However, questions as to whether cognitions, outside of risk probability, reflect adolescents' under-estimation of risk relative to young adults remain underexplored. Further, additional research is needed to determine the degree to which risk cognitions play a role in adolescents' problem behavior, especially once other relevant factors such as perceived benefits and decision experience are taken into account (Goldberg et al., 2002; Halpern-Felsher et al., 2001). Of these five risk cognitions, the most studied involves risk probability.

First, studies that compare adolescents' *risk probability* or *likelihood* with older age groups provide mixed evidence of developmental differences. Some studies have found that adolescents (13–18) underestimate the potential risk associated with occasional involvement in problem behaviors relative to their parents (Cohn et al., 1995); whereas others studies have found no evidence that adolescents underestimate risk likelihood relative to parents (Quadrel, Fischhoff, & Davis, 1993) or relative to young adults (20–30 year olds) (Millstein & Halpern-Felsher, 2002). One potential explanation for these inconsistencies is that developmental age group differences in decision making may be less attributable to adolescents' capacity to agree with already identified risks, and more attributable to adolescents' diminished capacity to generate potential risks on their own accord (Beyth-Marom, Austin, Fischhoff, Palmgren, & Jacobs-Quadrel, 1993; Millstein & Halpern-Felsher, 2002). Thus, age group differences may not exist for risk probability, but they may exist for risk identification, as described below. Evidence also suggests that the effect of adolescents' probability judgments on behavior may be neither independent nor linear. Although research often associates probability judgments with problem behaviors, the strength of this association is typically only weak to moderate, especially when the model includes perceived benefits (Maslowsky, Buvinger, Keating, Steinberg, & Cauffman, 2011). In light of recent characterizations of decision making as a dynamic process drawing on many cognitions simultaneously (Quartz, 2009), these modest effects suggest that risk probability judgments may influence behavior mainly through joint inter-dependencies with other cognitions. That is, risk probability may pattern together in specific ways with cognitions such as risk identification, risk tolerance, risk salience, and risk preference to drive adolescent choices.

The second cognition involves risk identification. Tasks in which adolescents spontaneously identify risks (*risk identification*) may capture developmental age group differences in risk cognitions not identifiable though probability judgments (Beyth-Marom et al., 1993; Millstein & Halpern-Felsher, 2002). For example, participants have generated their own lists of potential decision-risks in a small number of developmental studies (Widdice, Cornell, Liang, & Halpern-Felsher, 2006). These studies indicate that adolescents could spontaneously identify some risks, but developmental differences did emerge. For instance, adolescents (12–18) spontaneously reported fewer negative consequences of risky decisions (e. g. attending a beer party) than their parents on roughly half of all behaviors that they have engaged in only one-time (Beyth-Marom et al., 1993). Further, in a comprehensive exploration of developmental decision competencies, young adults (college students) considered more risks and long-term consequences associated with their hypothetical decisions than adolescents (grades 6–12) (Halpern-Felsher & Cauffman, 2001). Together these findings suggest that adolescents have a diminished capacity for identifying risks relative to young adults. However, rather than directly influencing adolescents' problem behavior involvement, diminished risk identification may contribute to specific patterns of cognitions, and these distinct patterns may convey either high or low risks to adolescents. As a result, it is not only important to examine age group differences, but also to assess how risk identification patterns together with other cognitions to shape adolescents' behavioral choices. For instance, adolescents who identify few risks may also report especially high risk preference. Together, problematic cognition constellations may characterize those adolescents who are most heavily disposed toward risky and antisocial choices.

Third, possible adverse outcomes deter adolescents less than young adults (i.e., they have greater *risk tolerance*), especially when pursuing

social and emotional incentives associated with risky and antisocial activities (Modecki, 2009). As a result, several scholars have attributed adolescents' problem behavior to their reduced penchant for avoiding harm (e. g. Spear, 2013). For example, evidence gleaned from the neuroimaging literature suggests that a natural inclination to respond to aversive stimuli and avoid harm may be suppressed among adolescents (Ernst & Fudge, 2009; Ernst et al., 2005; Spear, 2011). Illustratively, studies using variations of the IOWA Gambling Task found that adolescents (10–18) have a heightened tolerance for loss relative to adults (18–30) (Cauffman et al., 2010). Several studies have also found a link between adolescents' decreased sensitivity and externalizing and other problem behaviors (Ernst et al., 2005; Goudriaan, Grekin, & Sher, 2007; Hooper, Luciana, Wahlstrom, Conklin, & Yarger, 2008). Together, these findings suggest that adolescents may have an elevated threshold for negative outcomes. Further, as with other cognitions described here, risk tolerance may not impact behavior directly, but instead may be patterned together with other cognitions to either discourage or promote adolescents' problematic choices.

Fourth, adolescents may not only differ from young adults in assessing and responding to risk, they also may differ in the degree to which they care about risk (*risk salience*) (Sturman & Moghaddam, 2011). For instance, adolescents attribute less significance to aversive cues than adults within classical conditioning paradigms, and arguably, negative consequences may be less salient to problematic choices during this developmental period (see Spear, 2011). Public health scholars have likewise attributed adolescents' problem behavior to their diminished risk salience (Fischhoff et al., 2000; Swisher & Warner, 2013). Accordingly, adolescents may literally "care less" about potential negative consequences of problem behavior. Also important to understanding the impact of risk salience on adolescent behavior is the possibility that risk salience jointly patterns with other cognitions to create an overall impression conveying either high or low risk. For instance, some adolescents may be distinguished by a cognition pattern that deems potential adverse outcomes inconsequential and this cognition pattern could help to explain their heavy problem behavior involvement (Fischhoff et al., 2000; Haynie, Soller, & Williams, 2014; Tymula et al., 2012).

Finally, adolescents' preference for risk (*risk preference*) may also embolden their problematic choices (e. g. Shulman & Cauffman, 2013; Romer, 2010). Experimentation with problem behavior is a hallmark of adolescence and adolescents rapidly accumulate a series of reinforcements, both positive and negative, for their choices. According to social development models, these positive and negative reinforcements work to cultivate adolescents' personal risk calculus or preference. Thus, risk preference may be especially influential in catalyzing adolescents' risky and antisocial choices (Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996). Moreover, risk preference is also implicated in certain dual-systems interpretations of decision making. Namely, adolescent behavior may be mediated by a personal decision algorithm that weighs possible rewards relative to potential risks (Shulman & Cauffman, 2013). Different patterns of development in their brain systems may lead adolescents to assign less value to potential risks than rewards. Accordingly, adolescents may have an especially strong affinity for risk relative to young adults. Importantly, the link between adolescents' risk preference and problem behavior may not be direct, but instead, risk preference may interact multiplicatively with other cognitions to shape adolescents' choices. Thus, for some adolescents, strong risk preference may pattern with other risk cognitions to encourage their problem behavior.

The significance of patterned cognitions

As highlighted above, recent research argues for "intuitive" conceptions of decision making. These models have described decision making as a relatively automatic process in which individuals weigh an overall impression of risk against a general impression of potential rewards (Quartz, 2009; Shulman & Cauffman, 2014). Such decisions are efficient and occur quickly but are also computationally complex because they draw on a number of pieces of information simultaneously (Quartz, 2009). Here, the underlying representation of risk (or reward), rather than a single risk cognition, plays a crucial role (Quartz, 2009). Interrelated control cognitions may thus affect adolescents' antisocial choices through an overall impression of risk (Albert & Steinberg, 2011; Boyer, 2006; Fischhoff, 2008). If this is the case, the way in which cognitions pattern together to shape adolescents' choices is as important as the direct influence of cognitions on behavior. Person-centered approaches such as latent profile analysis (LPA) can identify these patterns or constellations of cognitions within different groups of individuals (e. g adolescents versus young adults) (Bauer & Shanahan, 2007). For instance, seemingly comparable groups of adolescents may appear indistinguishable in their risk cognitions at a mean level, but may manifest very different cognition patterns. LPA captures these potential differences in patterns and characterizes the dynamic cognitive process that interweaves contextual and psychosocial inputs to affect adolescents' choices (Michels, Kropp, Eyre, & Halpern-Felsher, 2005; Slovic & Peters, 2006).

Because research has not persuasively established predicted associations between adolescents' risk cognitions and behavior, this points to a need for a comprehensive approach for considering how cognitions affect behavior. Studies that combine traditional variable-centered methods, such as regression, with person-centered analyses, such as LPA, can offer such an approach. Variable-centered approaches assess which risk cognitions influence problem behavior most strongly and whether relations differ by developmental age group (adolescents versus young adults); whereas person-centered approaches capture heterogeneity in patterns of cognitions among different age groups. These distinct cognition patterns may differentiate between adolescents who display more (or less) problem behavior. As a result, research that uses both approaches, such as the current study, can provide a more expansive picture of how risk cognitions influence adolescent choices.

Current study

Because developmental research has rarely examined more than one or two risk cognitions within a single study, we know relatively little about whether adolescents and young adults differ in judging risks. Likewise, research might better characterize how risk cognitions influence problem behavior. Specifically, the degree to which cognitions influence behavior, and whether these relations differ for adolescents versus young adults remains poorly understood. Finally, research has yet to examine how cognitions pattern together among adolescents versus young adults and whether such cognition patterns influence behavior. The current study addresses these gaps. First, I compare adolescents and young adults on five key risk cognitions (*risk probability*, *risk identification*, *risk tolerance*, *risk salience*, and *risk preference*). Second, I examine the influence of cognitions on behavior for adolescents versus young adults. In variable-centered analyses, I test whether associations between individual risk cognitions and behavior differ as a function of age-group using moderated multiple regression analyses. In person-centered analyses, I derive adolescent and young adult decision making patterns from their risk cognitions. I test the validity of these profiles by examining whether individuals characterized by certain cognition patterns are differentially problem behavior involved. Importantly, all analyses control for a number of potential confounds. For instance, prior research reports positive correlations between perceived rewards and problem behavior involvement (see Albert & Steinberg, 2011) and negative correlations between prior decision experience and perceived risk (Benthin, Slovic, & Severson, 1993; Halpern-Felsher et al., 2001). Likewise, some studies have found that female sex and greater verbal ability are associated with greater perceived risk (Fried & Reppucci, 2001). I account for these and other potential confounds that could account for age

group differences on risk cognitions or that could otherwise impact adolescents' problematic choices.

Hypothesis

H1. Relative to young adults, adolescents will discern decreased risk as measured by all five cognitions (lower risk identification, risk probability, and salience and higher risk tolerance and preference).

H2. Regression analyses will reveal few unique contributions of risk cognitions on problem behavior. Age group will moderate the relations between risk cognitions and problem behavior; relations will be stronger for adolescents versus young adults.

H3. In person-centered analyses, meaningful profiles will be derived in both adolescent and young adult samples, and profile membership will differentiate individuals who are more heavily involved in problem behavior. Given that no study to date has explored risk cognition profiles, this study has no a priori hypotheses about numbers of profiles the analyses will reveal. Further, reflecting developmental differences, adolescents and young adults will not necessarily be characterized by the same number of profiles.

Methods

Participants

Adolescents and young adult attending schools in a northeastern US state participated in the current study. The adolescent sample was drawn from a large public high school in an industrial/suburban area with a state-average household income. The young adult sample consisted of undergraduates attending the largest public university in the state. In line with previous developmental decision making research (Beyth-Marom et al., 1993; Gardner & Steinberg, 2005; Millstein & Halpern-Felsher, 2002), I contrasted these samples to better explain developmental age group differences. Developmentally, individuals in these two age groups should differ not only in terms of maturation, but also in their norms, roles, and social contexts (Modecki, 2008). Therefore, grouping according to these distinct age-related stages makes theoretical sense. I implemented two controls for the fact that samples may differ on characteristics apart from age that could impact findings. First, to control for academic functioning, which may be higher in college students, I dropped high school students with average grades lower than a C average from the sample ($n = 15$). The sample retains young adult individuals with lower high school grades to provide a more conservative test for demonstrating that cognition differences are developmental and not a selection effect due to higher academic functioning among young adults. I also re-ran analyses to exclude adolescents whose parents never attended college to control for SES factors. All results were substantively similar to those reported here.

The adolescent sample (ages 12–18) consisted of 225 ($M_{age} = 15.61$; $SD = 1.37$) students enrolled in a public high school. The school was selected from an industrial/suburban area with an average household income equal to the state-average. The adolescent sample was 50.9% female, and 77% of adolescents were Caucasian, a lack of racial diversity that reflects the demographics of the New England state in which students reside. Nearly one-third of adolescents (31.4%) reported their parents had a high-school level of education or less, with the remainder attending at least some college and 21.7% with a 4-year undergraduate degree or more.

The young adult sample (ages 18–23) consisted of 275 ($M_{age} = 18.42$; $SD = .88$) undergraduates at a state university. The young adult sample was 57.7% female and 95.3% Caucasian. Most young adults' parents (90.2%) had some college and almost one-quarter (23.6%) reported their parents had earned a 4-year undergraduate degree or more.

Procedure

Appropriate IRB approval was obtained through the University, which allowed for informed assent from adolescents and passive consent from their parents. All students gave informed assent and no parents objected to the study. Students were told that their participation and responses would not affect their academic status, and were given a debriefing form upon completion of the survey. Young adults received class credit.

Measures

Table 1 presents bivariate correlations between key study measures.

Risk cognitions

Risk cognitions were based on participant responses across three decision scenarios adapted from Ford, Wentzel, Wood, Stevens, and Siesfeld, (1990) and O'Conner, Archer, and Wu (1992). These scenarios depict cheating on a competency exam for school or work, shoplifting, and an aggressive encounter in a movie theater. An example vignette is: "You're out shopping with some of your close friends and they decide to take some clothing without paying for it. You don't think it's a good idea, but they say you should take something too." Following each vignette, participants answered a series of questions to tap risk cognitions related to the depicted problem behavior. Items relevant to each risk cognition were averaged across the three scenarios. Table 2 describes cognition means and standard deviations for adolescents and young adults.

Risk identification

Following each vignette, participants were asked to list all possible risks they might consider, for example: "When you are deciding what to do, what are the reasons that would make you decide NOT TO take the clothing? Please list as many as you think of." Example responses included "Embarrassing if I get caught;" "Could set the alarm off;" and "Lose my parents trust." Participants were also asked to generate all of the reasons that would make them decide TO take the clothing (the covariate section discusses *Perceived Rewards*) and the order of presentation for risk identification and perceived rewards was counterbalanced across vignettes. Identification measures were based on Halpern-Felsher and Cauffman (2001) and previous research (Modecki, 2009) shows this measure is related to criminal behavior and psychosocial variables such as sensation seeking and future orientation.

Research teams consensus coded responses after establishing agreement with the principal investigator on $n = 60$ surveys. An additional 10% of surveys were cross-coded for inter-group reliability; % agreement = 94; Kappa = 92.97. Participants received a score of (1) for each listed risk. Risks were summed within each vignette and a higher score indicates greater risk identification. Risk identification was significantly correlated with a standardized risk perception scale[1] ($r = .321$, $p < .001$).

Risk probability

Items adapted from Fried and Reppucci (2001) were used to tap the perceived probability of negative consequences if the participant chose to engage in problem behavior. The measure included three five-point Likert scale items measuring perceived chances of getting caught by an authority figure, being found guilty of breaking a rule/law, and experiencing punitive consequences (e.g. school suspension or

[1] The study included a standardized Risk Perception Scale (RPS; Siegel et al., 1994) in order to assess the validity of risk cognitions. The RPS asks participants to rate the perceived risk of eighteen different problem behaviors, for example, "smoking marijuana," and "having sex without a condom" on a nine-point Likert scale from 0 "Not at all risky" to 8 "Extremely risky;" Cronbach's $\alpha = .91$.

Table 1
Bivariate correlation coefficients for risk cognitions and problem behavior.

	Risk identification	Risk probability	Risk tolerance	Risk salience	Risk preference	Problem behavior
Risk identification	1	.25***	−.12	.44***	−.56***	−.16*
Risk probability	.16**	1	−.16*	.42***	−.27***	−.25***
Risk tolerance	−.18**	−.12	1	−.11	.14*	.16*
Risk salience	.19**	.44***	−.31***	1	−.44***	−.43***
Risk preference	−.44***	−.24***	.37***	−.29***	1	.39***
Problem behavior	−.14*	−.23***	.22***	−.25***	.33***	1

Note. Adolescent bivariate correlations are above the midpoint; young adult bivariate correlations are below the midpoint.
Problem behavior is square root transformed.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

spending time in a detention facility). The scale ranged from 1 "Very unlikely" to 5 "Very likely" so that higher scores indicate higher perceived risk probability; Cronbach's α = .73. Results found a positive association between risk probability and standardized risk perception ($r = .34$, $p < .001$).

Risk tolerance

One item tapped risk tolerance for each of the three vignettes. This item was derived from prior research by Guerra and Slaby (1989) and read, for example: "How likely would it have to be that you'd get caught for you to decide NOT to (steal the clothes)?" Participants received a ruler-scale ranging from 0% to 100% and the instruction to mark an X along the provided scale. A high score indicates a high risk threshold; Cronbach's α of .72. Because of the large amount of variance on this measure relative to other scales in the latent profile analysis, this item was transformed by multiplying by .3 to reduce variance. Risk tolerance was negatively associated with standardized risk perception ($r = -.13$, $p = .004$).

Risk salience

One item from each vignette tapped risk salience, modified from Guerra (1989). Participants were asked to indicate how much they would care if they were caught engaging in the antisocial activity, on a four point scale from (1) "Not at all" to (4) "Very much," with a higher score indicating greater risk salience; Cronbach's α = .72. Risk Salience was positively correlated with standardized risk perception ($r = .50$, $p < .001$).

Risk preference

One item from each vignette tapped risk preference and was based on Fried and Reppucci (2001), in which the total number of perceived rewards (discussed below: % agreement = 93%, Kappa = .90) within each scenario was divided by the total number of perceived risks (% agreement = 94%, Kappa = 92.97). A higher score indicates a greater risk preference. Fried and Reppucci report that this is a valid indicator of risk preference and in their study, it correlated positively with a standardized risk preference scale (Benthin et al., 1993). In the current study, risk preference was significantly correlated ($r = -.38$, $p < .001$) with standardized risk perception.

Table 2
Adjusted and unadjusted age group means for risk cognitions.

Risk cognition	Age group	Mean (SD)	Adjusted mean[1] (SE)
Risk identification	Adolescent	2.20(1.01)[c]	2.32(.06)[a]
	Young Adult	2.76(.86)[d]	2.64 (.06)[b]
Risk probability	Adolescent	2.97(.69)[c]	2.94(.04)[a]
	Young Adult	2.92(.57)[d]	2.97(.04)[a]
Risk tolerance	Adolescent	1.34(.76)[c]	1.33(.06)[a]
	Young Adult	1.14(.76)[d]	1.12(.06)[b]
Risk salience	Adolescent	3.17(.74)[c]	3.22(.04)[a]
	Young Adult	3.55(.52)[d]	3.51(.04)[b]
Risk preference	Adolescent	1.15(.92)[c]	1.11(.04)[a]
	Young Adult	.88(.39)[d]	.89(.04)[b]

Note. Mean (*SD*).
Adjusted means with different letters differ at the $p < .01$ level
[1] Mean for randomly selected sub-sample of $n = 202$ adolescents and $n = 202$ young adults, adjusted for sex, ethnicity, SES, grade average for last year of high school, verbal ability, decision experience, and perceived rewards.
[c] n = 207
[d] n = 271

Covariates

All analyses controlled for the dichotomous variables of sex, ethnicity (Caucasian = 0, ethnic minority = 1), SES, grade average for most recent year of high school, verbal ability, decision experience, and perceived rewards. Sex and ethnicity were treated as dichotomous variables and the remaining covariates were treated as continuous. Previous research (Albert & Steinberg, 2011; Benthin et al., 1993; Fried & Reppucci, 2001; Halpern-Felsher et al., 2001; Millstein & Halpern-Felsher, 2002; Song et al., 2009) or theoretical assumptions support the use of these control variables. With the goal of equating age-groups on likelihood of attending post-secondary education, SES and high school grades were also included as covariates.

SES was measured based on parents' mean education level, from (0) Less then high school to (7) graduate/professional degree. Participants also reported their grade average for their most recent year of high school. For adolescents this refers to their last full year of school and for young adults this refers to their senior year of high school. Response options ranged from (1) All As to (9) All Fs. Analyses do not include adolescents with less than a C- average. Average grade for adolescents was $M = 2.53$, $SD = 1.15$ and for young adults was $M = 2$, $SD = .65$ where (2) = All As and Bs and (3) = all Bs.

Verbal ability

To control for differences in verbal ability, all participants completed the verbal subscale of the Wechsler Intelligence Scale for Children (Wechsler, 1991). For both adolescents and young adults, the measure was read aloud to an entire class of participants, who were asked to write their best definition for each word. Responses were scored by the principal researcher. $M_A = 40.25$, $SD_A = 7.06$; $M_{YA} = 45.02$, $SD_{YA} = 4.07$. Verbal ability was strongly correlated with average grades ($r = -.45$, $p < .001$) and level of education ($r = .45$, $p < .001$).

Decision experience

An item developed by Weinstein (1987) assessed experience making decisions from each vignette, asking, "About how much experience do you have with this type of decision?" Participants could endorse as many items as applied from a five-item scale that ranged in level of experience. Thus, items included, for example, (1) "I don't know anyone this has happened to" (3) "Close friends or family have had to make this kind of decision" and (5) "Has happened to me more than once." An average of the three highest responses, that is, the three responses that reflected the greatest level of exposure to each decision, was taken for each vignette. As a result, a higher score on this scale indicates more decision experience; Cronbach's α = .91. $M_A = 3.40$, $SD_A =$

1.04; $M_{YA} = 3.36$, $SD_{YA} = .86$. Decision experience was positively related to self-report problem behavior ($r = .38$, $p < .001$).

Perceived rewards

Perceived rewards were also assessed in relation to each decision vignette (e. g. Halpern-Felsher & Cauffman, 2001). Within each scenario, participants were asked "When you are deciding what to do, what are the reasons that would make you decide TO take the clothing? Please list as many as you think of." Example responses included "Will make me more accepted;" "fun;" and "I get to look good." Participants received a score of (1) for each listed reward. Rewards were summed within each vignette, so a higher score indicates greater perceived rewards. Percent agreement = .93% Kappa = .90. $M_A = 2.01$, $SD_A = .93$; $M_{YA} = 2.27$, $SD_{YA} = .90$. Perceived rewards was negatively correlated with standardized risk perception ($r = -.13$, $p = .004$).

Decision making outcome

Problem behavior

Elliott and Ageton (1985) self-report delinquency scale was used to measure problem behavior. This scale asks, for example, "How many times in the last year have you (Taken a vehicle for a ride (drive) without permission)." The scale consists of 45 items and measures risky, delinquent, and aggressive behavior and substance use. Five status behaviors were dropped from the analysis because they would be illegal for adolescents but not for young adults (e. g skipping school); therefore the total score reflects whether an individual engaged in 40 problem behaviors. A high score indicates participation in a wide range of problem behaviors; Cronbach's $\alpha = .92$. $M_A = 6.46$, $SD_A = 6.60$; $M_{YA} = 4.75$, $SD_{YA} = 4.28$. Adolescents engaged in significantly more problem behavior than young adults ($t(350.58) = -3.13$, $p = .001$). The measure was non-normally distributed, with skewness of 1. 98 ($SE = .11$). Thus, problem behavior was either treated as a count variable (using a negative binomial distribution in regression) or else was square root transformed, resulting in a skewness of .13 ($SE = .11$) (as an auxiliary variable in LPA).

Analytic strategy

To identify developmental age group differences in theoretically relevant risk cognitions, I ran a multivariate analysis of co-variance (MANCOVA). The MANCOVA tested for age group and sex differences between adolescents and young adults on the five risk cognitions (risk probability, risk identification, risk tolerance, risk salience, and risk preference) controlling for important covariates that could also explain age group differences on perceived risk. Next, two complementary analyses assessed how cognitions influence behavior. First, I ran a moderated regression to test whether the relations between risk cognitions and behavior significantly differed according to age group. Second, to identify risk cognition *patterns* within both age groups, I ran latent profile analyses (LPA). LPA is a person-centered statistical technique that assigns individuals to one mutually exclusive latent profile based on a number of observed continuous and categorical variables of interest (McCutcheon, 1987). These profiles are then characterized based on common response patterns within and between the profiles. Conducting the LPA analyses separately for adolescents and young adults allowed me to test whether cognitions pattern together to form meaningful constellations among these different age groups. Cognition profiles were then tested to determine whether, for instance, adolescents who belonged to different profiles were differentially involved in problem behavior. Although age group differences in cognition profiles was of theoretical interest, it was not feasible to run multi-group models to directly test differences between profiles because the adolescent and young adult samples were not characterized by the same number of profiles (Muthén, 2014).

The MANCOVA was run in SPSS v. 22 and the moderated regression and LPA were run in Mplus version 7 with full information maximum likelihood estimation (FIML) (Muthén & Muthén, 2012). Within the LPA's, the probability of an individual belonging to a specific profile and their categorization in that profile was calculated as a function of the scores on all five risk cognitions. Estimates of associations between indicators and the latent profiles were represented as means (e. g., average value for risk salience for adolescents in a specific profile). Based on the assumption that profiles would differ in their variability, models were specified with indicator variances free to vary across latent profiles but with covariances constrained to zero. To determine whether the characteristics of the profiles were significantly different across indicators, the equality of means for each indicator was compared across latent profiles using the Wald's model test. In validation analyses, covariates were accounted for by including them in the model command and regressing them on the profiles. Doing so did not significantly impact shape or membership of the profiles. In validation analyses, profile differences for outcomes not included in the model (problem behavior) were tested using the AUXILIARY option with the e-setting in Mplus (Muthén & Muthén, 2012). This approach uses pseudo class draws to form Wald chi-square tests for mean comparisons (Clark & Muthén, 2009). In the pseudo class method, multiple random draws are made from each person's posterior probability distribution to determine their profile membership. Having a number of random samples allows individuals to switch into adjacent profiles and gives a feel for the variability related to the distribution (Clark & Muthén, 2009). Mean tests are then computed based on these draws. Using class membership as an observed variable results in incorrect standard errors because the analyses fail to take uncertainty of classification into account (Clark & Muthén, 2009). As a result, the pseudo-class draws method represents an improvement over assigning individuals to a latent profile based on their highest posterior probability of being in a given class.

Results

Aim 1: developmental differences in decision making

First, I assessed age group and sex differences on the five risk cognitions through a MANCOVA using age group (adolescent or young adult) and sex (male or female) as the independent variables, the five risk cognitions (risk probability, risk identification, risk tolerance, risk salience, and risk preference) as the dependent variables, and sex, ethnicity, SES, grade average, verbal ability, and perceived benefits, and decision experience as the covariates. Box's M test of Equality of Covariances Matrices had a significant result, so, following Tabachnick and Fidell (2007), I equalized sample sizes for these analyses by random sampling of cases (n = 101) for each cell (age group by sex) within SPSS. Results showed sufficient homogeneity of regression for the analysis. Follow-up ANCOVAs were assessed for significance based on a Bonferroni correction ($\alpha = .05/5 = .01$).

Risk cognitions were significantly related to age group and the strength of this association was moderate (multivariate $F(5, 390) = 6.32$, Pillai's Trace = .08, $p < .001$, $\eta 2 = .08$). Significant univariate differences were found with small effect sizes for risk identification ($F(1,394) = 12.28$, $p = .001$, $\eta 2 = .03$), risk tolerance ($F(1, 394) = 6.98$, $p = .009$, $\eta 2 = .02$), risk salience ($F(1, 394) = 20.79$, $p < .001$, $\eta 2 = .05$), and risk preference ($F(1, 394) = 11.81$, $p = .001$, $\eta 2 = .03$), but not for risk probability ($F(1, 394) = .19$, $p = .67$, $\eta 2 = .001$). As Table 2 reflects, differences in risk perceptions were in the expected direction and adolescents reported lower risks than young adults on each of these cognitions.

Risk cognitions were also significantly related to sex (multivariate $F(5, 390) = 6.85$, Pillai's Trace = .08, $p < .001$, $\eta 2 = .08$). Significant univariate differences were found with small effect sizes for risk identification ($F(1,394) = 16.51$, $p < .001$, $\eta 2 = .04$), risk salience ($F(1, 394) = 17.64$, $p < .001$, $\eta 2 = .04$), and risk preference ($F(1, 394) = 10.07$, $p = .002$, $\eta 2 = .03$), but not for risk tolerance ($F(1, 394) = 1.91$, $p = .168$, $\eta 2 = .01$) or risk probability ($F(1, 394) = 1.49$, $p =$

.22, η2 = .004). Male participants identified fewer risks, experienced risks as less salient, and reported greater risk preference relative to female participants. However, risk cognitions were not significantly related to the interaction between age group and sex (multivariate $F(5, 390) = 1.48$, Pillai's Trace = .02, $p = .195$,1, η2 = .02).

Aim 2: the impact of cognitions on behavior

Variable-centered analyses

In variable-centered analyses, I ran a series of moderated regression analyses to assess whether the relations between risk cognitions and problem behavior differed for adolescents versus young adults. These analyses included the covariates (sex, ethnicity, SES, average grades, verbal ability, age, perceived benefits, and decision experience) all five risk cognitions, and an interaction term comprised of each risk cognition × age group.[2] I ran analyses in Mplus with problem behavior modeled as a count variable with a negative-binomial distribution.

Table 3 describes the results of the regression analyses. In the overall model, risk identification ($b = -.15$; $SE = .06$) risk tolerance ($b = .12$; $SE = .05$) and risk salience ($b = -.26$; $SE = .07$) were significantly associated with problem behavior, beyond the effects of the covariates. As Table 2 also shows, the link between age group and problem behavior was significantly moderated by risk salience ($b = -.32$; $SE = .14$). Probing the interaction showed that risk salience significantly predicted problem behavior for adolescents ($b = -.49$; $SE = .12$, $p < .001$) but not young adults ($b = -.07$; $SE = .13$, $p = .59$). The interaction was plotted with square-root transformed problem behavior as the dependent variable using ModGraph (Jose, 2013). Fig. 1 describes the form of the interaction. Greater risk salience was associated with diminished problem behavior involvement for adolescents, but there was no relation between risk salience and problem behavior for young adults.

Person-centered analyses

In complementary person-centered analyses, I ran two LPA's (for adolescents and for young adults) to derive latent decision making profiles from the five risk cognitions. To ensure that profiles were meaningful, stable, and not over-extracted, the decision was made a priori to exclude solutions with profile sizes comprised of less than 5% of the total sample, which is consistent with prior research (see Roesch, Villodas, & Villodas, 2010 for a discussion of profile size and over-extraction). For instance, as class proportions approach zero, small profile sizes can be a sign of class collapsing and over-extraction (Masyn, 2013). The LMR LRT (Lo, Mendell, & Rubin, 2001) and the bootstrapped likelihood test (McLachlan, 1987) were also used to compare a given estimated model versus a model that had one fewer class. For these tests, a small *p*-value supports retention of a more complex model. I also consulted the Bayesian Information Criterion (BIC; Schwarz, 1978), with lower BIC indicating improved fit. Finally, I considered model parsimony, interpretability, and profile size in determining the final model.

Adolescents

For adolescents, as the top of Table 4 shows, the three-profile solution emerged as the best fit for the data. The LMR LRT and the bootstrapped likelihood test indicated a significant improvement in model fit for the three-class versus two-class solution, as signified by a small *p*-value. However, the tests were non-significant for the four-class versus three-class solution, indicating the three-class solution should be retained. The BIC also pointed to the three-profile solution as the preferred model, given the lower BIC value. The top of Fig. 2 shows the three-profile solution. The profiles consist of 71, 126 and 30 individuals, with good model entropy (entropy = .81; Clark & Muthén, 2009).

[2] Analyses were also run with age as the moderating variable and controlling for level of education. Results were similar to those reported here.

The top of Table 5 describes the three adolescent cognition profiles: *High Probability/High Salience* (29% of the sample), *Moderate Identification/Moderate Salience* (57% of the sample), and *Low Identification /High Preference* (14% of the sample). Adolescents in the *High Probability/High Salience* profile (very likely sanctions for problem behavior and caring a great deal about possible sanctions) were characterized by significantly greater risk identification, risk probability, risk salience, and risk preference than those in either the *Moderate Identification/Moderate Salience* profile or the *Low Identification/High Preference* profile. Adolescents in the *Moderate Identification/Moderate Salience* profile (spontaneously detect moderate amount of risks and care moderately about possible sanctions) were characterized by greater risk identification and salience, and lower risk preference than those in the *Low Identification/High Preference* profile, but both groups were similarly lower in risk identification than the *High Probability/High Salience* profile. Finally, significantly lower risk cognitions relative to the other two profiles across the board, with the exception of risk tolerance, differentiated adolescents in the *Low Identification/High Preference* profile (spontaneously identify few or no risks and benefits greatly outweigh risks). A significantly greater risk preference relative to youth in the other two profiles also typified adolescents in this *Low Identification/High Preference* profile. Multivariate Wald's tests examined individual differences between the three profiles, and indicated that there were significant differences in grade average, Wald's $X^2(2) = 10.08.$ 33, $p = .006$, such that *Low Identification/High Preference* adolescents had poorer grades on average ($M_{ave\ grade} = 3.17$; SE = .22) than *Moderate Identification/Moderate Salience* adolescents ($M_{ave\ grade} = 2.51$; SE = .10) or *High Probability/High Salience* ($M_{ave\ grade} = 2.33$; SE = .15). However, there were no differences across profiles based on verbal ability, ethnicity, sex, or SES.

Analyses examined whether adolescents' cognition profiles were associated with differences in problem behavior (square root transformed), after accounting for demographic factors, decision experience and perceived rewards. Adolescent profiles differed on problem behavior involvement, Wald's $X^2(2) = 18.74$, $p < .001$. Post–hoc tests revealed that *High Probability/High Salience* adolescents engaged in less problem behavior ($M_{pb} = 1.46$, SE = .19) than *Moderate Identification/Moderate Salience* adolescents ($M_{pb} = 2.13$, SE = .12) or *Low Identification/High Preference* adolescents ($M_{pb} = 3.09$, SE = .28). *Moderate Identification/Moderate Salience* adolescents also reported less problem behavior than *Low Identification/High Preference* adolescents.

Young adults

For young adults, a two-profile solution best fit the data, as the bottom of Table 4 shows. The LMR LRT and the bootstrapped likelihood test indicated a statistically significant improvement in model fit for the two-class versus the one-class solution. However, the tests were non-significant for the two-class versus three-class solution. Moreover, although the BIC continued to decrease in the three-class solution, the three-class solution resulted in a model with a class comprised of less than 4% of the total sample, indicating a likely over-extraction of classes (Masyn, 2013). The bottom of Fig. 2 shows the preferred two-profile solution, and the profiles consist of 138 and 137 individuals. Model entropy was acceptable (entropy = .74; Clark & Muthén, 2009).

The bottom of Table 5 describes the two profiles that characterized young adults, *High Identification/High Salience* (50% of the sample) and *Moderate Identification/Moderate Salience* (50% of the sample). Young adults in the *High Identification//High Salience* profile (spontaneously detect many risks and care a great deal about possible sanctions) were characterized by significantly greater perceived risk on all indices relative to young adults in the *Moderate Identification/Moderate Salience* profile. That is, relative to those in the *Moderate Identification/Moderate Salience* profile (spontaneously detect moderate amount of risks and care moderately about possible sanctions), *High Identification//High Salience* young adults reported significantly higher risk identification,

Table 3
Summary of moderated regression analyses for risk cognitions predicting problem behavior for adolescents versus young adults.

	Model 1			Model 2	Model 3	Model 4	Model 5	Model 6
Variable	B	SE B	B	B	B	B	B	B
Age group	.04	.08	.44	.41	.43	.34	.44	.48
Sex	.36	.08	4.66***	4.60***	4.66***	4.66***	5.01***	4.76***
Ethnicity	.05	.13	.36	.34	.35	.41	.38	.54
Ses	.05	.03	2.18*	2.18*	2.19*	2.22*	2.38*	2.22*
Average grade	.16	.05	3.21**	3.19**	3.22**	3.21**	2.97**	3.16**
Verbal ability	−.01	.01	−.98	−1.07	−.99	−1.0	−1.07	−.97
Benefits	.31	.06	5.03***	4.66***	5.01***	4.93***	5.42***	5.05***
Decision experience	.31	.05	6.37***	6.30***	6.39***	6.28***	6.45***	6.38***
Risk identification	−.15	.06	−2.43*	−2.26*	−2.43*	−2.43*	−2.65**	−2.81**
Risk probability	−.09	.07	−1.26	−1.26	−1.23	−1.23	−1.28	−1.24
Risk tolerance	.12	.05	2.43*	2.33*	2.44*	2.40*	2.81**	2.62**
Risk salience	−.26	.07	−3.70***	−3.81***	−3.70	−3.74***	−2.82**	−3.58***
Risk preference	−.12	.07	−1.65	−1.14	−1.65	−1.68	−2.21*	−2.39*
Risk identification × age group				1.19				
Risk probability × age group					−.23			
Risk tolerance × age group						.70		
Risk salience × age group							−2.39*	
Risk preference × age group								1.63
BIC	2547.42			2552.45	2553.54	2553.15	2547.89	2551.70

Note. Age group: 0 = young adult, 1 = adolescent; sex = 0 = female, 1 = male. Ethnicity: Caucasian = 0, other ethnicity = 1; SES is a proxy based on own and partner's or both parents' education level. Average grade is scored such that higher grades are equated with lower numbers. Problem behavior is modeled based on a negative-binomial distribution.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

risk probability, and risk salience and significantly lower risk tolerance and risk preference. Multivariate Wald's tests indicated significant differences in sex across profiles Wald's $X^2(1) = 8.64$, $p = .003$, such that *High Identification/High Salience* young adults were more likely to be female ($M_{sex} = 1.67$, $SE = 0.04$) than young adults in the *Moderate Identification/Moderate Salience* profile ($M_{sex} = 1.48$. $SE = .05$). Profiles did not differ according to verbal ability, ethnicity, SES, or grade average. Validation analyses for the young adult profiles indicated differences on problem behavior (square root transformed); (Wald's $X^2(2) = 24.45$, $p < .001$). *High Identification/High Salience* young adults reported less problem behavior ($M_{pb} = 1.56$, SE = .09) than *Moderate Identification/Moderate Salience* young adults ($M_{pb} = 2.24$, SE = .09).

Discussion

Social scientists agree that adolescents' reduced cognitive control capacities are implicated in their heavy problem behavior involvement (Romer, 2010). Despite the intuitive appeal of this explanation, previous research has found inconsistent evidence that adolescents underestimate risks relative to (young) adults. As a result, researchers, practitioners, and parents may still wonder whether risk estimation affects teenagers' antisocial choices. The results of this study arguably suggest that yes, risks do matter for adolescents' problem behavior involvement and they matter in a couple of important ways. First, adolescents generally under-appreciate risks. Second, risk cognitions are inter-dependent

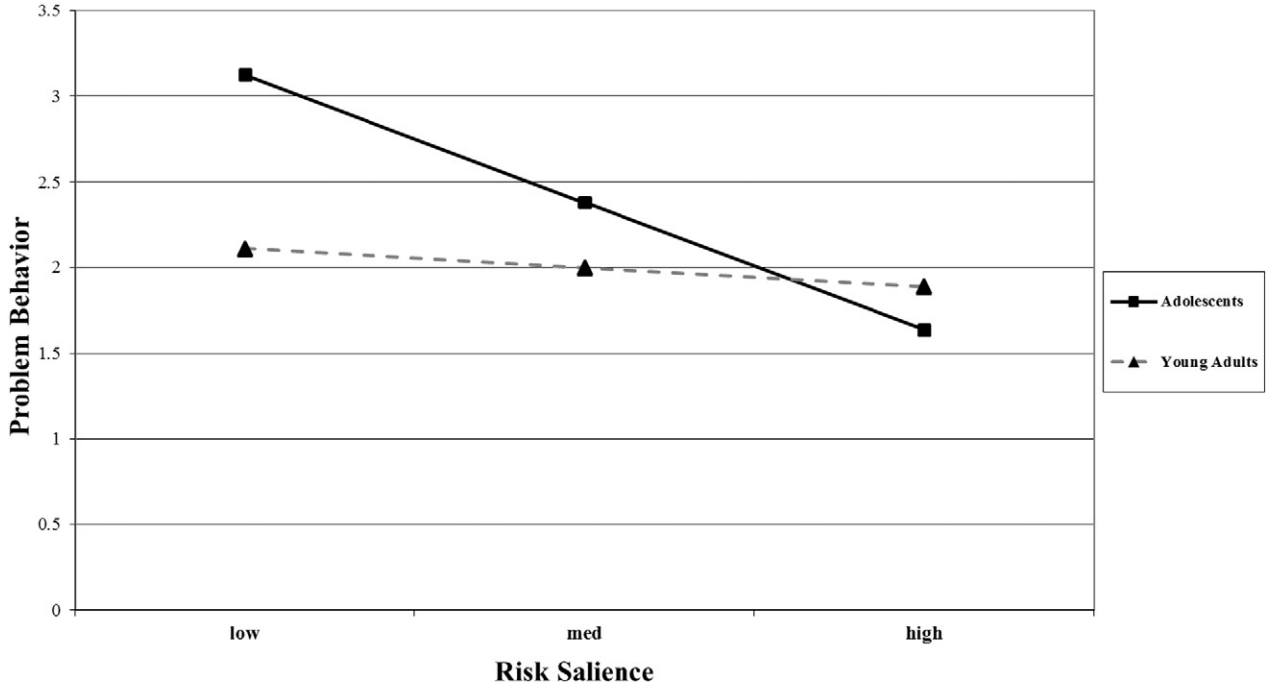

Fig. 1. Risk salience × age group interaction predicting problem behavior.

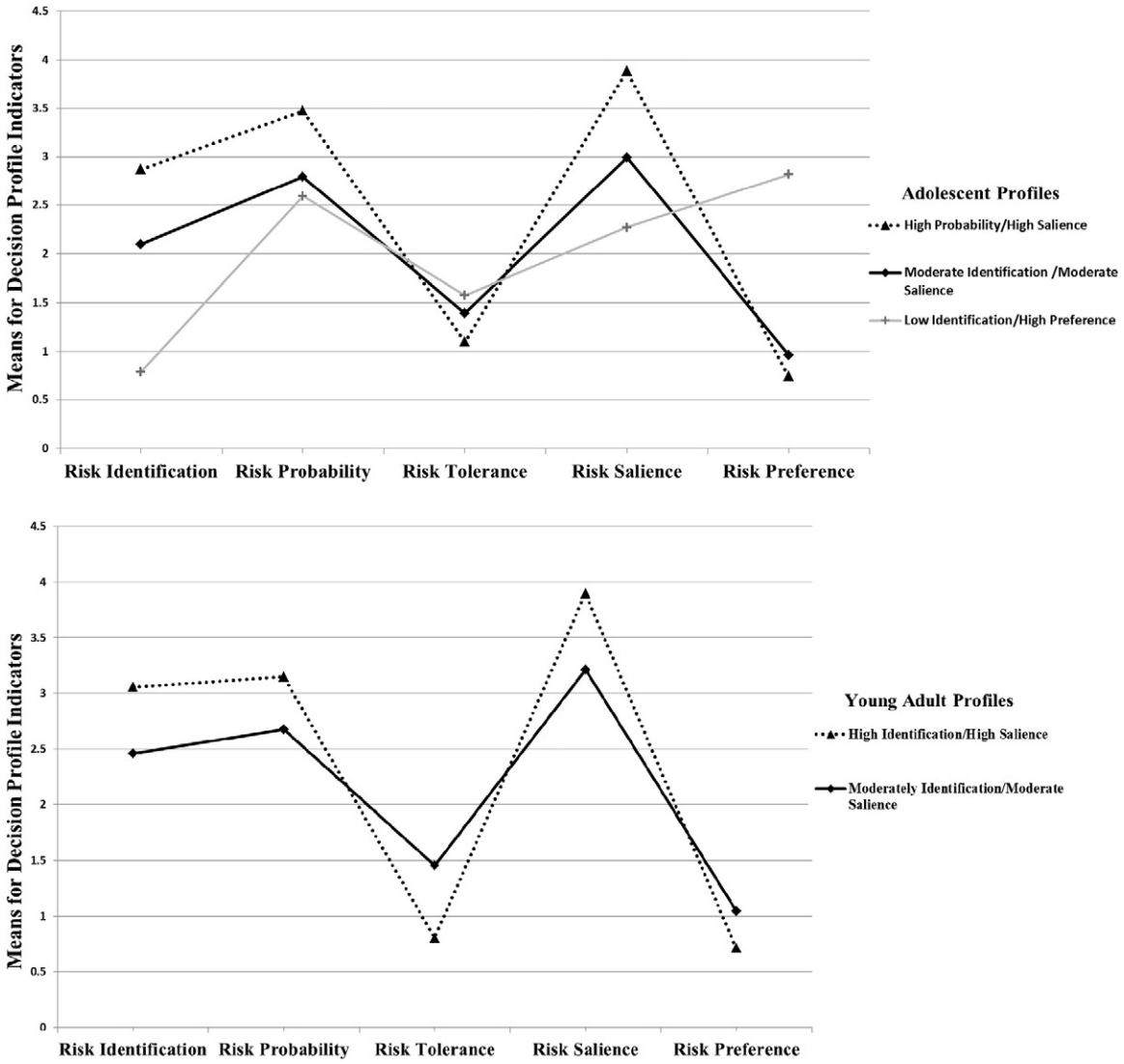

Fig. 2. Adolescent and young adult cognition profiles.

and multiple risk cognitions work together to predict problem behavior involvement, regardless of age. In this study, adolescents discerned decreased risk relative to young adults as measured by four out of five theoretically relevant risk cognitions. In fact risk probability judgments, which have been the mainstay of previous research, was the only cognition on which adolescents and young adults did not differ. Moreover, risk probability did not independently influence problem behavior, net of other cognitions and covariates. Importantly, cognitions also patterned together in different ways among adolescents versus young adults. Specifically, in this study a unique maladaptive cognition profile characterized adolescents but not young adults, *Low Identification/High Preference*. Adolescents who belonged to this maladaptive profile were particularly poor at identifying risks and were also the most heavily problem behavior involved. Thus, risk cognitions do matter. However, future studies need to broaden the scope of cognitions that are measured and consider that cognitions may work as a summation of their inter-related influences, rather than through independent effects.

Table 4
Model fit comparisons classes 1 to 4.

	BIC	VLMR *p*	LMR *p*
Adolescents			
Class 1	2802.94		
Class 2	2507.05	< .001	< .001
Class 3	2411.22	.0001	.0001
Class 4	2418.56	.10	.11*
Young Adults			
Class 1	2535.00		
Class 2	2319.55	.0003	.0003
Class 3	2308.90	.05	.052*

Note. BIC = Bayes Information Criteria; VLMR = Vuong–Lo–Mendell–Rubin likelihood ratio test; LMR = Lo–Mendell–Rubin likelihood ratio test.
p-values correspond with tests comparing the estimated model (number of profiles on the same line) versus a model that has one less class (number of profiles on the line above). A small *p*-value supports retention of the more complex model.
* Solution resulted in an over-extracted profile with less than 5% of participants.

Previous work has explored developmental differences in risk cognitions mainly through the use of probability judgments (Slovic, 1998; Slovic et al., 2004). Based on risk probability judgments, many studies have concluded there are few age differences in perceived risks. However, the literature has largely overlooked other important cognitions on which adolescents and young adults might differ. This investigation examined developmental differences in a total of five risk cognitions identified within the research literature as potentially important to adolescent decision making, risk probability, risk identification, risk tolerance, risk salience, and risk preference. Findings indicated that adolescents differed from young adults on four of these five cognitions, albeit with small effect sizes. Specifically, adolescents identified fewer risks, had a higher tolerance for negative consequences, cared less about

Table 5
Characteristics of profiles.

Adolescent indicators	High probability/high salience (28.93%)	Moderate identification/moderate salience (57.30%)	Low identification/high preference (13.77%)
Risk identification	[a]2.87(1.10)	[b]2.10(.71)	[c].79(.45)
Risk probability	[a]3.47(.67)	[b]2.80(.58)	[b]2.59(.52)
Risk tolerance	[a]1.10(.89)	[a]1.39(.64)	[a]1.58(.82)
Risk salience	[a]3.89(.16)	[b]2.99(.59)	[c]2.27(.80)
Risk preference	[a].75(.31)	[b].96(.35)	[c]2.82(1.59)
Young adult indicators	**High identification/high salience (49.81%)**	**Moderate identification/moderate salience (50.19%)**	
Risk identification	[a]3.05(.90)	[b]2.46(.71)	
Risk probability	[a]3.15(.54)	[b]2.68(.51)	
Risk tolerance	[a].80(.69)	[b]1.45(.69)	
Risk salience	[a]3.90(.16)	[b]3.21(.52)	
Risk preference	[a].71(.27)	[b]1.04(.42)	

Note. Manifest indicators that do not share a superscript (i.e., within row) are significantly different at $p < .001$.

possible negative consequences, and had a greater preference for risk than young adults. Adolescents could gauge the probability or likelihood of risks that the researcher provided just as well as young adults. These findings suggest that adolescents under-appreciate risk and risk-related consequences, and their attenuated risk perspective may help to explain adolescents' affinity for problem behavior.

To better understand the role of cognitions in problem behavior, this study took two complementary approaches. First, variable centered-analyses assessed whether risk cognitions exert an independent effect on behavior, net of other cognitions and covariates such as perceived benefits and decision experience. Of the five cognitions, risk identification, risk tolerance, and risk preference predicted problem behavior for the entire sample. Again, risk probability, the cognition most prior research has assessed, did not exert a significant independent effect. Further, moderated regression results indicated that the effect of risk salience on problem behavior significantly differed by age group. More specifically, lower risk salience predicted greater problem behavior involvement among adolescents but not young adults, suggesting that diminished risk salience may play a previously overlooked role in adolescents' risky and antisocial choices. This is important because if adolescents simply do not care about possible risks, interventions targeting risk perceptions in order to reduce antisocial behavior will likely fail. Indeed, scholars have argued that prevention programs need to consider the possibility of results such as these, which point to the prospect that different risk cognitions may impel different groups of individuals toward problem behavior involvement (Donohew et al., 2000).

Scholars have also argued that different individuals may draw on different cognitive *heuristics* when deciding to engage in problem behavior (Donohew et al., 2000). To test this notion, a complementary, person-centered approach to analyses was taken. These person-centered analyses tested whether discrete constellations of risk cognitions characterized distinct groups of individuals, highlighting the possibility of complex and non-linear associations between cognitions (Beadnell et al., 2005). Indeed, recent characterizations of decision making make it clear that individuals draw on numerous cognitions simultaneously, which combine to generate an overall impression of risk (e. g. Shulman & Cauffman, 2014; Slovic et al., 2004). By identifying particular constellations of cognitions among individuals, rather than focusing on single variables, this study identified substantive cognition patterns.

Specifically, among adolescents, the analysis identified three profiles (*High Probability/High Salience*; *Moderate Identification/Moderate Salience*; and *Low Identification/High Preference*). Among young adults, only two profiles were identified (*High Identification/High Salience*; *Moderate Identification/Moderate Salience*). These young adult profiles closely resembled adolescents' two most protective risk cognition patterns in shape. Thus a particularly maladaptive cognition profile, *Low Identification/High Preference* (spontaneously identified few or no risks and benefits greatly outweighed risks), only characterized adolescents. This maladaptive cognition profile was especially notable because adolescents belonging to this profile were also the most heavily involved in problem behavior.

Not only were adolescents in this *Low Identification/High Preference* profile most involved in problem behavior, but youth in this profile demonstrated a distinct pattern of cognitions—in both level and shape—relative to the other profiles. Illustratively, *Low Identification/High Preference* adolescents self-identified very few risks of problem behavior involvement and reported that potential negative consequences were not especially salient to them. *Low Identification/High Preference* adolescents also reported a very strong risk preference. Thus, a typical adolescent belonging to this profile was indifferent to potential risks and simultaneously held very favorable views of problem behavior involvement. Recent research has pointed to favorable risk valuations as a key driver of adolescent delinquency (Shulman & Cauffman, 2013). Using a person-centered approach, this study demonstrates that this preference for risk also patterns with an indifference to potential costs

Moreover, adolescents in this problematic decision profile, *Low Identification/High Preference*, were not uniformly deficient on all aspects of perceived risk. In fact, risk tolerance did not differentiate *Low Identification/High Preference* adolescents from those adolescents with average (*Moderate Identification/Moderate Salience*) or highly protective (*High Probability/High Salience*) profiles. Although experimental work points to adolescent deficiencies with respect to risk tolerance—adolescents appear to have a high threshold for risk (e.g. Cauffman et al., 2010)—this cognition was not particularly influential in characterizing subgroups of adolescents. One possible explanation for this null finding is that adolescents are homogenous in demonstrating relatively high risk tolerance, perhaps due to immaturity in the harm avoidance system, including the amygdala (Ernst et al., 2005). As a result of these ceiling effects, in which all adolescents demonstrated high risk tolerance, the analysis could not characterize distinct groups of adolescents based on their patterning of this cognition. Further, *Low Identification/High Preference* adolescents endorsed similar levels of risk probability as *Moderate Identification/Moderate Salience* adolescents. Many previous studies have examined risk probability as a central tenet of perceived risk (e.g. Halpern-Felsher et al., 2001). Given that risk probability did not distinguish the most problematic decision makers, however, researchers should not use this cognition as a litmus test for perceived risk among adolescents. More generally, the study's findings confirm that adolescents who are heavily engaged in problem behavior can be deficient on some risk cognitions, but not others. These findings thus agree with a body of variable-centered research that has provided mixed evidence of deficiencies in perceived risks among adolescents who engage in problem behavior.

In contrast to adolescent decision profiles, which were not uniformly high or low across all indices of perceived risk, the two young adult profiles were more consistent. *High Identification/High Salience* young adults were characterized by significantly higher risk identification,

risk probability, risk salience, and risk preference and by lower risk tolerance than *Moderate Identification/Moderate Salience* young adults. In other words, among young adults in this sample, all five cognitions contributed to meaningful cognition patterns and young adults were either high or moderate on each, across the board. For instance, moderate risk tolerance clustered with other cognitions to denote moderate risk, in general. Further, young adults who belonged to this moderate risk profile reported the highest involvement in problem behavior. Thus, these findings demonstrate that young adults rarely display low perceived risk, even those young adults who engage in relatively high levels of problem behavior. Moreover, given that the cognitions that comprise young adult profiles point to uniformly high (or moderate) risk, this may indicate that young adults have more coherent and better integrated cognitive control networks than adolescents (Crone & Dahl, 2012; Luciana, 2013; Luna, Padmanabhan, & O'Hearn, 2010).

Notably, adolescents and young adults could not be characterized by similar cognition profiles across the board. Instead, only two of the three cognition profiles found among adolescents were identified among young adults. Although fleshing out etiological processes would require longitudinal research, these cross-sectional results offer a speculative hypothesis that future studies might address. During adolescence, a problematic cognition profile that translates to an attenuated risk heuristic characterizes individuals who are at greatest risk for problem behavior involvement (e. g. Fischhoff, 2008). During the transition to young adulthood, individuals age out of this aberrant risk heuristic toward one of two decision patterns, both of which are more protective against problem behaviors.

It is also possible that the most problematic decision makers, characterized among adolescents by the *Low Identification/High Preference* profile, were simply not represented within the study's young adult sample, which was comprised of university students. For instance, higher academic ability or higher SES in the young adult sample arguably could have accounted for the lack of a third, more problematic cognition profile among young adults. That being said, several analysis checks were run to limit the possibility—eliminating adolescents who reported less than average grades from the study and re-running analyses to exclude those without at least some parental tertiary education—but doing so did not entirely eliminate this possibility. Because mixture models are sample-dependent, future research should replicate findings in other samples in order to ensure generalizability. It is possible that different numbers or types of profiles could emerge within other samples of young adults, particularly among young adults who engage in substantial amounts of problem behavior and/or are not on a developmental pathway that includes higher education. Additionally, unpacking the potential developmental change alluded to in these cross-sectional findings requires longitudinal research. In particular, research should assess whether and why adolescents transition into more protective cognition profiles as they move into young adulthood.

Assessing latent profiles of risk cognitions, in addition to testing regression models, provides better understanding of how risk cognitions influence adolescents' problem behavior. Specifically, regression results highlighted that risk probability may not drive risky and antisocial behavior. Moreover, results showed a unique association between risk salience and problem behavior for adolescents but not young adults. Latent profile analyses identified groups of adolescents (but not young adults) who were highly problem behavior involved, and indeed were very low on risk salience. Yet very low risk identification and very high risk preference also characterized these adolescents. Taken together these findings indicate that as a universal prevention strategy, increasing the salience of negative consequences for adolescents may be especially useful. Importantly, however, adolescents are not a homogenous group. Thus, for more targeted programs, such as diversion programs for adolescents who are already participating in antisocial behavior, strategies directed at all three aberrant cognitions in the *Low Identification/High Preference* profile, risk salience, risk identification, and risk preference, may be especially useful. Several scholars have outlined comprehensive approaches for targeting a broad swath of cognitions during adolescence (e. g. Fischhoff, 2008; Bruine de Bruin, Downs, & Fischhoff, 2007). Programs that take a multi-pronged approach toward altering inter-connected risk cognitions may mediate change in adolescents' problem behavior more effectively than other programs. Given known challenges in exacting behavior change among individuals who are most at-risk, such a multi-faceted approach seems warranted.

This study is comprehensive in that it measures many theoretical relevant risk cognitions and in subsequently making developmental comparisons between adolescents and young adults. It is also novel in that it tests complementary person-centered models, in addition to variable-centered models. However, the results of this study must also be considered within the context of its limitations. First, as described above, study data were cross-sectional and cohort differences may have existed between adolescents and young adults. To better understand developmental change in decision making, future research should follow adolescents across time, as they transition into young adulthood. Second, participants were almost entirely Caucasian and future research would benefit from inclusion of more diverse samples of adolescents and young adults. Third, to assess risk cognitions, this study used open-ended vignettes describing cheating, stealing, and aggression. In this study, adolescents and young adults did not significantly differ in their reported experiences with these types of decisions. However, findings could differ if vignettes described different types of behaviors such as risky sex or drug use. Because young adults may have greater opportunity to engage in these types of behaviors, it is possible that a third, problematic profile comprised of young adults most heavily involved in serious risk behaviors could emerge in this case. Moreover, although use of vignettes to assess risk cognitions represents an improvement over standardized measures that may not represent young peoples' actual experiences (Halpern-Felsher & Cauffman, 2001), future research would benefit from continued innovation of methods. For example, the field could benefit from decision making measures that can both mimic the dynamic experience of risky and antisocial decision making and can coherently disentangle risk cognitions.

In light of these limitations, the current study makes several new contributions to the literature. First, adolescents do report diminished perceptions of risk relative to young adults, on four out of five cognitions. The only cognition on which adolescents and young adults did not differ was risk probability, a measure often used to assess adolescents' risk perception. Second, risk probability did not independently influence problem behavior. Importantly, too, risk salience predicted problem behavior for adolescents, but not adults. Thus, caring little about potential negative consequences, whatever they may be, could play a previously-overlooked role in adolescents' heavy problem behavior involvement. Third, risk cognitions patterned together in different ways among different age groups. Adolescents were characterized by three meaningful cognition profiles, and young adults were characterized by two. Notably, only adolescents were uniquely characterized by a third, maladaptive cognition profile. This profile was distinguished by a constellation of cognitions that were not problematic across all indices, but nonetheless designated a heuristic representing low perceived risk. All told, these findings offer provocative preliminary evidence of developmental differences between adolescents and young adults on risk cognitions implicated in their problem behavior. Moreover, results point to key manifest cognitions that appear to drive a particularly worrisome cognitive pattern among adolescents. Practitioners might target these cognitions among at-risk youth to mitigate their problem behavior involvement.

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