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Positive and Negative Reinforcement Underlying Risk Behavior in Early Adolescents

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Abstract

The goal of the current study was to examine the combined influence of positive reinforcement processes using a behavioral task measuring risk taking propensity (RTP) and negative reinforcement processes using a behavioral task measuring deficits in distress tolerance (DT) on a range of risk taking behaviors among early adolescents. Participants included a community sample of 230 early adolescents (aged 9–13) who completed two behavioral tasks assessing reinforcement processes as well as reported on past year risk behavior involvement as assessed by items from the Youth Risk Behavior Surveillance System at a baseline and a 1-year follow-up assessment. Data indicated that at the Wave 2 assessment, RTP was positively related to number of risk-taking behaviors in the past year but only for those with low DT, with this finding persisting after controlling for the significant influence of male gender and higher sensation seeking. Results of the present study highlight the importance of considering both positive and negative reinforcement

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processes in combination when investigating vulnerability factors for early risk behavior engagement in youth.

Keywords

Adolescents; Risk taking; Reinforcement processes

Early adolescence, typically bounded by the ages of 10 to 14 years, is a critical developmental period during which engagement in risky behaviors typically emerges. There is a dramatic increase between childhood and early adolescence in onset of substance use (e.g., Windle et al. 2008), delinquency (Moffit et al. 2002), and other potentially health-compromising behaviors (DiClemente et al. 1996; Smith-Khuri et al. 2004). Although not all youth who experiment with risk behaviors will either experience deleterious consequences or progress to more problematic levels of such behaviors (Steinberg 2008), it is well established that earlier age of risk behavior onset can often be prognostic of poorer health and emotional outcomes into later adolescence and adulthood (e.g., Brook et al. 2004; Colman et al. 2007; Sourander et al. 2007).

Risk taking has been conceptualized as behavior that involves some potential for harm or negative consequence to the individual but that may also result in a positive outcome or reward (Byrnes et al. 1999; Leigh 1999). Research on adolescent risk taking behavior has traditionally emphasized the role of appetitive processes; that is, risky behavior resulting from a desire to pursue or enhance positive rewards (Cooper et al. 2000). Models often have focused on some aspect of reward seeking, specifically, how risk taking is influenced by the novelty, excitement and/or arousal associated with a given behavior. As such, it is thought that people are differentially prone to take risks because of some stable underlying individual difference in risk-seeking propensity (e.g., Fowles 1980; Lejuez et al. 2002; Zuckerman 1983). Moreover, a variety of adult and child appropriate self–report and behavioral measures have been used to target this appetitive aspect of risk taking (e.g., Eysenck et al. 1985; Fossati et al. 2002; Kirby and Maraković 1996; Monterosso et al. 2001; Patrick et al. 2002; Patton et al. 1995; Reynolds and Schiffbauer 2004).

One such behavioral assessment is the Balloon Analogue Risk Task (BART; Lejuez et al. 2002), a computer-based measure that assesses risk-taking propensity (RTP), defined as a behavioral tendency to take risks in response to cues for potential reward in spite of some probability for undesirable results. Within this RTP lab paradigm, repeated performance of a risk-taking behavior is usually reinforced with monetary gain but sometimes (unpredictably) punished with monetary loss. The participant has a choice to perform conservative behavior that terminates further risk-taking and saves accumulated money. The task was developed to provide a controlled setting in which to model risk taking in the natural environment, where risk taking up to a certain point leads to positive consequences, with further excessive risk taking leading to greater negative consequences that outweigh the positives. In adolescent studies, performance on the BART has found to be significantly correlated with a variety of real world risk behaviors; namely, greater RTP is associated with an increased frequency of substance use, gambling, delinquency behaviors, and risky sexual behavior (Aklin et al. 2005; Lejuez et al. 2005; Lejuez et al. 2007).

Although the assessment of the appetitive aspects of risk taking propensity is crucial to understand real world risk behavior, emerging evidence also suggests the relevance of negative affect reduction to risk taking behavior. Consistent with developmental changes in affect regulation beginning in early adolescence, adolescents are especially prone to engage in a specific behavior in the context of hot cognitive processes (i.e., thinking under

conditions of strong feelings or high arousal (Ganzel 1999; Metcalfe and Mischel 1999; Steinberg et al. 2006)). Negative reinforcement models emphasize that the motivational basis of behavior is the escape or avoidance of negative affective states (Baker et al. 2004; Solomon and Corbit 1974; Wikler 1965) and avoidance coping is associated with poor outcomes in youth (Cooper et al. 2003).

Several assessment strategies exist to understand negative affect, but there are few measures of negative reinforcement processes. A behavioral assessment strategy used largely with adults to measure a construct referred to as distress tolerance (DT) may provide a useful index of negative reinforcement. DT is defined as the ability to persist in goal directed behavior in the face of affective distress. The DT paradigm involves participant engagement in and persistence on a computerized task that gradually increases in difficulty thereby increasing emotional distress. The participant has the option to persist (with some small positive reinforcement available for persisting) or, in contrast, to terminate the task, thereby reducing emotional distress in the short term (negative reinforcement) but losing out on the rewards in the long term. Quitting the task is thought of as avoiding or escaping from uncomfortable or painful negative affectivity. In regard to its relationship to risk-taking behavior, low DT as measured by these behavioral tasks has been associated with increased substance use (Quinn et al. 1996), shorter durations of smoking cessation and illicit drug use abstinence attempts (Brandon et al. 2003; Brown et al. 2002; Daughters et al. 2005b), increased dropout rates from residential drug treatment (Daughters et al. 2005a), and higher rates of antisocial personality disorder among a sample of male participants (Daughters et al. 2008). These studies have been conducted with adults, but a recent study with early adolescents has linked low distress tolerance to risk taking behavior (Daughters et al. 2009).

Despite evidence suggesting the independent role of positive and negative reinforcement processes underlying adolescent risk behavior, no studies have considered their interactive effects. Given that early adolescence is a phase of development marked by increases in sensitivity to rewards (Steinberg 2008) as well as greater intensity of negative affective experiences (Steinberg et al. 2006), there is reason to suspect that early adolescents high in RTP and low in DT may be at heightened vulnerability for risk behavior engagement. This hypothesis is supported by Cooper et al. (2003) showing the interaction between self-reported disinhibition and avoidance coping served as generalized risk factors for involvement in a variety of risk-taking behaviors.

Current Study

The goal of the current study was to provide an extension of behavioral assessment of RTP and to expand our assessment from an exclusive focus on positive reinforcement underlying RTP to include a complimentary measure of negative reinforcement (DT) to examine the interactive effects of these processes on risk taking behavior in an early adolescent sample with a 1 year follow-up. Specifically, it was hypothesized that DT would interact with RTP in the relationship with engagement in risk taking behaviors (e.g., substance use, delinquency, and physical safety). We expected the greatest level of engagement in risk taking behaviors at higher levels of RTP and low DT. Further, we expected this finding above and beyond the significant influence of factors (e.g., demographics, sensation seeking) often associated with risk behavior involvement. For these analyses, we examined these relationships concurrently at two time points, as well as prospectively across the two time points.

Method

Subjects

This study employed data from a sample of early adolescents (*n*=277) ages 9 to 13 at initial enrollment participating in a larger prospective study of behavioral, environmental, and genetic mechanisms of risk for HIV-related risk behaviors in youth. Follow-up assessments were conducted at yearly intervals for 2 consecutive years and are ongoing with additional assessments planned. Permission to conduct research was obtained from the University of Maryland Institutional Review Board (IRB). Participants were a convenience sample of youth and their parents recruited in the greater metropolitan Washington D.C. area via media outreach and mailings with area schools, libraries, and Boys and Girls Clubs. Recruitment lasted approximately 2 years and was open to all youth in the 5th and 6th grades who were proficient in English; no other exclusion criteria were used. Interested families who met inclusion criteria were invited to come to the University of Maryland campus accessible by public transportation. Twenty-six additional families contacted the laboratory and were eligible for the current study but did not complete informed consent and did not attend a baseline assessment. Upon arrival at the baseline assessment session, a more detailed description of the study procedures was provided and the primary caregiver and youth signed informed consent/assent. The youth and caregiver were then accompanied to separate rooms to complete the assessments. Standardized specific instructions were given separately to the caregiver and youth. These procedures were repeated at all interview points.

Data Collection

Trained undergraduate, post-baccalaureate, and graduate research assistants read aloud specific, standardized instructions for each questionnaire to youth participants. Questionnaires were given to the youth one at a time at which point the experimenter moved out of sight of the participant responses; the participant indicated when they were done with a questionnaire and then the next one was explained using standardized instructions. Although experimenters were available at all times for questions, they did not have the ability to view participant responses. Youth were encouraged to ask any questions if the content of the questions were unclear. If reading difficulties were indicated by the youth or parent, questionnaires were read aloud. Caregivers were given the entire battery of questionnaires without individual verbal instructions for each questionnaire but were offered assistance with questions (e.g., encouraged to ask questions about any of the content, research assistants checked in periodically to see if any questions had arisen). Given the potential for order effects, the questionnaires were administered in a randomly selected order for each participant. Administrating the computer tasks to the caregiver and youth involved presenting a screenshot of the game accompanied by standardized verbal instructions from the research assistant. Specific procedures for each computer task are outlined below in *Measures*.

Participants included in the present analyses were youth who completed both the baseline and the first annual follow-up assessments (Waves 1 and 2). Participants were excluded from the present analyses if they did not complete Wave 2 of data collection (*n*=33) or were missing data on the risk behavior dependent variable at Wave 1 (*n*=11) or Wave 2 (*n*=3). Participants lost to attrition included those who could not be located, or did not respond to phone or letter inquiries. Excluded participants did not differ significantly on gender, age, ethnicity, sensation seeking, risk taking propensity, or distress tolerance variables (*p*'s>.10). The resultant sample of 230 youth included participants who at study enrollment were on average 11.0 years of age (*SD*=.8), 46.5% female, 51.3% non-Hispanic White, 33.9% African-American, 2.6% Latino, and 10.9% of mixed ethnicity.

Measures

Demographics—The parent/guardian completed a basic demographics form for personal information, as well as information about the child. The form included age, gender, race, education level of mother and father, and annual family income. The annual family income variable was collapsed into quartiles (0–48,000, 48,001–85,000, 85,001–120,000, 120,001–highest).

Self-reported Sensation Seeking—The Brief Sensation Seeking Scale (BSSS; Hoyle et al. 2002) was used to assess sensation seeking. The BSSS is an 8-item self-report measure designed specifically for use with youth populations. Example items include, "I would love to have new and exciting experiences, even if they are illegal." Participants are asked to rate each item according to the extent to which it accurately describes their experience using a 5-point Likert scale (1=strongly disagree; 5= strongly agree). The BSSS has been found associated with well-established measures of other aspects of disinhibition and is predictive of risky behaviors (Hoyle et al. 2002; Stephenson et al. 2003). Items were summed to create a total score. Internal consistency within this sample of youth was adequate at both Wave 1 (α=.69) and Wave 2 (α=.77).

Self-Reported Risk Behaviors—We used a modified version of the Youth Risk Behavior Surveillance System (YRBS; Centers for Disease Control and Prevention 2002) assessing past year engagement in the following behaviors: a) drank alcohol, b) smoked a cigarette, c) used any illicit drug, d) been in a physical fight, e) gambled for money, f) rode a bicycle or motorcycle without a helmet, g) rode in a car without wearing a seatbelt, h) crossing the street recklessly, i) carried a weapon, j) used a weapon, j) stole from a store, and k) stole from a person. Youth reported the frequency of past year engagement for these risk behaviors on a likert-type scale with the following response options: a) zero, b) once, c) a few times, d) 1–3 times per month, e) 1–3 times per week, f) almost every day or more. At Wave 1, four risk behaviors—smoked a cigarette, used an illicit drug, carried a weapon, and stole from a store—were highly truncated with over 93% of youth reporting not engaging in this behavior. At Wave 2, the distribution of these risk behaviors remained truncated, with the exception of carrying a weapon and stealing from a store, which both increased in prevalence to above 10%. Thus cigarette smoking and illicit drug use were excluded from further analysis as they contributed no variability; however, stealing from a store and carrying a weapon were included, but in Wave 2 analyses only.

In creating composite measures of risk behaviors, we used the following methods consistent with our previous work in examining risk behaviors in youth utilizing a modified version of the YRBS (Aklin et al. 2005; Lejuez et al. 2007). Because of the nonnormality of the risk behaviors distributions, we dichotomized each behavior to keep all variables on a relatively equal metric in order to combine these items into a single factor. Five risk behavior variables were truncated with greater than 50% of responses being zero (crossed street, been in a physical fight, stolen from a person, gambled, drank alcohol) and were subsequently dichotomized as yes/no engaged in that behavior. For the remaining two variables with a less truncated distribution (helmet and seatbelt, with under 30% reporting no engagement in that risk behavior in each case), we used a median split to classify each participant as either high or low on the risk-related behavior. Distributions of the risk behaviors did not substantively change across Waves, except for an increase in crossing the street recklessly, which was thus subjected to a median split, and the inclusion of carrying a weapon and stolen from a store, which were both dichotomized. The same methodology of dichotomizing or using a median split was applied for all other behaviors at both waves of data.

In the seven Wave 1 risk behaviors, results of an iterated principal factor analysis of tetrachoric correlations with robust weighted least squares estimation indicated a dominant first factor with an eigenvalue of 2.71, and accounting for 39% of the common variance among the items. Item loadings ranged from .43 (been in a fight) to.66 (stolen from a person), suggesting that all items loaded adequately on this factor. Items were then summed into a risk behavior composite with a scale mean of 2.81 (*SD*= 1.73) with a range of 0 to 7. Internal consistency for the scale was acceptable with Cronbach's alpha=.55. In the nine Wave 2 risk behaviors, conducting the same factor analyses as Wave 1, a dominant first factor with an eigenvalue of 3.55 was identified, accounting for 39% of the variance. Item loadings ranged from .43 (been in a fight) to .67 (seatbelt). The Wave 2 risk behavior composite had a scale mean of 3.26 (*SD*=2.05) with a range of 0 to 9. Internal consistency for the scale was acceptable with Cronbach's alpha=.64.[1]

Risk Taking Propensity as a Positive Reinforcement Process: Balloon Analogue Risk Task-Youth (BART-Y; Lejuez et al. 2007)—In the BART-Y, the youth inflates a computer-generated balloon. Each pump is worth one point, but if the balloon is pumped past its explosion point, then all points accrued for that balloon are lost. The probability that any particular balloon will explode is 1/128 for the first pump, 1/127 for the second pump, and so on until the 128th pump at which point the probability is 1/1. According to this algorithm, explosion values form a normal distribution around 64 pumps (Lejuez et al. 2002). During the task, participants had the opportunity to stop pumping the balloon at any time prior to an explosion and allocate the accrued points to a permanent prize meter. After a balloon exploded or points were allocated to the permanent prize meter, a new balloon appeared. After completion of 30 balloon trials, the position of the prize meter determined the final prize (small, medium, large, bonus). Standardized instructions were given to each participant prior to beginning the task. Further, participants were informed that "It is your choice to determine how much to pump up the balloon, but be aware that at some point the balloon will explode" and that "the explosion point varies across each of the 30 balloons, ranging from the first pump to enough pumps to make the balloon fill the entire computer screen." Participants were given no further information about the probability underlying the explosion point for each balloon.

Distress Intolerance as a Negative Reinforcement Process: The Behavioral Indicator of Resiliency to Distress (BIRD; Lejuez et al. 2006)—The BIRD, developed based upon the adult computerized distress tolerance task, the PASAT-C (Lejuez et al. 2003), was used as a behavioral measure of distress tolerance. Ten numbered boxes (1–10) are presented on a computer screen and participants are instructed to use the computer's mouse to click a green dot that appears above a numbered box before the green dot jumps to another number. If the numbered box where the green dot is located is successfully clicked before the dot moves, the bird then flies out of its cage, the computer makes a pleasant chirping sound, and a point is earned. Alternatively, if the green dot moves before the youth clicks on the numbered box or the wrong numbered box is clicked, a loud and unpleasant noise is made, the bird remains in its cage, and no point is earned. The first level of the BIRD lasts 3 min. This level begins with a 5-second latency in between dot presentations and titrates this latency based upon performance (correct answers reduce the latency by 0.5 s whereas incorrect answers or non-responses increase the latency 0.5 s); from this level an average latency is calculated to index skill level. The second level is more

[1]Given the difference in the number of behaviors included in the risk behavior composite across Waves 1 and 2, all Wave 1 analyses were also conducted using the same nine risk behaviors (assessed at Wave 1) as those used in Wave 2. Results of these analyses were equivalent to those conducted with the seven risk behavior composite. Thus, in line with our prior published work using these methods of developing risk behavior composites in youth (cf., Lejuez et al. 2007), all Wave 1 results presented herein were conducted with the seven-risk behavior composite.

difficult, beginning with the average latency from the previous level for 4 minutes and then reducing the latency in half for the final minute, making the task extremely difficult (i.e., challenge latency). Following a brief rest period, the final level includes the challenge latency for up to 5 min. At all points in the final level, the participant has an escape option. Specifically, the participant is informed prior to beginning the final level that they can click the 'quit game' button on the computer screen to end the game, but that the magnitude of the prize they would earn was dependent upon their task performance. Throughout the task, the total number of points earned was visible on the upper right-hand corner of the screen. Distress tolerance was indicated by persistence on the final level, and was examined as a categorical variable (whether or not they terminated the task). Total score on the first two levels was recorded to control for effects of skill on persistence. Participants were told their overall prize would be improved based on their performance but were given no other specific information about the requirements for each prize (Lejuez et al. 2003). Daughters and colleagues (2009) have previously demonstrated that persistence on the BIRD was related to adolescent alcohol use, delinquent behaviors, and depressive symptomatology.

To assess change in negative affect during the task, participants completed the Positive and Negative Affect Schedule-Children (PANAS-C: Laurent et al. 1999) prior to the first level and after the second level of the task. The PANAS-C consists of positive and negative affect sub-scales on a 10-point scale ranging from 'not at all' to 'extremely.' Participants rated the degree to which they currently felt excited, mad, interested, frustrated, happy, upset, energetic, embarrassed, proud, and nervous. Distress was indexed based on the composite of mad, frustrated, upset, embarrassed, and nervous. Internal consistency of this distress index ranged from .73 to .86 across the PANAS-C assessments.

Results

Overview

Analyses, conducted at both waves of data collection unless otherwise specified, are presented in the following steps. Distributional properties of variables were assessed to determine if they met the statistical assumptions for the analyses. Next, univariate linear regressions were conducted to examine the relationship between each independent variable, including potential covariates, and risk behaviors. Next, hierarchical linear regressions were conducted to examine the relative contributions of potential covariates (e.g., age), independent variables (RTP and DT) and the interaction of these variables in their concurrent relationships to risk behavior engagement within each assessment wave. Variables were centered prior to creation of interaction terms, and significant interactions were further explored. Finally, the above analyses were repeated examining the prospective relationship between Wave 1 predictors and Wave 2 risk behaviors.

Descriptive Statistics and Intercorrelations Among Predictors and Risk Behaviors

Descriptive statistics are presented for Waves 1 and 2 of assessments in Table 1. The skewness values for all variables were less than or equal to 1.1; thus, no transformations were required. Paired samples *t*-test indicated a significant increase in RTP across the 2 years from an adjusted average of 31.03 pumps (*SD*=13.40) in Wave 1 to 36.36 pumps (*SD*=15.07) in Wave 2 ($t(228)=5.42$; $p=.001$). Approximately half of youth each year quit the DT task. Further, the DT task reliably increased distress with a significant pre-post change in distress at both Wave 1 ($t(225)=4.76$, $p=.0001$) and Wave 2 ($t(225)=6.64$, $p=.0001$) indicating the task was psychologically stressful. However, pre-post change in distress in response to the task was unrelated to whether or not youth quit the BIRD in both years ($ps>.30$), indicating that lower persistence on the task is not simply a measure of increased negative affect. No changes were evidenced across time in proportion to who quit the BIRD

(McNemar test; p=.99) or on self-reported sensation seeking (t(228)=.98; p=.33). There were no gender differences on any of the predictors of interest (p's>.15).

Phi coefficient, point biserial, and Pearson correlations among the independent variables were examined and are presented in Table 2; Wave 1 correlations are displayed below the diagonal, Wave 2 correlations are presented above the diagonal. At Wave 1, the only significant associations were between DT and RTP (r_{pb} =.16), as well as between DT and sensation seeking (r_{pb} =.17; p's<.05). At Wave 2, correlation coefficients exhibited a wider range of magnitude, from −.03 to.22. Significant correlations differed from those exhibited at Wave 1; specifically, age of the youth was associated with sensation seeking (r=.22; p<.01), and DT was again positively associated with RTP (r_{pb}=.15; p <.05).

Point biserial and Pearson correlations were also conducted to assess the relationship of age, gender, sensation seeking, RTP, and DT with risk behavior engagement at both waves of data collection (See Table 2). At the first wave, age, gender, sensation seeking, and RTP were significantly related to risk behavior engagement. Older youth (r=.14; p<.05) and boys (r_{pb} =.16; p<.05) engaged in the greatest number of behaviors. Higher RTP (r=.14; p<.05) and greater sensation seeking (r=.40; p<.01) also corresponded with greater risk behavior engagement. DT was not significantly related to risk behavior at the first wave. At the second assessment wave, age, gender, and sensation seeking remained significantly related to engagement in risk behaviors. Again, older youth (r=.21; p<.01), boys (r_{pb} =.30; p <.01), and higher levels of sensation seeking (r=.38; p<.01) were associated with a greater number of risk behaviors. Neither RTP nor DT evidenced a significant univariate relationship with risk behavior engagement at Wave 2.

Multivariate Linear Regressions with Moderating Effects

Hierarchical linear regressions were conducted for the dependent variable of risk taking behaviors at both Waves 1 and 2. Thus, for both waves of data collection, age, gender and sensation seeking were entered in the first block, RTP and DT were entered on subsequent individual blocks, and the interaction between RTP and DT was entered in the final block. Standardized betas and changes in R^2 are presented in Table 3 for Waves 1 and 2 respectively. Other two-way (e.g., DT by gender) and three-way interactions not hypothesized in the present study were examined but were not significant, and thus models are presented without these effects.

As seen in Table 3, for the Wave 1 risk behavior model, risk behavior engagement was predicted solely by sensation seeking, with both gender and RTP no longer significant at p<.05. No two-way interactions were significant. The overall model explained 21% of the variance in year 1 risk behaviors engagement.

As depicted in Table 3, the Wave 2 risk behavior model presented a slightly different picture. The main effects of gender and sensation seeking were significant predictors of risk behavior engagement. In addition, although not exhibiting main effects, as hypothesized there was a significant two-way RTP by DT interaction in the relationship with risk behavior engagement. The overall model explained 27% of the variance in involvement in year 2 risk behaviors.

The significant two-way interaction was explored in line with procedures outlined by Aiken and West (1991). The RTP by DT interaction is depicted in Fig. 1 by plotting the regression of risk behavior engagement (dependent variable) on RTP (independent variable) as a function of DT (quit vs. did not quit). Unstandardized betas were used to calculate the regression lines. As displayed in Fig. 1, as expected, youth who evidenced low DT had both a positive and steeper slope across increasing levels of RTP. Thus, the greatest engagement

in risk taking behaviors was observed among youth with high RTP and low DT. However, an unexpected finding concerned youth who were high in DT for whom there was actually a negative slope, such that greater engagement in risk taking behaviors was observed among youth with low RTP and high DT, and decreased across levels of RTP.

In the next step, based on procedures outlined by Holmbeck (2002), we determined if the slopes of the relationships plotted in Fig. 1 were significantly different from zero. Two new conditional group variables were created based on the DT quit groups coded as follows: 1) Z_HighDT (0=quit task, 1=persisted on task) and 2) Z_LowDT (-1=quit task, 0=persisted on task). Then the cross-product of each new variable with Wave 2 RTP was computed to create interaction terms. Finally, engagement in risk taking behaviors was regressed on RTP, the conditional values of DT (i.e., Z_HighDT, Z_LowDT), and each cross-product in two separate regressions. The resulting *t* tests for the betas indicated the slope for the low DT group was significantly different from zero (B=.026, β=.191, $t(225)$=2.45, sr^2=.02, p=.02) as was the slope for the high DT group (B=−.027, β=−.194, $t(225)$=−2.15, sr^2=.015, p=.03).

Prospective Relationship Between Wave 1 Predictors and Wave 2 Risk Behaviors

In line with the steps described above, we also examined univariate relationships between proposed predictors assessed at Wave 1 and risk behavior engagement at Wave 2. Consistent with cross-sectional analyses, univariate linear regressions indicated that older age at baseline (B=.41, SE=.17, β=.16, p=.02), male gender (B=1.30, SE=.26, β=.31, p=.001), and sensation seeking (B=.13, SE=.03, β=.32, p=.001) predicted year 2 risk behaviors. Wave 1 risk behaviors also significantly predicted year 2 risk behaviors (B=.69, SE=.06, β=.59, p=.0001). However, there were no effects of the predictors of interest (RTP and DT) at the univariate level. Additionally, other than a significant effect of Wave 1 risk behaviors, there were no other significant main effects (including sensation seeking, p=.09) moderating effects of RTP and DT identified in the multivariate model, and thus these results are not presented further.

Discussion

The current study represents the first effort to examine the combined influence of positive and negative reinforcement processes on risk taking behavior in a sample of early adolescents. A univariate relationship was evident for the behavioral task of positive reinforcement and risk behavior involvement at Wave 1, and at the Wave 2 follow-up our hypothesized interaction occurred such that early adolescents exhibiting higher RTP and low DT reported a significantly greater number of risk taking behaviors in the past year, above and beyond the significant influence of male gender and higher sensation seeking. Although a wealth of literature has cemented the role of appetitive processes underlying risk taking behaviors (cf., Steinberg 2008), and more recently has begun to shed light on the critical need to understand the role of avoidance of affective distress as well (Cooper et al. 2003; Daughters et al. 2009), this finding highlights the importance of considering the combined vulnerability of positive and negative reinforcement processes when investigating early risk behavior engagement.

It is notable that although heightened RTP exhibited a univariate relationship with risk behaviors at baseline, other hypothesized relationships were not supported at this assessment or prospectively across the 1-year interval. When balanced against the lack of Wave 1 and prospective findings, one could suggest that the Wave 2 findings are anomalous and would not replicate in further years. However, there are several other plausible explanations worth considering. One explanation for the limited findings at study onset may be the composition of risky behaviors, given there were fewer ‘higher severity’ behaviors engaged in at this time point as compared to the 1-year follow-up. Although the methods by which we created

a risk behavior composite have been utilized previously with other samples of adolescents (Aklin et al. 2005; Lejuez et al. 2007), "physical safety" behaviors that are of lesser severity in terms of riskiness than delinquency and substance use behaviors, may hold less of a functional relationship with positive and negative reinforcement processes. Second, it may be the case that additional exposure to the tasks in Wave 2 provided more accurate reflections of participant RTP and DT, possibly either due to practice or increased comfort/predictability associated with already having completed the procedures previously. Third, given that Waves 1 and 2 spanned early adolescence in the current sample, increases in sensitivity to rewards (Steinberg 2008) as well as greater intensity of negative affective experiences (Steinberg et al. 2006) that occur during this developmental period may alter the magnitude of relationships seen between the interaction of risk taking propensity and distress tolerance and risk behavior engagement as youth start to mature. Finally, the majority of significant findings using the BART and the BIRD as they relate to risk behaviors have been found with older samples. Thus, it may be the case that these behavioral tasks are becoming more effective in this second Wave and will continue to do so as this sample of children move through older adolescence, thereby replicating the previous findings with older adolescents and young adults in future waves of data collection. For this reason, continued assessments as youth enter older adolescence will allow further identification of the strength of these relationships across time.

Sensation seeking was also a more robust predictor of risk taking behavior than RTP and DT. This finding is in accordance with previous studies demonstrating a stronger relationship between sensation seeking and risk taking behaviors than between RTP and risk taking behaviors (Lejuez et al. 2002, 2003). This consistently observed finding may be a result of the sensation seeking construct simply possessing a stronger relationship with risk behavior involvement as well as shared method variance (i.e., both risk behaviors and sensation seeking are assessed via self-report). Sensation seeking as measured in the current study also has clear content overlap with the risk behavior survey (e.g., "I like wild parties" and "I would love to have new and exciting experiences, even if they are illegal") which also may enhance the strength of the relationship to risk behaviors. It is notable that beyond strong cross-sectional findings, Wave 1 sensation seeking showed a prospective univariate relationship with Wave 2 risk behaviors, but was no longer significant related when controlling for Wave 1 risk behaviors. These findings support previous cross-sectional findings and suggest the important insight into risk processes that can be examined in the future with multiple waves of data.

The present research has several limitations including the relatively limited single year follow-up period, the reliance on self-report of past year adolescent risk behavior without corroborating parental or teacher reports, and small number of covariates. Further, although there are a number of strengths associated with utilizing behavioral measures, in capitalizing on these strengths in order to preserve internal validity there may also be a loss of ecological validity. Thus, it will be crucial in future work to expand upon data with the measures used herein with modified tasks that more fully capture real world risk taking propensity and resilience in the face of distress in order to better understand more real world behaviors as they occur in a natural social context. Finally, although the minimal exclusion criteria in the present study increases generalizability of the current findings, there is no way to assess the potential impact of factors such as developmental disabilities or traumatic head injury on the outcomes of this study. Keeping in mind the aforementioned limitations, results of the present study have several implications for investigating positive and negative reinforcement mechanisms underlying risk behavior involvement in early adolescents. Specifically, this study implicates the combination of risk taking propensity and avoidance of affective distress as common mechanisms related to risk taking behaviors in youth, supporting theoretical and empirical research linking these basic behavioral processes to poor outcomes

(Cooper et al. 2003). This work also provides perspective on the somewhat narrow view that risk taking propensity is necessarily associated with harmful real world risk behaviors, suggesting that a willingness to take risks is only associated with risk behaviors in the context of an inability to tolerate distress. In terms of future research directions it will be important to examine such relationships over additional years of assessment to determine the extent to which these behavioral measures of positive and negative reinforcement processes will ultimately prove to be useful longitudinal predictors.

Following from these data, there are important assessment as well as prevention and early intervention implications. Targeted prevention and intervention programs are typically best served by incorporation of components directly relevant to particular vulnerabilities and relevant skill building in line with these vulnerabilities (e.g., Nation et al. 2003). Such an approach targeted to relevant positive and negative reinforcement processes could be used in developing interventions to increase youths' ability to persist through distress while simultaneously offering alternative sources of reinforcement through engagement in healthy, prosocial and novel activities. This fits well with approaches that have been aimed at addressing the particular personality characteristics that make some youth vulnerable to risk behavior (Conrod et al. 2000, 2006, 2008). These programs have focused on four personality risk factors: negative thinking, anxiety sensitivity, impulsivity, and sensation seeking. Notably up to this point, the aforementioned programs have largely targeted a single vulnerability factor that a youth possesses out of these four personality risks. Thus, our findings suggest both the potential importance of targeting RTP as an additional personality risk factor, but also with a consideration of low DT, thereby supporting the potential benefit of targeting multiple personality processes simultaneously where such vulnerability is evident. Alternatively, this also suggests the utility of psychosocial interventions such as behavioral activation (Lejuez et al., in press) that target both positive and negative affect processes simultaneously and have been effective in treating substance use behaviors (e.g., MacPherson et al. 2010).

As additional waves of data become available from this longitudinal study, we will be able to further examine the use of the behavioral tasks of risk taking propensity and distress tolerance as potential indicators of a latent vulnerability towards future engagement in risk behaviors among youth. Moreover, future research will benefit from incorporation of the current behavioral assessments of RTP and DT into larger models including environmental and individual difference factors (e.g., specific genetic polymorphisms) to better understand the relative role of these reinforcement mechanisms as descriptors or predictors of trajectories of risk behavior engagement over adolescence.

In conclusion, the current study has several important strengths including a relatively large sample for a study utilizing behavioral measurement, with a high level of diversity across race/ethnicity and income. It is notable that our proposed theoretical framework allows for greater understanding of how moderating variables such as DT increase of understanding of the relationship between RTP and risk behavior. Clearly there were several aspects of our hypotheses that were not borne out in our data including no significant RTP and DT interaction at Wave 1 and in the prospective findings. However, understanding exactly how and when particular individual difference variables relate to risk behavior and how these relationships change over time is crucial to moving this research forward. With additional future waves of assessment, we will be able to provide a more comprehensive picture of how risk taking behavior itself evolves over time, as well as a clearer understanding of risk taking and its underlying processes in youth.

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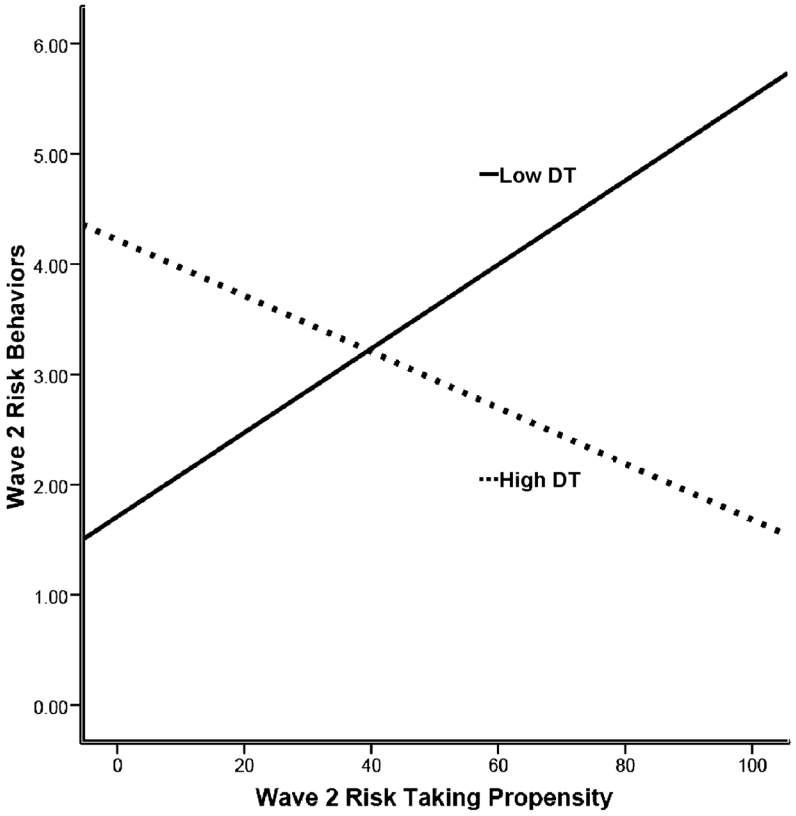

Fig. 1.
Interaction between Wave 2 measurement of risk taking propensity and distress tolerance as it relates to Wave 2 risk behavior engagement

Table 1

Predictors, potential covariates, and risk behaviors at Waves 1 and 2 assessments

	Wave 1 (*n*=230)	**Wave 2 (*n*=230)**
Demographic Variables:		
Age (*M*(*SD*))	11.01 (.81)	12.07 (.89)
Gender (% Female)	46.5	46.5
Ethnicity (%):		
White	51.3	51.3
Black	33.9	33.9
Hispanic	2.6	2.6
Mixed Ethnicity	10.9	10.9
Annual Family Income (%):		
0–48,000	25.7	18.7
48,001–85,000	26.7	26.2
85,001–120,000	24.3	24.9
120,001-highest	23.3	30.2
Risk Behavior Engagement *(M (SD))*[a]	2.81 (1.73)	3.26 (2.05)
BART-Y adjusted average *(M (SD))*[*]	31.03 (13.40)	36.36 (15.07)
BIRD (% quit task)	48.1	50.2
Sensation Seeking *(M (SD))*	12.90 (5.21)	13.25 (5.67)

[a] Risk behavior engagement is not comparable across years due to differences in the number of behaviors comprising each composite;

[*] Significant increase in risk taking propensity across the follow-up; $p<.01$

Table 2

Intercorrelations among predictors at Waves 1 and 2 assessments

	1	2	3	4	5	6
1. Age	–	**.14***	**.22***	.12	−.03	**.21****
2. Gender (0=female)	.06	–	.08	.06	−.01	**.30****
3. Sensation Seeking	.06	.09	**.54****	.07	−.06	**.38****
4. RT Propensity	.13	.05	.09	**.49****	**.15***	.08
5. Distress Tolerance (0=persisted on task)	.09	.03	**.17***	**.16***	**.30****	−.04
6. Risk Behaviors	**.14***	**.16***	**.40****	**.14***	.09	**.59****

Wave 1 intercorrelations are presented below the diagonal; Wave 2 intercorrelations are presented above the diagonal; correlations across Waves for the same measures are presented in the diagonals;

* $p<.05$;

** $p<.01$

Table 3

Hierarchical regressions examining interaction between RTP and DT in relation to risk behavior engagement

Predictor	Wave 1 Risk Behaviors	Wave 2 Risk Behaviors
Step 1	(.20****)	(.23****)
Age	.07	.10*
Gender	.12*	.27****
Sensation Seeking	.41****	.34****
Step 2	(.01*)	(.001)
Age	.05	.10
Gender	.12*	.27****
Sensation Seeking	.40****	.33****
Risk Taking Propensity	.11*	.02
Step 3	(.0001)	(.001)
Age	.05	.10
Gender	.12	.27****
Sensation Seeking	.40****	.33****
Risk Taking Propensity	.10	.03
Distress Tolerance	.01	−.03
Step 4	(.0001)	(.04***)
Age	.05	.10*
Gender	.12	.26****
Sensation Seeking	.39****	.35****
Risk Taking Propensity	.13	−.19**
Distress Tolerance	.01	−.02
Risk Taking Propensity X Distress Tolerance	−.03	.29***

N=230; Standardized β presented in each column.

ΔR^2 for each step appears in parentheses.

* $p<.10$.

** $p<.05$.

** $p<.01$.

**** $p<.001$