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Individual differences in risk-propensity: Associations between personality and behavioral measures of risk

Sandeep Mishra *, Martin L. Lalumière

University of Lethbridge, Department of Psychology, 4401 University Drive West, Lethbridge, Alberta, Canada T1K 3M4

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ABSTRACT

Previous research has demonstrated that various forms of risky behavior are highly associated among individuals, and such personality traits as impulsivity, sensation-seeking, and low self-control are correlated with risk-taking. However, little evidence indicates that self-report measures of personality traits associated with risky behavior significantly correlate with a behavioral preference for risk. We examined whether personality questionnaire measures of traits associated with risk (impulsivity, sensation-seeking, low self-control) were correlated with various behavioral measures of risk (future discounting, probabilistic risky choice). We show that measures of risk-propensity comprise three principal components: Future Discounting, Risky Personality, and Variance Preference. Risky Personality and Variance Preference were significantly correlated. Future Discounting was not associated with either of the other risk components. Together, the results provide some evidence suggesting that stable personality traits may represent proximate mechanisms through which a behavioral preference for risky outcomes manifests.

1. Introduction

Several theories suggest that various forms of risky behavior should be highly associated. Gottfredson and Hirschi (1990) argued that individuals who exhibit low self-control—a preference for immediate rewards at the cost of possible long-term negative consequences—tend to engage in a variety of risk-taking behaviors. They further suggested that low self-control gives rise to the "generality of deviance", where low self-control combined with opportunity accounts for most, if not all, risky and criminal behavior (Hirschi & Gottfredson, 1994). Jessor's (1991) problem-behavior theory suggests that a balance of instigations (e.g., peer modeling) and controls (e.g., parental monitoring) determine the degree to which individuals engage in a "syndrome" of problem behaviors including substance use, delinquent behaviors, risky driving, and early sexual intercourse. Daly and Wilson (2001) suggested that various risky behaviors are the product of "rational" decision-making processes designed to solve adaptive problems that arise in certain situations or environments.

These theories are supported by substantial evidence suggesting that various forms of risky behavior, including crime, substance use, risky driving, early sexual intercourse, sexual aggression, gambling, general delinquency, and antisocial behavior tend to co-occur both within individuals and at the aggregate level (e.g., Bartusch, Lynam, Moffitt, & Silva, 1997; Donovan & Jessor, 1985; Hirschi & Gottfredson, 1994; Leblanc & Girard, 1997; Lussier, LeBlanc, & Proulx, 2005; Mishra & Lalumière, 2009; Mishra, Lalumière, Morgan, & Williams, in press; Mishra, Lalumière, & Williams, 2010; Osgood, Johnston, O'Malley, & Bachman, 1988). Furthermore, individuals who regularly engage in various forms of risk-taking (including gambling and crime) score higher than others on self-report measures of poor self-control, impulsivity, and sensation-seeking (e.g., Samuels et al., 2004; White et al., 1994; reviewed in Zuckerman, 2007). If such personality traits are associated with real-world risk-taking in various domains, then high levels of these traits should be significantly associated with a behavioral preference for risk in laboratory tasks.

Self-report measures of personality traits associated with risk are contrasted with behavioral measures of risk-propensity, in which respondents make choices between concrete alternatives and directly experience the outcome. Many behavioral measures of risk-propensity reflect a definition of risk as outcome variance, where the riskier of two options with the same mean expected value is that with higher outcome variance. For example, choosing a 10% chance of earning $30 over receiving $3 guaranteed is a risky decision. These measures have been largely used in experimental situations where researchers measure changes in risk-propensity following an experimental manipulation (e.g., Daly & Wilson, 2001; Fessler, Pillsworth, & Flamson, 2004; Mishra & Lalumière, 2010). This use of behavioral measures of risk suggests that these

* Corresponding author.
E-mail address: mishrs@gmail.com (S. Mishra).

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measures may tap into more state-dependent risk-propensity than self-report personality measures.

Future discounting, or delay discounting, is another widely used behavioral measure of risk-propensity. Most future discounting instruments present participants with a series of forced paired choices between imminent smaller monetary rewards and delayed larger rewards (e.g., choosing between receiving $45 immediately, or $75 in 30 days; Kirby, Petry, & Bickel, 1999). People who discount the future tend to choose imminently available rewards. Future discounting measures have been previously described as behavioral measures of impulsivity (e.g., Reynolds, Ortengren, Richards, & de Wit, 2006). As with behavioral measures of variance preference, future discounting measures have also been used largely as state-dependent measures (e.g., Wilson & Daly, 2004).

Most research that has examined the relationship of different measures of risk-propensity has focused solely on inter-relationships between self-report and behavioral measures of impulsivity, not risk more generally conceived, with mixed results. Ostaszewski (1996) found that people who exhibited steeper discounting of delayed rewards scored higher on impulsive personality. Other studies have similarly found that impulsive populations engage in higher levels of future discounting (reviewed in Daly & Wilson, 2006), but others have found the opposite. Daly and Wilson (2006), for example, demonstrated that juvenile offenders were no more likely to discount the future than a control group of high school students. A growing body of evidence also suggests that self-report and behavioral measures of impulsivity are inconsistently associated (reviewed in Reynolds, Penfold, & Patak, 2008). For example, Reynolds et al. (2006) found that several self-report measures of impulsivity correlated highly amongst each other, but were not significantly associated with behavioral measures of impulsivity. Based on these findings, Reynolds et al. suggested that self-report and behavioral measures of impulsivity likely measure different constructs. These inconsistent results suggest that further study of the relationship of self-report and behavioral measures of risk is necessary.

Many risky behaviors are the products of immediate environmental influences (e.g., conditions of need; Mishra & Lalumière, 2010). However, personality traits may lead people to behave in consistently risk-accepting or risk-averse manners, or lead people to more often encounter situations that facilitate risk-taking. Personality traits such as impulsivity, sensation-seeking, and low self-control are highly associated with various forms of real-world risk-taking (reviewed in Zuckerman, 2007). If personality traits are proximate mechanisms through which a baseline preference for risky outcomes manifests, then variability in personality traits associated with risk should be associated with actual behavioral tendencies to choose riskier outcomes.

In this study, we (1) investigated the inter-relationships of several widely used personality and behavioral measures of risk-propensity, (2) determined whether there are distinct components underlying various types of risk measurement, and (3) examined whether components describing behavioral preferences for risk and personality associated with risk-acceptance were correlated. We predicted that (1) various measures of risky personality and risk-acceptance would be correlated, (2) distinct components would describe personality traits associated with risk and behavioral preferences for risk, and (3) these two components would be significantly correlated.

2. Method

2.1. Participants

This study comprised two phases. In phase one, 240 participants (120 men), age 18–25 (M = 20.3, SD = 1.9; 82.6% Caucasian, 8.7% Asian, 0.9% African–American, 7.8% Other) were recruited from undergraduate psychology classes and completed measures of personality associated with risky behavior. The same participants were used in Mishra and Lalumière (2010). All data were normally distributed. We conducted a principal components analysis (PCA) without rotation on these measures. A single principal component (PC), labeled Risky Personality, explained 66.4% of the variance (KMO = .69). All measures on this factor loaded highly (>.70) and positively. This factor was used to select participants for the second phase of the experiment, which began a week later. Scatterplots were used to examine linearity and homoscedasticity for all PCAs, with no obvious deviations from assumptions observed.

Scores on the Risky Personality component were used to select participants for phase two of the study. Phase two participants were 58 men and 57 women (age: M = 20.0, SD = 2.0), consisting of phase one participants who scored highest (20 males, 19 females), lowest (19 males, 23 females), and in the middle (19 males, 15 females) of the sex-relevant distribution of Risky Personality, consistent with a within-sex extreme-groups design. This two-phase extreme-groups design maximized variance on measures of interest (Preacher, Rucker, MacCallum, & Nicewander, 2005).

2.2. Measures

2.2.1. Personality

2.2.1.1. Zuckerman's Sensation-Seeking Scale (SSS-V). The SSS-V consists of 40 choices between paired statements regarding preferences for varied, stimulating experiences and disinhibited behavior (e.g., "A sensible person avoids activities that are dangerous" versus "I sometimes like to do things that are a little frightening"; Zuckerman, 1994). A total score was obtained by summing the number of high sensation-seeking choices.

2.2.1.2. Eysenck's Impulsivity Scale (EIS). The EIS (Eysenck, Pearson, Easting, & Allsopp, 1985) consists of 19 yes/no statements about impulsive behaviors (e.g., "Do you often buy things on impulse?"). A total score was obtained by summing the number of "yes" answers.

2.2.1.3. Retrospective Behavioral Self-Control Scale (RBS). The RBS (Marcus, 2003) measures behaviors across the lifespan that are associated with low self-control. It consists of 67 items, measuring the frequency of behaviors associated with low self-control in childhood (e.g., "I copied homework from classmates"), adolescence ("I have been late for school or work because I stayed out too late the night before"), and adulthood (e.g., "I have been caught in a speed trap"). Behaviors were rated on a scale from 1 (never) to 7 (always). A total score was obtained by summing ratings of frequency of engagement in risky behaviors; higher scores indicated lower self-control.

2.2.1.4. Domain-Specific Risk Taking Scale (DOSPERT). The DOSPERT (Weber, Blais, & Betz, 2002) is a self-report measure of the likelihood of engaging in risky behavior in five domains: financial (investing and gambling; e.g., "Betting a day's income at a high stakes poker game"), health/safety (e.g., "Not wearing a helmet when riding a motorcycle"), recreational (e.g., "Going whitewater rafting during rapid water flows in the spring"), ethical ("Having an affair with a married man or woman"), and social risky behaviors (e.g., "Arguing with a friend about an issue on which he or she has a very different opinion"). Participants rated the likelihood of engagement in each behavior from a scale of 1 (extremely unlikely) to 5 (extremely likely). A total score was obtained by summing all of the items (as in Weber et al., 2002).

2.2.2. Behavioral measures of risk

2.2.2.1. Choice task (CT). Participants made six decisions, each between two monetary options (adapted from Fessler et al., 2004; Mishra & Lalumière, 2010). Both options had equal expected values but differed in variance (e.g., "Would you rather choose [A] $3 guaranteed, or [B] a 30% chance of earning $10?"). At the end of the task, participants rolled a die and received the value of one of the six choices they made corresponding with the number on the die (this was done to reduce participant costs while still keeping each decision as realistic as possible). If the number on the die corresponded to a risky option, participants drew a bead from a cup containing the appropriate ratio of black and white beads. For example, for the choice of a 10% chance of earning $30, participants drew from a cup containing 10% black beads and 90% white beads; if they drew a black bead, they earned $30. A total score of number of risky choices was computed.

2.2.2.2. Balloon Analogue Risk Task (BART). Participants saw a computer screen with a deflated balloon and a "PUMP" button. Each pump of the balloon increased participants' earnings by one cent, and increased the degree to which the balloon was inflated. The balloon was set to pop randomly, with 65 pumps required on average before popping. If the balloon popped, participants lost all money gained for that trial. Participants could end a trial at any time by clicking on a "COLLECT" button. Thirty trials were presented. The first five trials were excluded from analysis as training. The average number of pumps for all trials where the balloon did not pop was computed (Lejuez et al., 2002). Participants received the amount of their earnings from the BART following completion of the task.

2.2.2.3. Variance preference task (VPT). Participants chose between two options (Rode, Cosmides, Hell, & Tooby, 1999). The first option involved two possible choices: (1) "Choose one of two cups, one with 100 black beads (Cup A), and one with 100 white beads (Cup B). You are allowed to pick either Cup A or Cup B (without knowing which contains the black or white beads), and draw 10 beads from that single chosen cup. The second option offered "A single cup that contains a random combination of white and black beads totaling 100. You are allowed to draw 10 beads from this cup, replacing each bead after drawing it." Participants were not given the exact ratio of beads in Option 2 in order to make the choice uncertain (following Rode et al., 1999). The ratio of beads in Option 2 was randomized for each participant. Participants earned $1 for each black bead drawn. Option 1 is a riskier option (all-or-nothing) than Option 2. A binary score of risky/not-risky was used.

2.2.2.4. Future discounting I (FDI). Participants were presented with a series of 21 choices between an amount of money available today, and an amount of money available in the future (Kirby et al., 1999). Choices were either for small, medium, or large amounts of money (seven in each category; for a complete list of options, see Kirby et al., 1999). Instructions for the task indicated that participants would receive the amount of one of their 21 choices in the form of a cheque. At the end of this task, participants picked one of 21 ping-pong balls labeled from 1 to 21 (each corresponding to one of the 21 future discounting decisions), and earned the amount of their choice in the form of cheque (either immediately cashable, or post-dated to the relevant date in the future). The dependent measure consisted of a discounting parameter (k) for each of small (FD_S), medium (FD_M), or large rewards (FD_L), calculated as described in Kirby et al. (1999). Higher discounting parameters indicated a greater preference for immediate over later rewards.

2.2.2.5. Future discounting II (FDII). At the end of the experimental session, participants were offered the opportunity to either collect their total earnings immediately, or delay earnings collection by three weeks and collect an additional $10 (Marcus, 2003). A binary discounting score (discounted, not discounted) was used.

2.3. Procedure

Phase one participants filled out paper versions of the personality measures (SSS-V, EIS, RBS) in small groups. Phase two participants were tested at individual computer stations, and completed the DOSPERT along with all behavioral measures. After each task, participants called the experimenter to make any relevant draws and collect earnings (which were denoted with poker chips in order to make earnings more tangible). Poker chips were exchanged at the end of the session for a cheque. All questionnaires and tasks were presented in random order. Average earnings were $44.38 (*SD*: $22.54, *Range*: $10.75–106.50).

All data were normally distributed, except for the BART and the three FDI measures (FD_S, FD_M, FD_L). These measures were all normalized using logarithmic transformations. FDII and VPT were nominal variables, and so non-parametric statistics were used where possible. Missing values ($n = 1$ for RBS, EIS, SSS, DOSPERT; $n = 2$ for SSS, FD_M, FD_L; $n = 4$ for FD_S) were imputed with the series mean. No outliers were detected.

3. Results

3.1. Inter-relationships between measures of risk-propensity

The correlation matrix for all personality and behavioral measures of risk-propensity is presented in Table 1. Because all of the DOSPERT subscale measures were significantly inter-correlated (all but one comparison was significant, $rs > .22$, $ps < .02$), we used the total DOSPERT score in all analyses in order to reduce the number of comparisons and increase statistical power. Personality measures associated with risk-propensity were highly and significantly inter-correlated. Behavioral and future discounting measures were inconsistently inter-correlated amongst themselves and with risky personality traits. Males scored higher than females on all measures. Significant sex differences were obtained for all measures except for CT, FD_S, FD_L, and FDII. Fisher's Z-tests indicated that correlation magnitudes significantly differed between men and women for only 2 of 55 comparisons. After Bonferroni correction for multiple comparisons, no significant differences remained. As a result, data from men and women were combined for all subsequent analyses.

3.2. The component structure of measures of risk-propensity

If different measures of risk-propensity assess a similar underlying construct of risk, a single factor should underlie all personality and behavioral measures of risk. A confirmatory factor analysis using a maximum likelihood procedure was conducted to test whether an one-factor model could adequately account for the underlying variance in risk measures. A goodness-of-fit test indicated that an one-factor model did not adequately account for variance in measures of risk, $\chi^2(44) = 200.42$, $p < .001$ (KMO = .72).

An exploratory PCA was used to examine if there were a small number of components underlying the various measures of risk-propensity. Three PCs with eigenvalues greater than 1.0 were extracted and rotated using a promax ($\kappa = 4$) rotation procedure (allowing for factors to be correlated but interpretable; Table 2). These three PCs were labeled Future Discounting (PC1), Risky Personality (PC2), and Variance Preference (PC3). These three components explained 28.4%, 23.0% and 10.7% of item variance respectively (62.1% total; KMO = .72). FDII was correlated with

Table 1
Correlation matrix between personality measures associated with risk-propensity and behavioral measures of risk-propensity, including future discounting.

	EIS	RBS	DOS	VPT	CT	BART	FD_S	FD_M	FD_L	FDII
SSS	**.459**	**.491**	**.680**	.055	.119	.158	.096	.094	.091	**.240**
	(.00)	**(.00)**	**(.00)**	(.63)	(.20)	(.10)	(.31)	(.32)	(.33)	**(.01)**
EIS		**.541**	**.462**	.071	.156	.103	.088	.103	.100	**.253**
		(.00)	**(.00)**	(.45)	(.10)	(.28)	(.35)	(.28)	(.29)	**(.01)**
RBS			**.529**	−.023	.120	.052	.056	.072	.115	.140
			(.00)	(.81)	(.20)	(.61)	(.55)	(.44)	(.22)	(.14)
DOS				.091	.107	.159	.070	.102	.072	**.273**
				(.33)	(.26)	(.09)	(.46)	(.28)	(.44)	**(.00)**
VPT					.007	.142	.033	.134	.154	−.061
					(.94)	(.14)	(.73)	(.15)	(.10)	(.52)
CT						**.208**	.009	−.012	.057	.047
						(.03)	(.92)	(.90)	(.54)	(.62)
BART							−.158	−.171	−**.221**	.082
							(.09)	(.07)	**(.02)**	(.38)
FD_S								**.856**	**.820**	−.088
								(.00)	**(.00)**	(.36)
FD_M									**.873**	−.133
									(.00)	(.16)
FD_L										−.078
										(.41)

Notes: P values for each correlation are in parentheses. All tests are two-tailed Pearson *r*, except for those involving FDII and VPT (Spearman's ρ). Significant correlations ($p \leqslant .05$) are in bold. SSS = Zuckerman's Sensation-Seeking Scale, EIS = Eysenck's Impulsivity Scale, RBS = Retrospective Behavioral Self-Control Scale, DOS = Domain-Specific Risk-Taking Scale, VPT = Variance Preference Task, CT = Choice Task, BART = Balloon Analogue Risk Task, FD_S = small future discounting parameter, FD_M = medium future discounting parameter, FD_L = large future discounting parameter, FDII = future discounting II.

Table 2
Factor loadings after Promax rotation; loadings above .40 are bolded.

	PC1 Future Discounting	PC2 Risky Personality	PC3 Variance Preference
FD_S	**.930**	.104	−.082
FD_M	**.965**	.144	−.070
FD_L	**.961**	.098	−.038
FDII	.134	**.437**	.129
SSS	.074	**.817**	.238
EIS	.100	**.752**	.192
RBS	.068	**.768**	.115
DOS	.068	**.848**	.264
VPT	.176	.074	**.451**
CT	.015	.149	**.628**
BART	−.258	.141	**.787**

Notes: See Table 1 notes.

other self-report personality measures and loaded highly on the Risky Personality PC.

3.3. Inter-relationships between risk components

Pearson correlations were used to investigate the relationship between the three PCs, with one significant result emerging: Risky Personality and Variance Preference were significantly and positively correlated, $r = .217$, $p = .01$. Future Discounting was not significantly associated with Risky Personality, $r = .109$, $p = .13$, or with Variance Preference, $r = -.095$, $p = .16$. One-tailed tests were used because of the *a priori* prediction that various components of risk-taking would be significantly associated.

4. Discussion

Results indicate that various instruments of risk-propensity may measure different components of risky behavior. Three PCs explained variance in measures of risk-propensity: Risky Personality, Variance Preference, and Future Discounting. Variance Preference and Risky Personality were significantly correlated, suggesting that there is an association between personality traits associated with risk and a behavioral preference for risky outcomes. Future Discounting was unrelated to other measures of risk-propensity, suggesting that it may represent a separate construct from behavioral preferences for risk. Together, the results support the hypothesis that such personality traits as impulsivity, sensation-seeking, and low self-control are proximate mechanisms through which a baseline behavioral preference for risky outcomes manifests.

Future discounting and impulsivity both reflect a tendency to prefer immediate rewards over later rewards. Several studies have demonstrated a link between future discounting and individual differences in personality, but have mostly done so in populations that exhibit high baseline levels of impulsivity (Bickel, Odum, & Madden, 1999; Kirby et al., 1999; Kollins, 2003; but see Daly & Wilson, 2006). We found an inconsistent relationship between future discounting and impulsivity. These results suggest that among university students, these two instruments might measure different constructs, a hypothesis supported by similar findings in other studies (Daly & Wilson, 2006; Reynolds et al., 2006). Different manifestations of a preference for immediate rewards may have different causes; Daly and Wilson (2006), for example, suggested that risk-preference may be mediated by variable attitudes toward the future, differences in the estimate of the utility of rewards, or the degree of risk involved in a reward. Further study of the nature and measurement of time preference and its relationship to impulsivity and general risk-propensity is required.

The component structure of measures of risk-propensity obtained in this study may be in part due to shared method variance. All of the personality instruments were self-report measures collected on paper, and all of the behavioral measures of risk were collected on a computer and involved choices that had real monetary consequences. The self-report and behavioral measures were also administered one week or more apart. It is possible that self-report instruments of risk-propensity measure stable individual differences associated with tendencies to take risks, and behavioral measures of risk are more state-dependent. That there was a significant association between Risky Personality and Variance Preference, however, suggests that personality traits do influence immediate behavioral choices to engage in risky behavior to some degree. Because of shared method variance, this association may have in fact been underestimated in the present study.

Although the various measures of personality traits associated with risk were highly and significantly intercorrelated, the behavioral measures were not. The BART and CT were significantly associated, but neither was significantly associated with the VPT or the future discounting measures. Correlations between the underlying risk components indicated that future discounting measures explained variance independent of other behavioral measures of risk. That the VPT was not significantly associated with the BART or the CT, however, is puzzling. It is possible that a one-shot decision-making task such as the VPT may not effectively measure individual differences in behavioral risk-acceptance.

The sample size in this study was modest. However, we maximized variance in measures of interest by utilizing an extreme-groups design, which demonstrably increases statistical power in situations with constrained variability in measures of interest (Preacher et al., 2005). Furthermore, our PCAs reflected subjects-to-variables ratios of greater than 10:1, exceeding the threshold for interpretable results (Velicer & Fava, 1998). Another limitation involved the measures chosen for inclusion in this study. Although there are other measures available for personality traits associated with risk (e.g., the Barratt Impulsiveness Scale; Patton, Stanford, & Barratt, 1995), the measures used in this study are some of the most widely used, highly validated measures available, and thus, we chose them over others (Marcus, 2003; Zuckerman, 1994, 2007). We also did not include a response inhibition task in this study (e.g., a go/no-go task). Future research should include a broader range of risk-taking measures in order to more effectively examine inter-relationships between personality traits and behavioral measures of risk.

Although we used an extreme-groups research design, variability among traits of interest may have been constrained in our undergraduate sample. Future studies should investigate the relationships of various risk measures among a more representative general population, or populations known to exhibit high levels of risk-acceptance (e.g., young males, gamblers). The relationship among different risk measures may be different among populations with higher levels of baseline risk-acceptance. Future studies should also compare the predictive validity of these components of risk by examining objective measures of risk (or outcomes of risk), such as delinquency records, school suspensions, or driving incidents. The stability of these risk measures is also an open question; it is presently unclear whether risk-acceptance is largely contingent on environmental circumstances, or whether individual differences in risk-acceptance are relatively stable over time and situation. It is clear, however, that different measures of risk-acceptance appear to measure different aspects of risk, indicating that researchers should exercise caution when choosing and interpreting measures of risk-propensity in future studies.

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