Revisiting the Effects of Anger on Risk-Taking: Empirical and Meta-Analytic Evidence for Differences Between Males and Females

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Abstract

That anger elicited in one situation can carry over to drive risky behavior in another situation has been described since the days of Aristotle. The present studies examine the mechanisms through which and the conditions under which such behavior occurs. Across three experiments, as well as a meta-analytic synthesis of the data, results reveal that incidental anger is significantly more likely to drive risky decision making among males than among females. Moreover, the experiments document that, under certain circumstances, such risk-taking pays off financially. Indeed, the present experiments demonstrate that, because the expected-value-maximizing strategy in these studies rewarded risk-taking, angry-male individuals earned more money than did both neutral-emotion males and angry females. In sum, these studies found evidence for robust disparities between males and females for anger-driven risk-taking. Importantly, although men did not experience more anger than women, they did show a heightened tendency to respond to anger with risk-taking.

Revisiting the Effects of Anger on Risk-Taking

NASCAR driver Jimmie Johnson, known for his even temper, admits that early in his career he let his anger get the best of him. In one now-notorious instance, he recalls getting out of his wrecked car and walking past speeding cars to confront the driver who caused the crash: "I guess that's my one time of letting emotion get to me." Although uncharacteristic of Johnson, such instances are common in this male-dominated sport, leading NASCAR to enact rules that prohibit such flagrantly unsafe actions. Yet Johnson himself questions whether such mandates would prevent such behavior: "Will that stop a driver that's really upset? I don't know. It's hard to say" (quoted in Bernstein, 2014). These and countless other variations on road rage highlight ways in which anger can drive risk-taking.

The scholarly literature has begun to examine the mechanisms underlying this phenomenon, documenting that anger facilitates optimistic risk perceptions (Hemenover & Zhang, 2004; Lerner & Keltner, 2001; Lerner & Tiedens, 2006; see Lerner, Li, Valdesolo, & Kassam, 2015), including in a nationally representative sample of U.S. citizens (Lerner, Gonzalez, Small, & Fischhoff, 2003). Anger is also associated with tendencies to choose a risky option over a certain option of equal expected value (Lerner & Keltner, 2001) as well as a pattern of neural activation characteristic of approach motivation (Carver & Harmon-Jones, 2009; Harmon-Jones, 2003). According to the Appraisal Tendency Framework (ATF; Han, Lerner, & Keltner, 2007; Lerner & Keltner, 2000; 2001), anger's influence on risk perception is partially explained by the fact that anger is characterized by high levels of the cognitive appraisal dimensions of certainty and control (Smith & Ellsworth, 1985). Such effects might be especially strong when individuals consider risks associated with redressing a transgression or deterring future transgressions (Frijda, 1986; Lerner & Tiedens, 2006). Importantly, anger's influence extends beyond risk perceptions to actual risk-taking, even when the stakes are real. In one experiment, induced anger increased risk-taking on a gambling task, as compared to fear (Kugler, Connolly, & Ordonez, 2010), demonstrating anger's potential to drive actual risk-taking in structured task paradigms (i.e., choosing between two options, each with the same expected utility but a different combination of risk/reward).

Examining how gender (i.e., people who identify as females vs. males) interfaces with determinants of risk-taking, such as anger, is critical given research finding reliable gender differences in risk-taking and suggesting that women are more effective at managing risk (e.g., Barber & Odean, 2001). Indeed, males tend to engage in riskier behavior than females (Mahalik et al., 2013). For example, smoking rates are higher among men than women (Centers for Disease Control and Prevention, 2014). Moreover, experimental evidence suggests that risk-taking under anger may be more prominent among males. Fessler et al. (2004) demonstrated that anger increased risk-taking among males (but not females) on a behavioral choice task where participants chose between a guaranteed and a risky monetary reward of the same expected utility. Research on other affective states, such as psychological stress, suggests that they too influence risk-taking differently for men and women (Mather & Lighthall, 2012; Van Den Bos, Taris, Scheppink, de Haan, & Verster, 2014).

An evolutionary framework predicts that although anger may motivate both men and women to terminate or prevent transgression (e.g., Frijda, 1986; Levenson, 1999), the evolutionarily based cost of risk-taking (i.e., aggressing) is lower among men due to physical differences and those associated with protecting offspring (Plavcan & Van Schaik, 1997), which leads to less risk-taking among females when angry. If men are riskier when angry, this may result in a high prevalence of risky behavior, given that males experience disproportionately greater anger in response to aggression and disasters (Lerner e al., 2003). Note that meta-analytic evidence suggests that males exhibit consistently riskier choices (van den Bos, on the Balloon Analogue Risk Task (BART; Cross, Copping, & Campbell, 2011), in accordance with men's greater risk-taking propensity in everyday life.

We extend previous findings (Fessler et al., 2004; Kugler et al., 2010) by examining how anger influences risk-taking in the context of uncertainty and experientially-learned risk perceptions. This is an important next step, given that risky behaviors often are undertaken without understanding of the precise probability of a consequence. For example, the dynamic fluctuations of financial markets have complex and random determinants. While gain or loss resulting from an investment decision can be anticipated to some extent, the probability of those consequences cannot be made explicit and are learned from experience. Likewise, real-world risk-taking based on experientially-derived risk perceptions is fundamentally different from decisions made under explicit probabilities (Weber, Shafir, & Blais, 2004). Moreover, real-world risk-taking often involves repeated interdependent choices with risk levels escalating as a result of one's previous decisions (e.g., Goldberg & Fischhoff, 2000; Leigh, 1999). For example, smoking one cigarette is not itself a strong risk factor for lung cancer, but rather influences cancer risk by predicting a pattern of smoking that compounds into a higher risk for lung cancer.

Across three experiments and a meta-analysis of the data, we examined incidental anger's potential contribution to risk-taking under risk and uncertainty. We used the BART, a dynamic paradigm in which the probability of avoiding a loss is not made explicit but rather is learned through experience with the task. Moreover, the risk associated with each choice is dependent on choices made previously (Lejuez et al., 2002). One key advantage of the BART paradigm is that, for each iteration of a BART study, researchers can program the degree to which risk-taking increases or diminishes expected utility. Another key advantage is that scores on the BART provide a relatively stable measure of the propensity for risk-taking across time (White, Lejuez, & Harriet, 2008). Perhaps most importantly, scores on the BART predict several real-world risky behaviors, including smoking, alcohol consumption, drug use, gambling, and sexually risky behavior (Aklin Lejuez, Zvolensky, Kahler, & Gwadz; 2005; Fernie, Goudie, & Field, 2010; Frankenburger, 2004; Hopko et al., 2006; Lejuez, Aklin, Zvolensky, & Pedulla, 2003a; Lejuez et al., 2003b; Lejuez, Simmons, Aklin, Daughters, & Dvir, 2004; Nelson et al., 2008; Ronay & Kim, 2006). By elucidating the influence of anger on risk-taking in a controlled laboratory setting, using an ecologically valid task that is predictive of real-world risky behaviors, the present studies aim to shed light on fundamental decision-making processes that generalize to real-world outcomes.

Moreover, we ran analyses to examine whether the influence of anger on risk-taking differed for men and women. In Experiment 1, we included a sadness condition to test predictions that anger would increase risk-taking due to its cognitive appraisal tendencies rather than its valence. Sadness is lower than anger on cognitive appraisals of certainty and control (Smith & Ellsworth, 1985) but is associated with a core appraisal theme of loss (Lazarus, 1991) and with action tendencies toward reward-taking as means of mitigating the loss (e.g., Lerner, Small, & Loewenstein, 2004; Raghunathan & Pham, 1999). Thus, if angry participants took more risks than sad participants, the result would be due to the differences in certainty and control. If angry and sad participants displayed similar risk preferences, it would indicate that the result could be attributed to the general negative valence, motivating either reward-seeking or certainty and control. In Experiments 2 and 3, we examined only anger and neutral-condition comparisons.

We predicted that anger would increase risk-taking as compared to neutral emotion (and, in Experiment 1, sadness) (*Hypothesis 1)*. Moreover, we predicted that this effect may differ among men and women (*Hypothesis 2).* Specifically, we predicted that the magnitude of risk-taking in response to anger may be greater for men than for women (*Hypothesis 3).*

Experiment 1

Method

Participants and design. Experiment 1 took the form of a one-factor, three-level design (Emotion: neutral, anger, sadness). One hundred and twelve participants were recruited through a university participant pool. Four participants experienced computer malfunctions, and one did not follow instructions. These five were excluded from analyses. Another participant was excluded as an outlier greater than three standard deviations above the mean for a component of the risk-taking outcome, described below,[1] leaving 106 participants (61 men, 34 women, 11 non-responding; M_{age} = 20.00, *SD* = 1.39, range 17-25) in the sample. A breakdown of participants' gender and age by condition is located in Table 1. Participants were remunerated with course credit, plus their earnings on the BART, rounded up to the nearest dollar.

Procedure. Upon entering the lab, participants were seated in a private cubicle with a computer and headset. Participants first filled out a consent form and an English fluency assessment; all participants passed.

Participants were informed that they would be performing two tasks on a computer, the first of which involved writing and then viewing a video, and the second of which consisted of a game. In the first task, they completed pre-experiment measures of emotion. Participants were randomly assigned to the anger, sadness, or neutral condition. A standard autobiographical induction (Strack, Schwarz, & Gschneidinger, 1985) widely employed across the literature to successfully induce anger and sadness (see Lench, Flores, & Bench, 2011) was used: participants were instructed to write in detail about an incident that had made them angry or sad. Neutral participants were asked to write in detail about their daily evening activities as a time-matched but unemotional control. When they had finished typing, the experimenter approached them and started the next computer program, which played one of three video clips (matched to the emotion condition of the essay) typically used in elicitation of anger or neutral affect (i.e., clips from the films "My Bodyguard," "The Champ," and "The Great Barrier Reef"; Gross & Levenson, 1995).

Participants were then transitioned to the second task, which involved the BART. In this computer-administered task, participants decided how much air to pump into a series of balloons. Each pump of air was worth five cents; however, at some point the addition of air would cause the balloon to burst, negating earnings for that balloon. If participants no longer wished to risk the balloon popping by further pumping, they could terminate the round and bank any money they had earned. The underlying task structure used sampling without replacement to determine whether the balloon should pop upon being pumped. Here, the maximum number of pumps was set at 64; this meant that on the first trial, participants had a 1/64 chance of bursting the balloon on the first pump, a 1/63 chance on the second pump, and so on. Participants were given verbal instructions about the BART, but, importantly, probability that each pump would burst was not explained to participants.

Participants were exposed a total of six blocks, each consisting of five balloons. Three blocks involved active participation, and three blocks were simulations where participants viewed the balloon pumping and bursting but did not have control over the pumping. The three passive blocks were inserted to facilitate future (as yet not undertaken) replication with fMRI methodology (to control for neural activation associated with viewing the balloon pumping and thus isolate only neural activation associated with active participation in the task). Whether a block would be active or passive was delineated on the screen with an “$” or “X” immediately preceding the block. Blocks one, five, and six were active, while blocks two, three, and four were passive.[2] Between blocks four and five, the computer program displayed an emotion induction reminder, asking participants to think back on the situation they described in their essay to combat degradation of the induced emotion. At the end of the experiment, 14 randomly selected participants filled out the emotion questionnaire for the second time as a post-experiment manipulation check.

Measures. As a pretest and manipulation check, participants rated the extent to which they were feeling each of different affective states on a nine-point Likert scale. Reliability for each sub-scale was acceptable in both pre- and post-experiment assessments. The anger scale consisted of three items: angry, furious, and mad (pre- $\alpha = .91$; post- $\alpha = .99$). The sadness scale consisted of three items: sad, depressed, and blue (pre- $\alpha = .88$; post- $\alpha = .96$).

To achieve maximal stability for the outcome measure, and because the two outcome measures were correlated ($r = .54$, $p < .001$), we combined both outcomes in the BART: 1) the average number of balloon pumps prior to a burst (adjusted average pumps),[3] and 2) total earnings (a non-linear function of total pumps prior to a burst).[4] More specifically, we calculated the risk-taking outcome variable by taking the average of the standardized *z*-scores for these two variables.

Analyses. Following Keppel & Zedeck’s (1989) analytic strategy for testing a-priori hypotheses, we conducted a series of planned comparisons. To empirically justify combining the sadness and neutral conditions to test Hypothesis 1 below, we first conducted a preliminary planned independent samples *t*-test comparing sad and neutral participants' risk-taking. To test *Hypothesis 1* – that angry participants would take greater risk than would neutral and sad participants – we needed to first test whether risk-taking differed between sadness and neutral conditions. If they did not, then we could conduct a planned independent samples *t*-test comparing anger to the combination of sadness and a neutral state on risk-taking. To test *Hypothesis 2,* that the effect of anger may differ between men and women, we conducted a full-factorial 2 (anger vs. sadness and neutral combined) x 2 (men vs. women) analysis of variance (ANOVA).[5] Eleven participants did not report their gender, so we conducted these analyses on the remaining 96 participants.

Results

Manipulation checks. Means and standard deviations for pre- and post-test anger and sadness scales are reported in Table 2. There were no differences in baseline anger by emotion condition, $F(1,91) = 1.59$, $p = .211$, or gender, $F(1,91) = 1.10$, $p = .297$, nor were there differences in baseline sadness by emotion condition, $F(1,91) = 0.13$, $p = .716$, or gender, $F(1,91) = 0.22$, $p = .641$.

Demonstrating its efficacy, participants in the anger condition experienced significantly increased subjective anger compared to the neutral condition, $F(1,7) = 15.61$, $p = .006$, $d = 2.04$, and sad condition, $F(1,7) = 11.71$, $p = .011$, $d = 1.77$. Demonstrating its efficacy, participants in the sadness condition experienced significantly increased subjective sadness as compared to the neutral condition, $F(1,7) = 6.67$, $p = .036$, $d = 1.38$, although the difference between the sadness and anger conditions was not significant, $F(1,7) = 1.81$, $p = .221$, $d = .72$.

Effect of anger on risk-taking. Means and standard deviations by experimental condition and gender are located in Table 3. As predicted, the neutral and sadness conditions did not differ in their risk-taking, $t(70) = -.71$, $p = .483$, $d = .17$, empirically justifying their combination. Importantly, planned comparisons supported *Hypothesis 1*, indicating that angry participants took significantly more risks than did individuals in the combined sadness and neutral condition, $t(104) = 2.56$, $p = .012$, $d = .31$. *Hypothesis 2* was not supported: the effect of anger did not differ for men and women, $F(1,89) = 0.83$, $p = .921$, $d = .19$.[6] Note that there were no baseline differences (i.e., within the neutral emotion condition) between men and women's risk-taking, $F(1,27) = 0.68$, $p = .417$.

Discussion

This study provided evidence that anger heightens risk-taking. Angry participants took more risks than did sad (and neutral) participants, and sad participants behaved similarly to neutral participants, suggesting that the discrete state of anger, rather than generalized negative affect, is responsible for the effect of anger on risk-taking behavior. One can conclude that the reward-seeking tendency associated with sadness (see Cryder, Lerner, Gross, & Dahl, 2008; Lerner, Li, & Weber, 2013) is less strong than the tendency for anger to diminish perceptions of risk or that sad participants simply did not recognize the relationship between risk taking and future reward. Importantly, Experiment 1 provides the first evidence we know of that anger increases risk taking even when expected values are not equal, thus building on the findings of Kugler, et al. (2010), who documented anger's effect with choices involving equal expected value.

In Experiment 2, we aimed to replicate findings concerning anger and risk-taking. Replication is particularly important, given that these findings supported only the hypothesis for the main effect of anger, but did not support predictions regarding gender differences in risk-taking under anger based on previously documented work (Fessler et al., 2004). Because the strong differences between anger and sadness supported the hypothesis that anger – rather than generalized valence – was responsible for the effect, we chose to further explore only angry vs. neutral comparisons in Experiment 2.

Experiment 2

Method

Participants and design. Experiment 2 took the form of a one-factor, two-level (neutral vs. anger) design.[7] Sixty-six participants were recruited from a New England university community sample, a change in region from Experiment 1. Two participants whose computers malfunctioned were dropped from the analyses, leaving 64 participants (30 women, 25 men, 9 non-responding; $M_{\text{age}} = 21.69$, $SD = 3.74$, ranging from age 18-35) in the sample. A breakdown of participants' gender and age by condition is located in Table 1; participants' education information was not collected.

The procedure was identical to Experiment 1, with three exceptions: 1) there were only two emotion conditions, anger and neutral; 2) there were only three blocks of balloons, with no inactive blocks; and 3) participants were remunerated with $10 plus their earnings on the BART, rounded up to the nearest dollar. Thus, they began the study in the gain domain, allowing us to test for generality. Consistent with our approach in Experiment 1, and because chance resulted in an even higher correlation between pumps and earnings ($r = .843$, $p < .001$), we combined adjusted average pumps and earnings into a single risk-taking index by averaging their standardized *z*-scores.

Measures. Measures of anger and sadness were identical to those employed in Experiment 1. Reliability for each sub-scale was high in both pre- and post-experiment assessments (anger: pre- $\alpha = .92$; post- $\alpha = .98$; sadness pre: $\alpha = .838$; post: $\alpha = .859$).

Analyses. To test *Hypothesis 1,* that angry participants would take more risks than neutral participants, we conducted a planned independent samples *t*-test. To test *Hypothesis 2,* that differences in anger-induced risk-taking by gender may have obscured a significant main effect, we conducted a fully factorial 2 (anger vs. neutral) x 2 (male vs. female) ANOVA. To test Hypothesis 3, that an interaction would be driven by greater anger-induced risk-taking among men than women, we also conducted two planned independent *t*-tests, stratified by gender, comparing risk-taking among angry and neutral participants. Ancillary regression analyses were conducted to examine whether the subjective experience of anger predicted risk-taking differentially for men and women; Moderated mediation analyses were not undertaken due to lack of statistical power.

Results

Manipulation checks. Means and standard deviations for pre- and post-test anger and sadness scales are reported in Table 2. There were no differences in baseline anger by emotion condition, $F(1,51) = 0.27$, $p = .871$, or gender, $F(1,51) = 0.30$, $p = .862$, nor were there differences in baseline sadness by emotion condition, $F(1,51) = 0.07$, $p = .795$, or gender, $F(1,51) = 0.53$, $p = .468$.

Demonstrating the efficacy of the anger manipulation, the anger induction significantly increased subjectively experienced anger as compared to the neutral condition, $F(1, 54) = 142.47$, $p < .001$, $d = 3.16$). Neither gender, $F(1, 54) = 1.83$, $p = .183$, $d = .36$, nor the interaction term, $F(1, 54) = 0.54$, $p = .467$, $d = .19$, were significant predictors.

Effect of anger and gender on risk-taking on the BART. Table 3 contains means, standard deviations, and ranges for the risk-taking outcome. Inconsistent with *Hypothesis 1,* there was no main effect of anger on risk-taking, $t(62) = .50$, $p = .619$, $d = .13$. However, *Hypothesis 2* was supported: the anger-by-gender interaction was significant, $F(1, 51) = 4.92$, $p = .031$, $d = .60$. Planned comparisons were somewhat consistent with *Hypothesis 3:* although angry men took no more risks than neutral men, $t(23) = 1.15$, $p = .259$, $d = .48$., angry women took *less* risks than neutral women, $t(28) = -2.11$, $p = .044$, $d = -.80$.[8] Consistent with the finding that the anger induction led to reduced risk-taking among women but not men, self-reported anger was negatively associated with risk-taking among women, $\beta = -.45$, $p = .013$, whereas the association was positive, albeit not significant, among men, $\beta = .33$, $p = .106$. Note that there were no baseline differences (i.e., within the neutral emotion condition) between men and women's risk-taking, $F(1,27) = 1.08$, $p = 307$.

Discussion

These data suggest that the effect of incidental anger on risk-taking may differ for men and women, supporting Hypothesis 2. However, the pattern of interaction was different than expected; angry women took significantly less risk than women in a neutral affective state, somewhat in contrast to predictions that men would drive any interaction effects. These results stand in contrast to the results of Experiment 1 (and do not support Hypothesis 1), which uncovered a main effect of anger but no anger-by-gender interaction. Importantly, gender differences in risk-taking could not be explained by a difference in the self-reported emotional experience of men and women, given that there were no anger-by-gender differences in the anger manipulation checks (a finding consistent with the body of literature demonstrating a lack of differences in the experience of emotion between men and women; see Kring, 2000).

There are two potential explanations for this discrepancy. First, there could be meaningful differences between the samples that would explain moderation by gender in Experiment 2 but not Experiment 1. The second possibility is that random variation caused the discrepancy. To explore these possibilities further, we conducted a third experiment to test the potential main effect and anger-by-gender interaction on risk-taking on the BART. We designed Experiment 3 to systematically test the main effect of and interaction between gender and anger on risk-taking, as well as to provide additional evidence that could contribute to a meta-analytic synthesis. Thus, we replicated the design of Experiment 2 but increased the number of participants, recruiting roughly 15 more males and 15 more females.

Experiment 3

Method

Participants and design. Ninety-four participants were recruited from a New England university community sample. Fifteen participants whose computers malfunctioned were excluded from analyses. One subject was a statistical outlier above three standard deviations for earnings; this subject was also dropped from the analyses, leaving 78 participants in the sample (38 women, 38 men, 2 non-responding).[9] We were only able to collect age data from 64 participants (M_{age} = 24.06, *SD* = 7.24, ranging from 18-62). A breakdown of participants' gender and age by condition is located in Table 1; participants' education information was not collected

Procedure. The procedure and compensation structure were identical to Experiment 2. Consistent with our approach in Experiments 1 and 2, and because chance resulted in an even higher correlation between pumps and earnings ($r = .858$, $p < .001$), we combined adjusted average pumps and earnings into a single risk-taking index by averaging their standardized *z*-scores.

Measures. Measures of anger and sadness were identical to those employed in Experiments 1 and 2. Reliability for each sub-scale was acceptable (anger: pre- $\alpha = .93$; post- $\alpha = .99$; sadness pre: $\alpha = .854$; post: $\alpha = .942$).

Analyses. Analyses were identical to those employed in Experiment 2.

Results

Manipulation checks. Means and standard deviations for pre- and post-test anger and sadness scales are reported in Table 2. There were no differences in baseline anger by emotion condition, F(1,69) = 1.86, p = .177, or gender, F(1,69) = 0.41, p = .526, nor were there differences in baseline sadness by emotion condition, F(1,68) = 1.10, p = .298, or gender, F(1,68) = 0.61, p = .434.

Demonstrating the efficacy of the manipulation, the anger induction significantly increased subjectively experienced anger as compared to the neutral condition, $F(1, 72) = 99.97$, $p < .001$, $d = 1.72$. Neither gender, $F(1, 71) = 0.001$, $p = .974$, $d = .01$, nor the interaction term, $F(1, 72) = 0.24$, $p = .623$, $d = .11$, were significant predictors.

Effect of anger and gender on risk-taking. Table 3 contains means, standard deviations, and ranges for the risk-taking outcome. Inconsistent with *Hypothesis 1*, and consistent with the results of Experiment 2, there was no main effect of anger, $t(76) = .69$, $p = .494$, $d = .16$. Supporting *Hypothesis 2*, the anger-by-gender interaction was significant, $F(1, 72) = 5.02$, $p = .028$, $d = .52$. Planned comparisons supported *Hypothesis 3*, indicating that angry men took more risks than did neutral men, $t(36) = 2.26$, $p = .030$, $d = .75$. Analyses among women revealed no effects of anger on risk-taking, $t(36) = -1.00$, $p = .326$, $d = -.33$.[10] Consistent with the finding that the anger induction increased risk-taking among men but not women, self-reported anger was not associated with the risk outcome among women, $\beta = .01$, $p = .948$, whereas the association approached significance among men, $\beta = .28$, $p = .090$. Note that there were no baseline differences (i.e., within the neutral emotion condition) between men and women's risk-taking, $F(1,34) = 2.85$, $p = .100$.

Discussion

These data contribute to evidence suggesting that the effect of incidental anger on risk-taking may be different for men and women. We found that men engage in more risk-taking when they are angry versus when they are not angry. Again, the effect could not be attributed to self-reported differences in the subjective experience of emotions because the men and women did not differ in their emotional responses to the emotion induction. The fact that the interaction pattern was duplicated in Experiments 2 and 3 suggests that the difference may be reliable, although seemingly discrepant from Experiment 1. To examine the strength of the interaction – and the main effect of anger – across data from these three experiments, we conducted a meta-analysis.

Meta-analysis

Method

Effect size calculations. For each experiment, we calculated effect sizes separately for males and females, resulting in six risk-taking effect sizes. Effect sizes (*d*) were calculated by taking the mean difference between the anger condition and the neutral condition. Positive effect size indicated an increase in risk-taking in the anger condition as compared to the neutral condition. To correct for sample size bias, all effect sizes were weighted by the inverse of the effect size variance (Hedges, 1981).

Analyses. To evaluate whether effect sizes were homogeneous among studies, we calculated the *Q* statistic. A significant *Q* indicates a rejection of the null homogeneity hypothesis, suggesting there is significant variance among effect sizes.

Because effect sizes were not homogenous for either outcome, we employed random effects meta-analysis models. We first examined a main effects meta-analysis model to test

Hypothesis 1, that anger had a direct effect on risk-taking across the three experiments. Then, we performed a meta-regression to examine *Hypothesis 2*, that the effect of anger on risk-taking differed for men and women. Finally, we conducted a series of two main effects meta-analyses, stratified by gender, to test *Hypothesis 3*, that anger increased risk-taking more among men than among women. Analyses were performed using Comprehensive Meta-Analysis v3.

Results

Main effects of anger. Effect sizes were not homogeneous, $Q(5) = 13.12$, $p = .022$. I^2 and Tau-squared calculations indicated that variability among effect sizes was moderate, $I^2 = 61.89\%$, Tau-squared = .221. Thus, we examined a random-effects model, which indicated that the average effect size was not significant, $d = 0.17$, *95% CI* = -0.31, 0.65, $p = .479$, suggesting that anger did not uniformly influence risk-taking across the experiments, inconsistent with *Hypothesis 1*.

Moderation by gender. Figure 1 contains a forest plot of all effect sizes of anger stratified by gender. To explain the heterogeneity across effect sizes and further examine the hypothesis that the influence of anger is moderated by gender, we conducted random-effects moderator analyses. Participant gender significantly influenced the magnitude of the effect size, $B = .77$, $p = .042$, consistent with *Hypothesis 2*. There was residual heterogeneity, Q(1) = 4.13 , p = .042, which was quantified as relatively low, $I^2 = 35.61\%$, Tau-squared = .076. Residual heterogeneity is not unexpected given that the effect size for earnings is determinant not only on behavior but also on chance factors. Model fit was good, R^2 analogue = 0.66.

Moreover, in analyses restricted to males, the overall effect size was significant, $d = 0.54$, *95% CI* = 0.13, 0.94, $p = .009$. In analyses restricted to females, the effect size was not significant, $d = -0.21$, *95% CI* = -0.93, 0.52, $p = .578$. Thus, *Hypothesis 3* was supported, as analyses suggest that across these three experiments, anger increases risk-taking among males but does not influence risk-taking among females.

General Discussion

In a meta-analytic, quantitative synthesis using data across three experiments, we uncovered evidence that men and women respond to incidental anger differently, resulting in opposite patterns of risk-taking under uncertainty. Specifically, men have a greater tendency to take risky actions when angry, a pattern not exhibited by women. These findings are consistent with previous research on gender differences in the influence of anger on risk-taking behavior (Fessler et al., 2004), but extend them to a dynamic paradigm where risk is learned through experience with the task rather than made explicit. One reason risk-taking in response to anger may be so common is that it can be very rewarding (e.g., Coates & Herbert, 2008; Mishra & Lalumiere, 2010), thus serving an evolutionarily based, functional purpose (see Solomon, 2003). Indeed, in our experimental protocol, because the risky option is also associated with the greatest expected utility, anger led to better outcomes among men, but not women. However, this pattern would be reversed if the task rewarded risk-averse behavior for risky behaviors that are real-world correlates of this task, including smoking, substance use, alcohol consumption, gambling, and risky sexual behavior (e.g., Hopko et al., 2006; Lejuez et al., 2003a; Lejuez et al., 2004).

These findings lead to an important hypothesis concerning mechanisms underlying differences in patterns of risk-taking between men and women (e.g., Centers for Disease Control and Prevention, 2014; Mahalik et al., 2013), namely that men are more likely than women to respond to aggression and disasters with anger (Lerner et al., 2003; although see Kring, 2000 for the lack of differences in emotional experience for men and women). Thus, it seems likely that gender differences in risk-taking may be a function of the male-specific experience of anger and its influence on risk-taking. That is, if men experience more everyday anger and uniquely respond to such anger by exhibiting risk-taking, one would expect gender disparities in risk-taking such as smoking, alcohol abuse, gambling, and substance use.

According to an evolutionary perspective, whereas men are motivated to react to transgressions by approaching and aggressing in order to end current, and deter future, transgressions (as well as to decrease reproductive competition), women are motivated to disengage because the costs to themselves and their offspring of aggressing are too high (Plavcan & Van Schaik, 1997). According to this view, females would undergo a "risky shift" (Burnstein et al. 1971) and respond to risk by seeking affiliation or attachment rather than pursuing risk (Taylor et al., 2000). By taking action under risk in modern society, men may be achieving the same ends as confrontational risk in the past by establishing a reputation for insensitivity to costs (Daly & Wilson, 2001). Note that these gender differences are driven in part by the interaction between the demands of the physical environment and cultural norms in gender roles for responding to such demands rather than solely being due to evolutionary mechanisms (Eagly & Wood, 1999). As such, although these findings may be universal among most industrialized Western societies, gender differences may manifest differently in non-industrialized societies.

The findings regarding women are seemingly inconsistent with ATF predictions concerning overarching effect of anger on risk-taking. However, if action tendencies associated with anger differ for men and women, the ATF would predict that anger's influence on judgment and decisions would differ correspondingly. Moreover, it is possible that angry men and angry women differ in their appraisals of the situation. That is, women may feel less certainty and control following anger. Previous research has shown that women feel similarly angry in response to transgressions but feel considerably less in personal control than men do (Brody, Lovas, & Hay, 1995; but see Tiedens & Linton, 2001). The integration of ATF and an evolutionary framework predicting gender differences in appraisals and action tendencies is consistent with previously articulated perspectives that evolutionary frameworks can complement, rather than undermine, traditional emotion frameworks (Haselton & Ketelaar, 2005).

These findings are similar to previously documented findings concerning stress and risky decision making, where physical and psychological stress trigger riskier choices for men than women on the BART (Lighthall, Mather, & Gorlick, 2009; Mather & Lighthall, 2012), as well as on the Iowa gambling task (van den Bos, Harteveld, & Stoop, 2009) and Cambridge Gambling task (van den Bos et al., 2014). Although the pattern of male and female risk-taking in response to anger and stress may be similar, we suggest that the psychological mechanisms underlying these effects may differ. Whereas anger facilitates risk-taking among men by activating control appraisals and approach-related action tendencies (Lerner et al., 2000; 2001), stress is thought to facilitate risk-taking among men via neurobiological processes that promote reward-seeking that are differentially activated among men and women (Lighthall et al., 2012). Importantly, research suggests that reward-seeking processes are activated by sadness (Cryder, Lerner, Gross, & Dahl, 2008; Lerner et al., 2013; 2014); as such, if the effects of anger and stress on risk-taking share a psychological mechanism (i.e., reward-seeking), sadness should trigger a similar pattern of risky behavior. However, the pattern of results in Experiments 1 does not support this prediction, where sad participants and neutral participants performed similarly on the BART.

Our findings stand somewhat in contrast to research linking anger to optimistic risk perceptions, regardless of gender (e.g., Lerner & Keltner, 2000; 2001; Lerner et al., 2003). Gender differences were not examined in previous work on emotion and risk perception; as such, this discrepancy in findings may be explained by simple methodological and analytical differences. However, it is possible that the explanation is more complex. Risk perceptions assessed in previous studies were deliberatively (rather than affectively) derived – that is, participants were asked about the likelihood of a risk, rather than about how they *felt* about the risk. Deliberatively and affectively derived risk perceptions do not always correspond (e.g., Ferrer et al., 2011; in press; Portnoy, Ferrer, & Klein, 2013), and affectively derived risk perceptions are often more predictive of risk-taking than deliberatively derived risk perceptions (e.g., Dillard, Ferrer, Ubel, & Fagerlin, 2012; Janssen, van Osch, de Vries, & Lechner, 2011). Indeed, advantageous decisions on tasks involving experientially derived risk rely heavily on affectively laden "somatic markers" that highlight the best choice (Damasio, 1994/ 2006). As such, it seems plausible that anger's effect on deliberative risk perceptions would not correspond to effects on risk-taking in a dynamic paradigm where risks are learned experientially over time.

Our conclusions are somewhat limited by small sample size and lack of power within each experiment. This may have contributed to somewhat equivocal findings across experiments, and in particular the finding that there were no gender differences in the effect of anger on risk-taking in Experiment 1. This weakness is offset by a meta-analytic synthesis suggesting that gender reliably moderates the association between anger and risk-taking across studies, which lends credence to the idea that gender differences in the effects of anger and risk-taking reflect a real phenomenon rather than something captured by chance. However, future research should examine conditions under which anger leads to risk-taking among women. Moreover, limited power precluded moderated mediation analyses to examine whether the differential effect of the anger induction on risk-taking among men and women was mediated by self-reported anger. Although the pattern of associations we uncovered is consistent with the hypothesis that the subjective experience of anger mediates effects, future research is necessary to more fully explore this hypothesis. Additional research is also necessary to uncover the mechanisms underlying gender differences in response to anger.

We are also limited to drawing conclusions about risky behavior among angry young males, as our sample consisted solely of young adults. As such, future research should examine whether these findings are consistent when older males are included in the sample. Future research should also examine the role of gender in moderating the influence of other high-certainty and high-control emotions on risk-taking. Research has shown that such emotions (i.e., guilt) result in patterns of optimistic risk perceptions and risk-taking similar to those elicited by anger (Kouchaki, Oveis, & Gino, 2014), but no research to date has examined whether gender moderates such effects.

Another limitation is that the anger induction also increased sadness to some extent, a common problem across research involving emotion inductions (e.g., inducing anger may also to some degree induce other negative emotions; Gross & Levenson, 1995). However, future research should identify inductions for isolating anger. Finally, we acknowledge that we did not consider many individual differences other than gender, such as level of trait anxiety (De Visser et al., 2010) and hormonal variations (Mehta, Welker, Zilioli, & Carre, 2015; Sapienza, Zingales, & Maestripieri, 2009; Stanton, Liening, & Schultheiss, 2011; although see Zethraeus et al., 2009), that may affect risk-taking propensities. It was therefore important to use strict random assignment to conditions in each study in order to ensure that variables not of interest would be controlled. Future research may extend this work, now that the respective roles of anger and gender have been identified, by considering additional individual differences.

Despite these limitations and clear future directions, the present findings may have important implications. In everyday life, while risks may be beneficial in the short term (e.g., Coates & Herbert, 2008; Mishra & Lalumiere, 2010), increasingly taking more risks can lead to impulsive behavior, carelessness, and eventually a greater loss overall (e.g., Booth, Johnson, & Granger, 1999; Kuhnen & Knutson, 2005). Importantly, given that the BART is reliably associated with real-world risk-taking (e.g., Lejuez et al., 2004), it is possible that anger may systematically increase these behaviors in men but not women. Although it is not clear whether manipulating responses to the BART translates to corresponding changes in everyday risk-taking behavior, it seems plausible that influences on risk-taking or aversion induced by anger may generalize, particularly in the context of behavioral initiation (before other factors such as addiction or habit have contributed to comprising behavioral choices). It is critical that future research examine this possibility to elucidate how emotions such as anger may influence risk-taking.

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Table 1. Participant gender and age by experimental condition.

			Age	
	n	*% within condition**	*M*	*SD*
Experiment 1				
Angry men	20	58.8%	20.05	1.23
Angry women	10	29.4%	20.30	0.82
Sad men	23	62.2%	20.36	1.71
Sad women	13	35.1%	19.31	1.25
Neutral men	18	51.4%	19.56	0.71
Neutral women	11	31.4%	20.00	1.41
Experiment 2				
Angry men	14	43.8%	20.54	2.60
Angry women	12	37.5%	20.82	3.10
Neutral men	11	34.4%	23.22	5.93
Neutral women	18	56.3%	22.38	3.42
Experiment 3				
Angry men	24	40.0%	25.84	11.43
Angry women	16	60.0%	23.75	5.40
Neutral men	14	36.8%	23.36	3.93
Neutral women	22	57.9%	22.78	4.02

*Percentages do not add up to 100% due to non-response/ missing data on participant gender.

Table 2. Pre- and post-test anger and sadness scores by experimental condition and gender

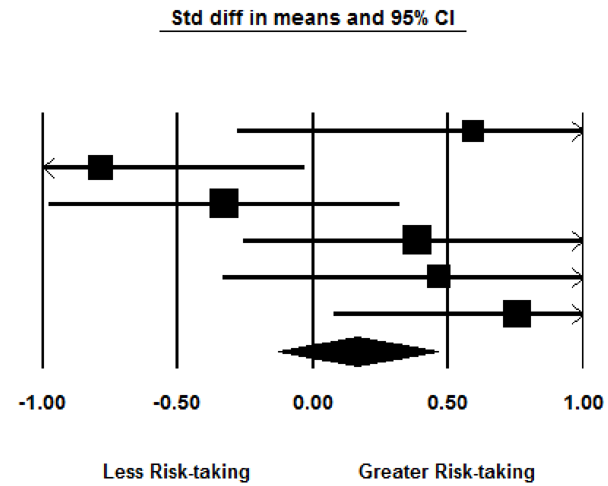
	Pre-test anger		Post-test anger		Pre-test sadness		Post-test sadness	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Experiment 1	2.13	1.51	3.02	2.68	2.83	1.78	3.57	2.55
Angry men	2.47	1.87	4.17	4.01	2.70	1.79	2.83	2.12
Angry women	1.20	0.32	6.33	2.83	2.77	1.73	4.33	3.77
Sad men	2.09	1.16	1.56	0.69	2.67	1.70	4.44	2.91
Sad women	2.51	1.77	1.33	0.47	3.38	1.99	7.00	1.41
Neutral men	1.93	1.49	1.44	0.77	2.80	1.72	1.33	0.58
Neutral women	2.58	1.96	1.00	-	2.65	2.06	1.00	-
Experiment 2	1.63	1.26	3.61	2.71	2.33	1.28	2.81	1.67
Angry men	1.57	0.88	5.98	1.64	1.88	0.83	3.17	1.80
Angry women	1.44	0.83	5.19	2.12	2.42	1.36	3.81	1.24
Neutral men	1.36	0.50	1.33	0.49	2.27	1.20	1.85	1.06
Neutral women	1.57	1.04	1.15	0.35	2.19	1.09	1.76	0.85
Experiment 3	1.64	1.30	3.84	2.89	2.21	1.50	3.10	2.18
Angry men	1.42	0.59	6.04	2.25	2.02	1.21	4.08	2.02
Angry women	1.54	1.10	5.93	1.81	2.13	1.38	4.44	1.92
Neutral men	2.17	1.73	1.74	1.72	2.69	1.67	1.88	1.81
Neutral women	1.65	1.64	1.52	1.69	2.22	1.83	2.00	1.81

Table 3. Means, standard deviations, and ranges for adjusted average pumps, earnings, and risk-taking by experimental condition and participant gender

	Adjusted Average Pumps				**Earnings**				**Risk-Taking**			
	N	*M*	*SD*	*Range*	*N*	*M*	*SD*	*Range*	*N*	*M*	*SD*	*Range*
Experiment 1	106	22.94	6.71	5.36-41.00	106	9.04	3.11	2.05-17.70	106	0.00	0.88	-2.29-2.61
Angry men	20	24.52	5.83	11.00-34.25	20	10.42	3.48	4.40-16.45	20	0.34	0.87	-1.64-1.59
Angry women	10	23.04	5.72	15.18-35.57	10	10.07	2.22	6.45-12.70	10	0.17	0.72	-0.69-1.49
Sad men	23	23.07	7.98	5.36-41.00	23	8.56	3.61	2.05-17.70	23	-0.07	1.02	-2.29-2.61
Sad women	13	19.87	6.79	9.82-35.43	13	7.86	2.52	2.30-12.40	13	-0.42	0.80	-1.56-1.47
Neutral men	18	23.02	6.96	9.82-32.67	18	9.04	2.88	3.30-13.55	18	0.01	0.87	-1.56-1.37
Neutral women	11	21.72	6.29	14.60-32.80	11	8.04	2.27	2.85-10.60	11	-0.25	0.70	-1.29-0.80
Experiment 2	64	21.65	7.86	4.6-41.45	64	10.29	3.91	2.30-22.80	64	0.00	0.96	-2.11-2.86
Angry men	14	23.41	8.30	12.67-41.45	14	11.49	4.71	5.70-22.80	14	0.27	1.12	-1.16-2.86
Angry women	12	16.80	6.69	4.60-28.00	12	8.62	3.65	2.30-15.00	12	-0.52	0.85	-2.11-0.88
Neutral men	11	20.66	8.32	10.09-32.44	11	9.03	3.48	5.55-15.05	11	-0.22	0.95	-1.34-1.24
Neutral women	18	22.88	7.12	10.79-35.71	18	10.55	2.86	5.75-15.20	18	0.11	0.77	-1.04-1.18
Experiment 3	78	18.15	8.05	2.91-37.14	78	8.17	3.04	1.60-14.50	78	0.00	0.96	-2.03-1.97
Angry men	24	19.71	7.94	4.67-37.14	24	9.11	2.91	2.80-14.50	24	0.25	0.95	-1.72-1.97
Angry women	16	17.09	8.11	4.93-33.29	16	7.38	3.00	3.50-13.50	16	-0.20	0.94	-1.60-1.51
Neutral men	14	14.50	7.05	3.90-30.000	14	6.96	2.50	2.00-11.20	14	-0.43	0.79	-1.91-0.74
Neutral women	22	19.39	8.74	2.91-34.63	22	8.55	3.41	1.60-13.90	22	0.14	1.08	-2.03-1.96

Figure 1. Forest plot of effect sizes across studies.

Study name	Subgroup within study	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
		Statistics for each study						
Experiment 1	Female	0.594	0.446	0.199	-0.281	1.469	1.331	0.183
Experiment 2	Female	-0.787	0.386	0.149	-1.544	-0.030	-2.037	0.042
Experiment 3	Female	-0.327	0.331	0.109	-0.975	0.321	-0.989	0.323
Experiment 1	Male	0.384	0.328	0.107	-0.259	1.026	1.170	0.242
Experiment 2	Male	0.468	0.408	0.167	-0.332	1.268	1.146	0.252
Experiment 3	Male	0.758	0.347	0.121	0.077	1.439	2.183	0.029
		0.166	0.150	0.022	-0.128	0.460	1.106	0.269



Note: Squares represent effect sizes corresponding to each experiment, stratified by gender. Confidence intervals for effect sizes are represented by horizontal lines. The diamond at the bottom of the figure represents the overall effect size across studies.

Endnotes

[1] The pattern of results remained unchanged when the outlier was included in the analyses.

[2] Due to the concern that results could be attributed to differential learning without risk by condition or by gender during the simulations, we conducted comparisons of the correlation between risk score in block 1 and blocks 5-6 (averaged), and found no significant differences. Specifically, the angry (r = .099, p = .227) and neutral (r = .096, p = .253) participants' risk scores did not differ across block 1 and blocks 5-6 (z = 0.01, p = .992), a result that held in analyses stratified by gender (men: z = 0.29, p = .772; women: z = 0.34, p = .734). Moreover, within condition, the correlation between men and women's risk scores pre- and post-simulation blocks did not differ (anger: z = 0.69, p = .490; sadness: z = 0.75, p = .453; neutral: z = 1.35, p = .177).

[3] Use of this outcome measure is preferred to use of total pumps because the latter measure would include pumps on burst trials and would thus reduce the between subject variability in the measure.

[4] Analyses examining adjusted average pumps and earnings separately are available in the online supplementary materials. Findings generally follow the same pattern.

[5] Finding no significant interaction, we did not conduct stratified planned *t*-tests to examine *Hypothesis 3*.

[6] When included as covariates in the ANOVA, neither sadness-change score, $F(1,8) = 0.57$, p = .471, nor anger-change score, $F(1,8) = 3.06$, p = .118, predicted the risk outcome. Moreover, the pattern and significance of the main effect of anger did not change when controlling for these, $F(1,8) = 7.03$, p = .029. Anger-change score did not interact with emotion condition (β = -0.16, p = .62) to predict the risk outcome. Sadness-change score did not interact with emotion condition (β = -.18, p = .280) to predict the risk outcome. Finally, anger induction did not influence sadness, $F(1,10) = 0.01$, p = .939, nor was there an effect of gender, $F(1,10) = 0.54$, p = .479, or the interaction, $F(1,10) = 0.01$, p = .915, on sadness. Note that analyses controlling for change scores were undertaken only on the 14 respondents for whom post-test emotion measures were administered.

[7] We also included a BART version where the balloon automatically inflates and individuals push the button to stop it from pumping, thus uncoupling action and risk-seeking. Because we hypothesized that the effects were due to action tendency under anger and risk rather than general reward-seeking, we predicted that in the modified BART conditions where risk-seeking and action were not confounded, anger and neutral emotion conditions would yield similar results. However, the practicality of decoupling risk and action in the experimental protocol was problematic; individuals had difficulty with a task that involved pulling back to inflate the balloon. Thus, we do not have full confidence in the utility of this task for decoupling risk and action. Consequently, although our prediction was supported, we do not report these results in

the body of this paper. (There were no significant effects in the modified BART conditions.) Additional research is needed to examine whether action tendency underlies the effects uncovered in these three experiments.

[8] When included as covariates in the ANOVA, neither sadness-change score, $F(1,49) = 0.47$, $p = .496$, nor anger-change score, $F(1,49) = 0.06$, $p = .813$, predicted the risk outcome. Moreover, the pattern and significance of the interaction did not change when controlling for these, $F(1,49) = 4.81$, $p = .033$. Anger-change score did not interact with emotion condition ($\beta = .05$, $p = .962$) or gender ($\beta = .28$, $p = .158$) to predict the risk outcome, nor was there a three-way interaction ($\beta = 1.2$, $p = .120$). Sadness-change score did not interact with emotion condition ($\beta = -.06$, $p = .660$) or gender ($\beta = -.09$, $p = .792$) to predict the risk outcome, nor was there a three-way interaction ($\beta = .46$, $p = .328$). Finally, although the anger induction significantly increased sadness, $F(1,51) = 23.16$, $p < .001$, there was no effect of gender, $F(1,51) = 0.62$, $p = .435$, or the interaction, $F(1,51) = 1.09$, $p = .303$, on sadness.

[9] When this participant was retained in analyses, the pattern of results remained unchanged.

[10] When included as covariates in the ANOVA, neither sadness-change score, $F(1,61) = 0.01$, $p = .920$, nor anger-change score, $F(1,61) = 0.27$, $p = .604$, predicted the risk outcome. Moreover, the pattern and significance of the interaction did not change when controlling for these, $F(1,61) = 5.11$, $p = .027$. Anger-change score did not interact with emotion condition ($\beta = .14$, $p = .509$) or gender ($\beta = -.10$, $p = .519$) to predict the risk outcome, nor was there a three-way interaction ($\beta = -0.27$, $p = .545$). Sadness-change score did not interact with emotion condition ($\beta = .08$, $p = .357$) or gender ($\beta = -.15$, $p = .286$) to predict the risk outcome, nor was there a three-way interaction ($\beta = -.09$, $p = .737$). Finally, the anger induction did not significantly increase sadness, $F(1,68) = 1.10$, $p = .298$, and there was no effect of gender, $F(1,68) = 0.24$, $p = .627$, or the interaction, $F(1,68) = 0.62$, $p = .434$, on sadness.