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Effects of Emotion on Medical Decisions Involving Tradeoffs

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Abstract

Risk perceptions for a disease can motivate use of medications that reduce disease risk. However, these medications are often accompanied by elevated risks for other adverse health effects, and perceived risk of these side effects may also influence decisions. Emotions experienced at the time of a decision influence risk judgments and decision making, and they may be important to examine in these tradeoff contexts. This study examined the effect of experimentally induced fear and anger on risk perceptions and willingness to use a hypothetical medical treatment that attenuates risk of one condition but increases the risk for another. Participants ($N = 1948$) completed an induction of fear, anger, or neutral emotion and then read about a hypothetical medication that reduced risk for one health condition but increased risk for another, and they indicated their willingness to use it. Deliberative, experiential, and affective risk perceptions about both health conditions were measured, conditional on taking and not taking the medication. Fear condition participants were more willing to take the medication than those in the neutral condition ($\beta = 0.14$; $P = 0.009$; 95% confidence interval, 0.036–0.25). Fear also increased deliberative, experiential, and affective risk when conditioned on *not using* the medication, Ps < 0.05. In contrast, anger did not influence willingness to use the medication ($P = 0.22$) and increased deliberative and affective risk of side effects when conditioned on *using* the medication ($P < 0.05$). As one of the first studies to examine how emotion influences tradeoff decision making, these findings extend our understanding of how fear and anger influence such decisions.

Keywords

affect, medical decision making, risk perception, tradeoff

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Many medical treatments lower the risk of one health condition yet increase the risk of another. Tamoxifen therapy reduces breast cancer risk but raises endometrial cancer risk.[1] Hormone replacement therapy reduces colorectal cancer risk but raises breast cancer risk.[2] Patients with slow growing or early stage cancers, such as prostate, must decide between treatment options that pose different combinations of tradeoffs, such as the increased anxiety that arises with active surveillance or the side effect risks of surgery or radiation. These tradeoff decisions are ubiquitous, and risk-related judgment and decision making in this context are different from those involving no or minimal risk of adverse effects, such as decisions to avoid sedentary behavior. For instance, people have an aversion to medication side effects that is

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particularly insensitive to objective estimates of likelihood and severity, and they express less willingness to use medications that have side effects, regardless of net effects on risk.[3–8] Also, these decisions often occur in contexts of clinical equipoise where there is no objectively superior option or where a clinically superior option may exist but patients may interpret their risks differently based on unique circumstances. Thus, there may not be a recommended course of action for all individuals, making a more nuanced understanding of decision making critical.

Because these medically relevant tradeoff decisions are often prompted by a new diagnosis, decline in prognosis, or other change in health status, they may be influenced by heightened emotions, such as fear or anger, that these events evoke.[9,10] Evidence suggests that such medical decisions can be particularly affect laden.[11–14] Despite this real-world relevance, as well as the influence of anger and fear on risk propensity and decision making in nontradeoff scenarios,[15,16] little work has examined how emotions influence risk-related judgments and decision making in tradeoffs. Greater understanding of how emotions influence these choices may inform support tools and risk communication techniques for those facing high-stakes medical tradeoffs. This research may also advance fundamental knowledge of how emotions influence decision making when all options convey risk.

Discrete Emotions

Anger and fear experienced at the time of a decision influence risk judgments, decision making, and behavior. Although both fear and anger are negative emotions, they have opposite certainty and control appraisal tendencies, which are the dimensions of emotions known to influence risk judgments and decision making.[17–20] Anger conveys a sense of high certainty and control and tends to produce optimistic risk perceptions and greater risk propensity. Because it is characterized by the goal to deter or right a transgression, it also often results in an orientation toward approaching action.[18,21] In contrast, fear is associated with a sense of uncertainty and low controllability and thus increases risk perceptions and risk-averse behavior. Because it is characterized by the goal of protecting oneself against an existential threat, it often (but not always; see Loewenstein et al.,[15] Witte and Allen,[22] and Ruiter et al.[23] for reviews in health contexts) results in an orientation toward avoiding action.[18,19,24] Importantly, anger and fear are thought to influence decision making similarly regardless of whether the emotion is integral (evoked by a decision) or incidental (evoked by another source).[18,19]

Risk Perceptions

Perceptions of susceptibility to threat (i.e., risk perceptions) are a robust predictor of decisions and behavior across health contexts. However, risk perception is not a unidimensional construct, and emotions may influence some types of risk perceptions differently than others. For instance, risk perceptions can be deliberative (perceptions of the likelihood of a threat, often numerically based, and reflecting elaborated information processing), affective (worry or other emotions evoked by considering the risk), or experiential (intuitive or gist-based judgments about risk) in nature.[25,26] Although each represents a reaction to threat, they are conceptually and empirically distinct and uniquely predict behavior, sometimes even in opposite directions.[26–30] Given this, as well as evidence that affectively based interventions can influence affective and cognitive factors differently, anger and fear may have different effects on deliberative, affective, and experiential risk perceptions, as well as their associations with behavior.

Emotions may also influence risk perceptions differently depending on the behavioral conditions that inform the risk perception. For example, a smoker may hold 2 types of risk perceptions: her risk if she continues to smoke (i.e., does not take action) and her risk if she quits (i.e., takes action). If unconditional risk perceptions are assessed without specifying any behavioral conditions, such as quitting or continuing to smoke, she is likely to report the version of risk perception conditional on whichever future behavioral pattern she deems most likely. Thus, it is not possible to infer from her response whether her risk perception is conditional on an action (quitting) or avoidance/inaction (continuing to smoke) orientation.[31–33] For tradeoff decisions, each choice confers risk, so anger and fear may not influence decision making solely according to their risk-taking (anger) and risk-avoiding (fear) appraisal tendencies. Instead, the effects of anger and fear on tradeoff decision making may also reflect these emotions' different action orientations. Because anger motivates an action orientation, it may have a greater effect on risk perceptions that are conditioned on *taking action*, whereas fear, with its action-avoidant orientation, may have a greater effect on risk perceptions conditioned on *not taking action*. By assessing conditional risk perceptions, the effects of both the risk and action orientations of anger and fear can be examined.

Objectives and Research Questions

This study examined the effect of experimentally induced fear and anger on willingness to use a hypothetical

preventive medical treatment said to attenuate risk of one condition yet increase risk for another. Given their risk appraisal tendencies, we hypothesized that anger would decrease willingness to use the medication, whereas fear would increase willingness.

We also conducted exploratory analyses to examine the effects of fear and anger on conditional affective, deliberative, and experiential risk perceptions and to test whether they mediated emotions' effects on willingness. We hypothesized that side effect risk would more strongly influence willingness than perceived risk of the target condition. We also expected that fear and anger would influence inaction and action-oriented risk perceptions, respectively. We did not have hypotheses regarding which type(s) of risk perception (i.e., perceived risk of side effects or target condition; deliberative, experiential, or affective risk) would be influenced by the induction.

Method

Procedure

To increase the likelihood that scenarios would be personally relevant, participants ($N = 1948$) were assigned to 1 of 2 health contexts based on their age. Those aged 40 years and older ($n = 575$) read about a hypothetical medical treatment related to chronic diseases, and those younger than 40 years ($n = 1373$) read about a treatment related to sexual health. Once assigned to a health context, a 3 (emotion condition) $\times$ 2 (health condition) between-groups experimental design was used to randomly assign participants to 1 of 6 conditions that differed in emotion (anger [$n = 633$], fear [$n = 638$], or neutral [$n = 677$] emotion) and the health condition that was targeted by the medication (i.e., for which risk was lowered). Those aged 40 or older were assigned to cancer ($n = 294$) or heart disease ($n = 281$); those under 40 were assigned to sexually transmitted infections (STIs; $n = 681$) or sexual pleasure loss ($n = 692$). The health condition not targeted by the medication served as the side effect.

The study was conducted online in 2 separate waves administered approximately 6 months apart. Participants were recruited using Amazon's Mechanical Turk (MTurk), an online platform that has been used successfully to recruit research samples with acceptable measurement reliability and validity. MTurk workers with a US-based IP address were eligible for the study. Participants were remunerated $1.00 USD. A post hoc sensitivity power analysis estimated that our sample size ($N = 1948$) was large enough to detect a very small effect of emotion condition on willingness (Cohen's $F = 0.087$), given the specified alpha (.05) and desired power (.95).

A cover story in which the protocol was described as 2 separate studies was constructed to reduce demand characteristics.[34] Participants first completed individual difference measures and an autobiographical emotion induction task shown to be an effective means of inducing fear and anger. Participants wrote for 3 to 5 minutes about a time in the past year they felt the angriest (most fearful) or about a room in their house (neutral condition).[35] As the ostensibly second study, participants read the hypothetical medication scenarios and completed questionnaires designed to assess their interpretation of the risk information, willingness to use the medication, and conditional risk perceptions.

Medication Scenario

All participants completed both a benchmark and tradeoff scenario about a hypothetical daily medication in counterbalanced order. A pilot study was conducted to determine the specific probabilities of risk and benefit that produced a meaningfully complex decision, as evidenced by large variability in willingness to use the medication. Using these findings, the medication in the benchmark scenario reduced participants' risk of getting the target condition from 20 to 6 out of 100 people and had no side effects. This served as a measure of participants' willingness to use a medication in the absence of negative consequences.

The medication in the tradeoff scenario reduced participants' risk of getting the target condition the same amount but also increased their risk of experiencing a side effect from 6 to 15 out of 100 people. In the chronic disease scenarios, the medication reduced the risk of cancer and increased the risk of heart disease, or the opposite. In the sexual health scenarios, the medication reduced the risk of getting an STI and increased the risk of experiencing a loss in sexual pleasure, or the opposite. Counterbalancing across participants which disease was the target condition and which was the side effect enabled us to test whether disease-specific beliefs, such as fear about cancer, influenced decision making and ensured choices did not reflect a default effect (i.e., avoiding the loss of what one already has or would have had). Both scenarios were accompanied by arrays that visually depicted the change in risk for each health condition (Figure 1).

Measures

Risk perceptions. Each of 3 deliberative, 3 experiential, and 1 affective risk perception item was assessed 4 times: conditional on taking and not taking the medication, as

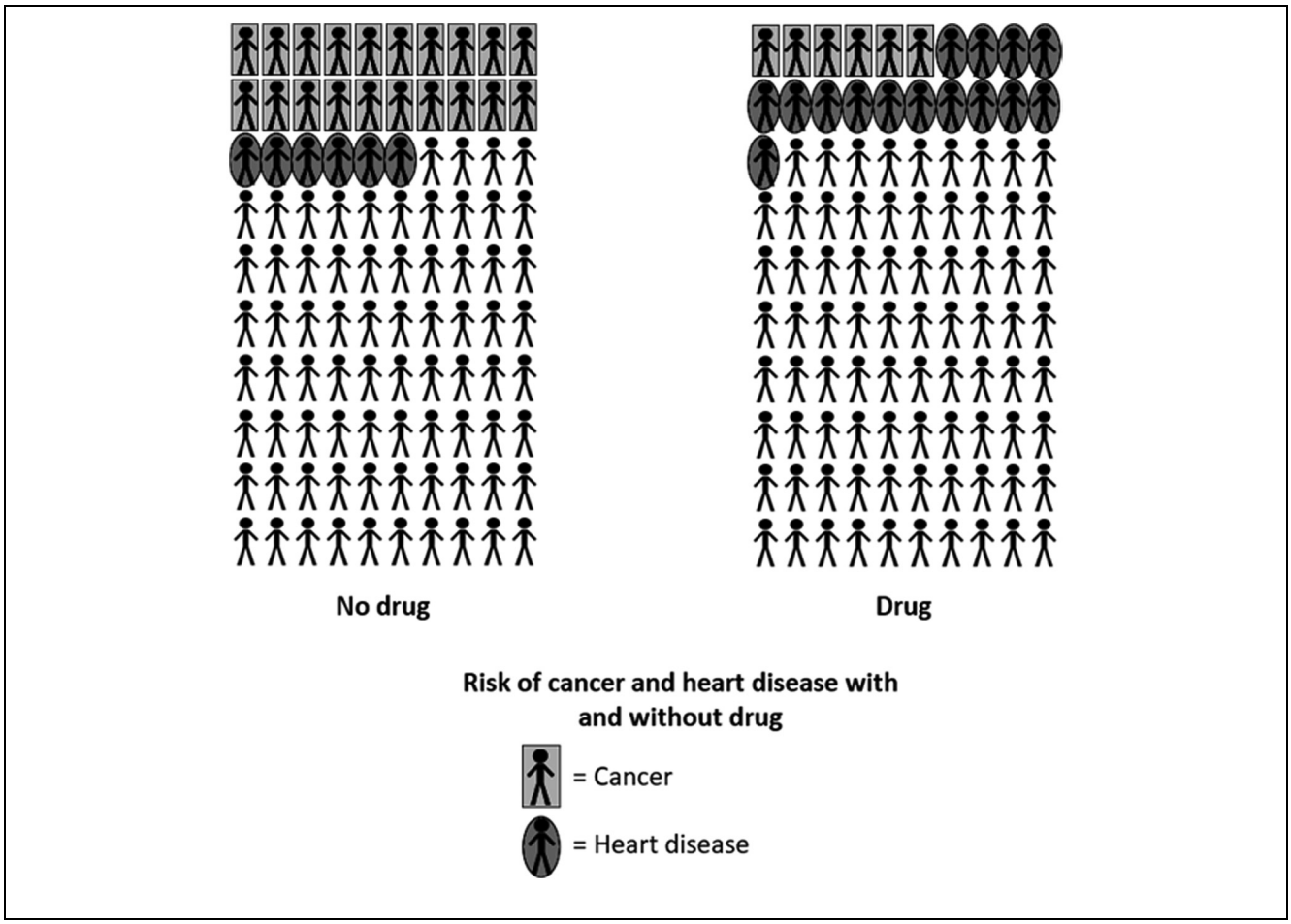

Figure 1 Black-and-white version of array corresponding to the tradeoff scenario in which the pill reduced cancer risk but raised heart disease risk.

well as about the hypothetical medication's targeted and side effect conditions. All items used a 7-point Likert-type scale. Deliberative risk perception items included, "If you [did not take/took] this pill, how likely would you be to get [target condition/side effect] in the future?" with response options ranging from (1) *very unlikely* to (7) *very likely*. Experiential items included, "If you [did not take/took] this pill, how easy would it be for you to imagine yourself getting [target condition/side effect]?" with response options ranging from (1) *not at all easy* to (7) *extremely easy*. Affective risk perceptions were assessed with the following item: "If I [did not take/took] this pill and then got [target condition/side effect], I would be devastated" with response options ranging from (1) *strongly disagree* to (7) *strongly agree*. For both the deliberative and experiential items, 4 scale means were computed, which represented risk perceptions about the target condition and side effect, conditional on taking and not taking the medication (see Discussion for possible implications of conditioning affective risk items).

Medication use decision. Willingness to use the medication was assessed with the item, "If this were a real choice, would you take this pill?" on a scale from (1) *definitely would not* to (7) *definitely would*. This item was assessed after both the benchmark and tradeoff scenario; however, due to a survey programming error, the benchmark scenario data were only available for half of participants ($n = 1004$). This error did not affect data from the tradeoff scenario.

Accuracy of risk evaluation. The accuracy with which participants were able to recall the effect of medication on disease risk was assessed with 1 item: "Doctors sometimes assume that patients understand what they say

without checking. According to the doctor's numbers, how would taking this new pill affect your risk?" Five nonnumeric response options were provided, including one that reflected the correct risk estimation (e.g., "It would increase my risk of losing sexual pleasure but reduce my risk of getting a sexually transmitted infection"), as well as an "I don't know" option.

Responses were categorized as *correct* or *incorrect*, generating a dichotomous variable. To separately compare responses that were incorrect and also either optimistically biased or not, a 3-level variable was created with responses categorized as (1) *correct* ("It would increase my risk of [side effect] but reduce my risk of [target condition]"), (2) *incorrect* ("It would increase my risk of [target condition] but reduce my risk of [side effect]" or "I don't know"), or (3) *optimistic* ("It would decrease my risk of [side effect] and have no effect on my risk of [target condition]" or "It would decrease my risk of [target condition] and have no effect on my risk of [side effect]").

Manipulation check. Reporting emotion may alter the subjective experience of emotion.[36,37] Thus, half of participants ($n = 999$) were randomly assigned to complete a 4-item assessment of current mood as an induction check, providing a test of whether this assessment influenced the induction's effects on study outcomes. Means were computed for 2 items that assessed fear (afraid, anxious, $r = 0.73$) and anger (angry, hostile, $r = .77$).

Participant characteristics. Age, sex (male or female), education level, race/ethnicity (5 dummy codes representing 5 nonmutually exclusive categories; see Table 1), marital status (married/cohabitating or unmarried), self-rated health status (5-point scale), and disease history were assessed.

Analysis Plan

Analyses were conducted in Stata, version 14 (StataCorp, College Station, TX). Continuous items were standardized to mean = 0 and SD = 1. We used analysis of variance (ANOVA) and chi-square tests to determine whether participant characteristics differed across study condition and linear regression to test whether they influenced willingness to use the medication. Characteristics that did were included as covariates in subsequent models. We also used linear regression to test whether the medication's targeted health condition (e.g., cancer) had an effect on willingness and/or moderated the effect of emotion on willingness.

We used linear regression to test whether emotion (a 3-level variable with neutral serving as the reference category) influenced risk perceptions and willingness to use the medication. Given the number of statistical comparisons in the risk perception analyses, P values were also corrected for multiple comparisons using the Benjamini and Hochberg[38] procedure. Effects were examined using a conservative false discovery rate ($Q = .05$; equal to α) and a less conservative rate of $Q = 0.25$.[39]

Logistic regression models tested emotions' effects on recall accuracy. We conducted a multinomial logistic regression using a 3-level recall accuracy variable (correct, incorrect, or optimistic) as the outcome to separately compare correct responders to those whose incorrect responses were or were not also optimistic.

We examined whether risk perceptions mediated the effects of induced emotions on willingness in a series of path analysis models. This approach permitted simultaneous testing of direct, indirect, and total effects. Because indirect effects are calculated as the product of 2 regression coefficients, they are not normally distributed, and statistical estimations that require such assumptions tend to be biased. Therefore, we used a Monte Carlo method to generate sample statistics and confidence intervals based on the asymptotic sampling distribution of the indirect effect.[40,41]

Results

Participants

Participants were 38.22 years old on average (SD = 12.56), and half (52.5%) were female. Three quarters (76.5%) self-identified as white, 10.0% as Asian/Pacific Islander, 8.2% as Hispanic, 7.0% as black, and 4.9% as another race. Most (82.1%) completed at least some college, with half (53.5%) having a 4-year degree. No participant characteristic differed across emotion conditions, Ps > 0.05 (Table 1). Aside from age, which was intended to differ across the chronic disease and sexual health arms of the study, education was the only other characteristic that differed across the 2 arms. Adjusting for age, education level was higher in the sexual health arm, $F(1, 873) = 6.18$, $P = 0.013$.

Manipulation Check

Self-reported anger was highest in the anger condition, and fear was highest in the fear condition, suggesting the emotion induction influenced emotion as intended (see Table 1). Specifically, anger was higher in the anger condition than the neutral condition, $F(1, 996) = 224.64$,

Table 1 Participant Characteristics[a]

Characteristic	Study Condition				F Test or χ^2
	Neutral	Anger	Fear	Overall	
Age, mean (SD), y	37.67 (12.06)	38.99 (13.05)	38.32 (12.08)	38.31 (12.37)	1.79
Sex (female), *n* (%)	355 (52.8)	333 (52.8)	332 (52.2)	1020 (52.6)	0.054
Race, *n* (%)					
White	511 (75.5)	486 (76.8)	493 (77.2)	1490 (76.5)	0.63
Asian	74 (10.9)	78 (12.3)	65 (10.2)	217 (11.1)	1.51
Hispanic	50 (7.5)	51 (8.2)	55 (8.8)	156 (8.2)	0.69
Black	51 (7.5)	47 (7.4)	54 (8.5)	152 (7.8)	0.58
Other race	39 (5.8)	30 (4.7)	37 (5.8)	106 (5.4)	0.90
Education (7-point scale), mean (SD)	5.09 (1.57)	5.08 (1.61)	5.04 (1.57)	5.07 (1.58)	0.19
Health status (5-point scale), mean (SD)	3.34 (1.00)	3.34 (0.98)	3.28 (0.99)	3.32 (0.99)	0.78
Manipulation check, mean (SD)					
Current anger (5-point scale)	1.48 (0.90)	2.79 (1.26)	2.03 (1.21)	2.10 (1.25)	113.17***
Current fear (5-point scale)	1.63 (0.96)	2.13 (1.14)	2.56 (1.26)	2.09 (1.19)	57.15***

[a]Analysis of variance and chi-square models tested whether participant characteristics and current emotions were significantly different across emotion conditions (anger, fear, neutral).
***$P < 0.001$.

$\omega^2 = 0.18$, $P < 0.001$, and fear condition, $F(1, 996) = 73.60$, $\omega^2 = 0.068$, $P < 0.001$. Fear was higher in the fear condition than in the neutral condition, $F(1, 996) = 114.02$, $\omega^2 = 0.10$, $P < 0.001$, and anger condition, $F(1, 996) = 24.45$, $\omega^2 = 0.023$, $P < 0.001$.

Anger was also higher in the fear condition than in the neutral condition, $F(1, 996) = 39.55$, $\omega^2 = 0.037$, $P < 0.001$, and fear was higher in the anger condition than in the neutral condition, $F(1, 996) = 33.05$, $\omega^2 = 0.031$, $P < 0.001$, suggesting moderate crossover of the induction's effects.

Completing the measure of emotion did not moderate the effect of the emotion induction on risk perceptions and willingness to use the medication, Ps > 0.05.

Willingness to Use the Medication

Participant characteristics. As expected, participants were more willing to use the medication in the benchmark scenario without side effects than in the tradeoff scenario (mean [SD] = 4.20 [2.11] v. 2.54 [1.75]), $t(1002) = 24.94$, $d = 0.79$, $P < 0.001$. In the benchmark scenario, willingness was lower among younger, Asian, and healthier participants and higher among white and black participants, Ps < 0.05 (Table 2). In the tradeoff scenario, willingness was lower among women, nonwhite, Asian, Hispanic, and healthier participants, Ps < 0.05. In all subsequent analyses, age, sex, race/ethnicity, health status, and the health condition targeted by the medication are included as covariates.

Targeted health condition. Willingness to use the medication in the tradeoff scenario differed depending on the health condition targeted. For chronic disease scenarios, participants were more willing to use the medication when the medication reduced cancer risk and increased heart disease risk than when it reduced heart disease risk and increased cancer risk (M_{adj} [SE] = 2.98 [0.10] v. 2.41 [0.10]). For sexual health scenarios, participants were more willing to use the medication when it reduced STI risk than when it reduced risk of losing sexual pleasure (M_{adj} [SE] = 2.68 [0.067] v. 2.28 [0.066]). The same pattern emerged in the benchmark scenario (Table 2).

Induced emotions. In the tradeoff scenario, participants were more willing to use the medication in the fear condition than in neutral condition (M_{adj} [SE] = 2.67 [0.070] v. 2.42 [0.068]; $\beta = 0.14$; $\omega^2 = 0.0030$; $P = 0.009$; 95% confidence interval [CI], 0.036 to 0.25). Willingness did not differ between the anger and neutral conditions ($\beta = 0.066$; $\omega^2 = 0.00019$; $P = 0.22$; 95% CI, –0.041 to 0.17). For the benchmark scenario, there was no effect of emotion condition on willingness to use the medication, Ps > 0.05. This pattern of findings was consistent across adjusted and unadjusted models (Table 2) and was not moderated by age, sex, or the medication's targeted health condition, Ps > 0.05.

Recall Accuracy

Overall, 72.5% of participants accurately recalled how the medication in the tradeoff scenario would influence

Table 2 Effects of Participant Characteristics and Study Condition on Willingness to Use the Medication in the Benchmark and Tradeoff Scenarios[a]

	Benchmark Scenario (n = 1004)			Tradeoff Scenario (n = 1948)		
	β	*P* Value	ω^2	β	*P* Value	ω^2
Age	0.14***	<0.001	0.020	0.0082	0.72	–0.00046
Sex (male)						
Male	Reference			Reference		
Female	–0.12	0.054	0.0027	–0.16***	<0.001	0.0060
Race						
White	–0.15*	0.039	0.0032	–0.28***	<0.001	0.013
Asian/Pacific Islander	0.23**	0.010	0.0056	0.35***	<0.001	0.012
Hispanic	–0.062	0.59	–0.00071	0.37***	<0.001	0.010
Black	–0.25*	0.044	0.0030	0.021	0.80	–0.00048
Other race	–0.18	0.45	–0.00043	–0.15	0.33	<0.0001
Education	0.0032	0.92	–0.00099	–0.032	0.16	0.00051
Health status	0.12***	<0.001	0.014	0.086***	<0.001	0.0068
Pill's target health condition						
Cancer	Reference			Reference		
Heart disease	–0.47***	<0.001	0.019	–0.32***	<0.001	0.0069
Sexually transmitted infections	–0.70***	<0.001	0.055	–0.17***	<0.001	0.0024
Loss in sexual pleasure	–0.76***	<0.001	0.065	–0.39***	<0.001	0.016
Emotion condition, adjusted (unadjusted) values						
Neutral	Reference			Reference		
Anger	–0.041 (–0.035)	0.61 (0.65)	–0.00072 (–0.00079)	0.066 (0.079)	0.22 (.15)	–0.00019 (0.00053)
Fear	–0.022 (–0.028)	0.86 (0.72)	–0.00089 (–0.00087)	0.14* (0.13**)	0.009 (.012)	0.0030 (0.0025)

[a]The effects for the tradeoff scenario do not differ if analyzed using only the participants who also completed the baseline scenario. All continuous variables were standardized; statistics should be interpreted as standardized beta coefficients. Adjusted models included age, sex, race/ethnicity, health status, and target health condition as covariates.
*$P < 0.05$. **$P < 0.01$. ***$P < 0.001$.

Table 3 Effects of Emotion Condition on Perceived Risk (PR)[a]

	Perceived Risk of Target Condition						Perceived Risk of Side Effect					
	If Took Pill			If Did Not Take Pill			If Took Pill			If Did Not Take Pill		
	β	*P* Value	ω^2	β	*P* Value	ω^2	β	*P* Value	ω^2	β	*P* Value	ω^2
Deliberative risk perceptions												
Emotion condition												
Anger	0.072	0.13	0.00073	0.028	0.58	–0.00039	0.10	0.038	0.0019	0.051	0.32	<0.001
Fear	0.0087	0.86	–0.00055	–0.035	0.49	–0.00029	0.034	0.47	–0.00028	0.12	0.022	0.0024
Experiential risk perceptions												
Emotion condition												
Anger	0.041	0.55	–0.00036	0.099	0.16	0.00057	0.028	0.7	–0.00048	0.034	0.62	–0.00042
Fear	–0.00036	0.99	–0.00056	–0.0068	0.92	–0.00055	0.075	0.31	2.1E–05	0.15	0.03	0.0021
Affective risk perceptions												
Emotion condition												
Anger	0.87	0.15	0.00058	0.052	0.36	<0.0001	0.17[b]	0.002	0.0046	0.049	0.41	–0.00017
Fear	0.034	0.55	–0.00035	0.12	0.024	0.0022	0.015	0.83	–0.00051	0.062	0.28	<0.0001

[a]Adjusted models included age, sex, race/ethnicity, health status, and target health condition as covariates.
[b]Statistically significant effect in models adjusted for multiple comparisons when $Q = .05$ (all effects remained significant when $Q = .25$).

their risk for the target condition and side effect. Participants who were older (odds ratio [OR] = 1.21; $P < 0.001$; 95% CI, 1.09–1.34), female (OR = 1.35; $P = 0.002$; 95% CI, 1.11–1.63), white (OR = 6.75; $P < 0.001$; 95% CI, 5.49–8.30), and more educated (OR = 1.19; $P = 0.002$; 95% CI, 1.06–1.33) were more likely to accurately recall the risk information, Ps < 0.05.

Participants in the fear condition were less likely to accurately recall the information compared to participants in the neutral condition (OR = 0.68; $P = 0.009$; 95% CI, 0.51–0.91), as well as the anger condition (OR = 0.83; $P = 0.034$; 95% CI, 1.12–1.41). There were no differences in accuracy between the anger and neutral conditions (OR = 0.94; $P = 0.69$; 95% CI, 0.69–1.27).

Participants who accurately recalled the risk information were less willing to take the medication (β = –0.71; $\omega^2 = 0.077$; $P < 0.001$; 95% CI, −0.82 to −0.60). There was an indirect effect of fear on willingness via accuracy (β = 0.071; $P = 0.010$; 95% CI, 0.017 to 0.13) and a nonsignificant direct effect (β = 0.17; $P = 0.067$; 95% CI, –0.12 to 0.36), suggesting the lower accuracy in the fear condition mediated the effect of fear on willingness.

To help elucidate why a decline in accuracy was associated with greater willingness among fearful participants, we conducted a multinomial logistic regression and separately compared incorrect and optimistic participants to a correct reference category. Individuals in the fear condition were no more likely than those in the neutral condition to be incorrect (relative risk [RR] = 1.01; $P = 0.92$; 95% CI, 0.71–1.46), but they were more likely to be optimistic (RR = 1.56; $P = 0.020$; 95% CI, 1.07–2.27), suggesting that the inaccuracies evoked by fear reflected optimistic biases. There were no differences between the anger and neutral conditions in the likelihood of providing an incorrect or optimistic versus correct response, Ps > 0.05.

Conditional Risk Perceptions

Twelve conditional risk perception scales were examined, reflecting whether they were deliberative, experiential, or affective; conditional on taking or not taking the medication; and about the target condition or side effect (Table 3). Five effects of emotion condition were significant across 24 comparisons. In each case, perceived risk was higher in the fear and anger conditions compared to the neutral condition. When conditioned on action (taking the medication), perceived deliberative and affective risk of the side effect was higher in the anger condition (relative to neutral), Ps < 0.05. When conditioned on inaction (not taking the medication), deliberative and experiential risk of the side effect, as well as affective risk of the target condition, was higher in the fear condition, Ps < 0.05.

When effects were corrected for multiple comparisons using a conservative false discovery rate ($Q = .05$), only the effect of anger on affective risk perceptions about the side effect conditioned on action was significant. Using a less conservative false discovery rate ($Q = .25$), all 5 effects remained significant.

For the 5 risk perception scales for which the emotion condition had an effect, we used path analysis to estimate

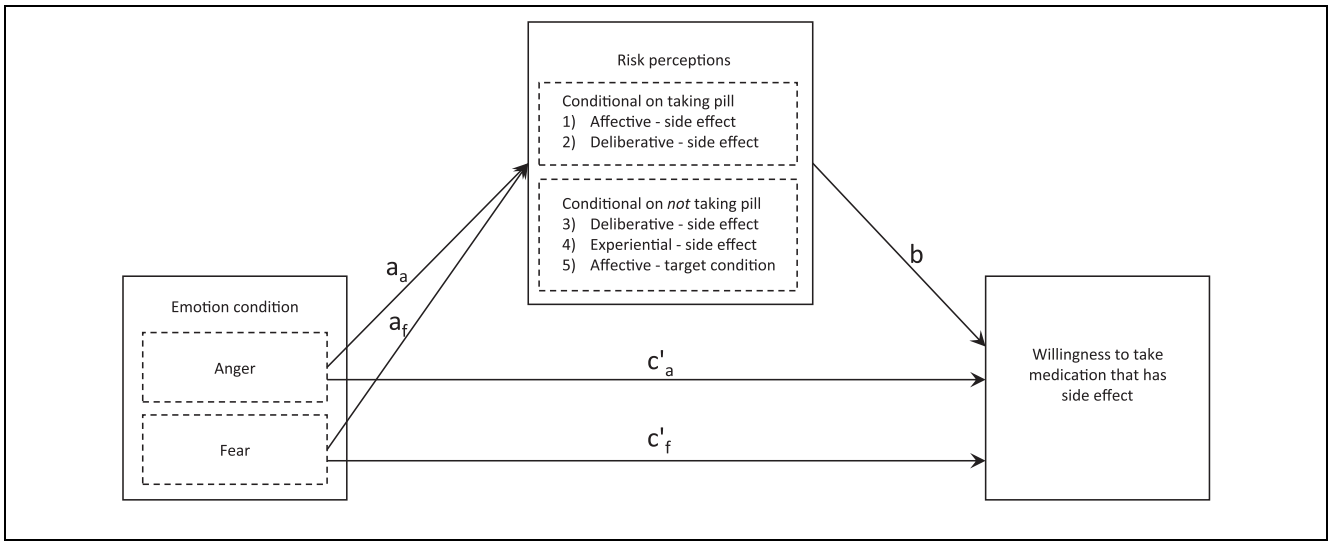

Figure 2 Mediation model illustrating indirect effect of emotion condition on willingness via changes in the 5 risk perception scales that were influenced by the emotion condition.

Table 4 Mediational Pathways: Indirect Effect of Emotion Condition on Willingness to Use Medication Through Effects on Perceived Risk (PR)[a]

	Direct Effects					Indirect Effect ($a \times b$)	
	Emotion on PR			Emotion on Willingness		Emotion on Willingness	
Risk Perception Tested	Anger (a_a)	Fear (a_f)	PR on Willingness (b)	Anger (c'_a)	Fear (c'_f)	Anger	Fear
Conditional on taking pill							
1. Affective PR of side effect	0.17**	0.015	–0.28***	0.13	0.25**	–0.047**	–0.0041
2. Deliberative PR of side effect	0.096*	0.028	–0.061	0.089	0.28**	–0.0059	–0.0017
Conditional on *not* taking pill							
3. Deliberative PR of side effect	0.048	0.11*	0.53***	0.065	0.21*	0.026	0.059*
4. Experiential PR of side effect	0.032	0.13*	0.37***	0.069	0.19*	0.012	0.050*
5. Affective PR of target condition	0.052	0.12*	0.37***	0.062	0.20*	0.019	0.045*

[a]Parenthetical abbreviations correspond to labels in Figure 2. All models adjust for age, sex, race/ethnicity, health status, and target health condition.
*$P < 0.05$. **$P < 0.01$. ***$P < 0.001$.

the direct effects of emotion on risk perceptions (a_a and a_f in Figure 2 and Table 4) and of risk perceptions on willingness (b in Figure 2 and Table 4), as well as the indirect effects of emotion on willingness through risk perceptions. The effect of anger on willingness was mediated by affective—but not deliberative—risk perceptions about the side effect conditioned on action, $P < 0.05$ (Figure 2; Table 4). The effect of fear on willingness was partially mediated by 3 risk perception scales conditioned on inaction, Ps < 0.05. In each case, fear also had a main effect on willingness, Ps < 0.05.

Discussion

This study examined the effects of experimentally induced fear and anger on conditional risk perceptions and willingness to take risk-mitigating action in a risk tradeoff decision-making scenario: choosing whether to use a medication that reduced risk for one health condition but increased risk for another. Overall, participants in the fear condition were more willing to take the medication than those in the neutral condition, and this effect was mediated by lower accuracy in the recall of risk information. Those in the fear condition were more

likely to be inaccurate in ways that reflected optimistic biases about their risk, which is consistent with prior evidence[42] and may help explain why the observed decline in accuracy was associated with increased willingness.

Willingness and Recall Accuracy

Fear can influence information processing, reducing accuracy and attention to the most relevant risk information, as well as increasing attention to unrelated details instead.[42,43] In this study, fear may have made stored knowledge (e.g., fatalistic beliefs about cancer) more accessible in the decision-making process, potentially overriding a refined assessment of the scenario's risk information.[44] This may help explain why those in the fear condition were less likely to accurately recall the risk information and why their greater willingness was partly mediated by greater perceived risk of the side effect conditioned on inaction, a presumably irrelevant risk perception for that decision.

Another plausible complementary account, consistent with the appraisal tendency framework that informed this study, is that participants' willingness reflected an alignment of the message's loss framing with fear's risk-averse appraisal tendencies (i.e., the medication was described as risk-mitigating and fear evokes a desire to avoid risks).[18,19,45] Although the fear evoked by the manipulation was incidental to the threat, if it was attributed to the target health condition, these effects would be similar to the effects of integral fear/worry about health threats, as well as fear appeal interventions, as motivators of health-promoting behaviors.[22,23,46–50] They are also consistent with related evidence that fear can serve as a form of and/or draw attention to risk information.[15,16,44,51]

Risk Perceptions

This is the first known study to examine the effects of emotion on conditional risk perceptions. Results from these exploratory analyses suggest fear and anger had small effects on some types of risk perceptions. However, given the attenuation of results after adjusting for multiple comparisons, inferences based on these results should be considered preliminary, and replication is essential. Specifically, 3 potentially important patterns emerged that warrant examination in future work, including the salience of side effects, the role of the emotions' action orientations, and the potentially context-specific effects of anger.

Side effects. Four of the 5 effects of emotion on perceived risk involved side effects, which is consistent with research demonstrating individuals' disproportionate attention to side effect information, affectively based aversion to them, high sensitivity to changes in side effect risk, and strong influence of side effect risk on medication decisions.[8,52,53] Given their central focus, emotions may influence side effect risk perceptions more than other risk judgments. This may also help explain why emotion influenced willingness to use the medication in our tradeoff scenario but not in the benchmark scenario where the medication did not have side effects.

Action orientations. Consistent with our hypotheses, anger increased 2 of 3 side effect risk perceptions that were conditional on taking the medication, whereas fear increased 2 of 3 side effect risk perceptions conditional on *not* taking the medication. These findings are consistent with the emotions' action tendencies; anger increased the focus on action, fear increased the focus on inaction, and the conditional risk perceptions changed accordingly.

These findings suggest that when both options pose risks, changes in perceived risk may depend on both the risk appraisals and action tendencies of emotions. In fact, anger's effects on risk perceptions combined with its action tendencies may help explain the nonsignificant effect of anger on willingness to use the medication. Whereas anger's action tendencies should have increased willingness, anger also increased risk perceptions conditioned on action, which may have decreased willingness. Thus, these 2 effects may have operated in opposing directions, essentially canceling each other out.[54,55] These findings may have important implications for theoretical work examining the effects of emotion on decisions involving risk tradeoffs, and future work is needed to elucidate the complex roles of conflicting risk appraisals and action orientations.

Anger. Contrary to past work in which anger facilitates optimistic risk perceptions because it is a high-certainty and control emotion,[18–20] both fear *and* anger increased risk perceptions. If participants followed instructions and considered how the medication would affect their side effect risk independently of other factors, one possibility is that this tradeoff scenario was experienced as low control because both using and not using the medication posed risk. Prior work has shown anger does not produce optimistic risk judgments when it is experienced as low control,[56,57] and the effects of anger on risk judgments

are less consistent than those for fear.[45,56,58] However, the conditional risk perception format used in the current study reduces the ability to compare current findings to past work.

Limitations

Some limitations should be considered when interpreting these findings. We did not assess attitudes about medication (e.g., perceiving daily medication as a burden) that could have also influenced willingness. There was also a 6-month gap between 2 waves of data collection, and a coding error prohibited use of benchmark scenario data for half of participants.

Our medication scenario provided necessary methodological and experimental control, but it did not reflect the complexity of many real-world medical decisions. Although we avoided the term *side effect* in the scenarios, participants may have nonetheless interpreted their increased risk as a medication side effect, inducing side effect aversion. This side effect information (or any information unrelated to how the medication influenced target condition risk) may have reduced focus on the target condition risk information. Moreover, the current study did not consider non–health medication consequences, such as medication costs, and whether tradeoff decision making differs depending on the type of consequence. Future work would benefit from manipulating these aspects of the scenario to elucidate their unique contributions to medication decisions.

It was important that risk perception items be conditional on using or not using the medication, given our hypotheses regarding the role of action tendencies. However, this made it difficult to draw on existing work to generate a priori predictions and created several dependent variables, increasing the possibility of type 1 error. Thus, these findings should be interpreted with caution and need to be replicated. It also resulted in affective risk perception items more reflective of anticipated emotions (expectations about one's future feelings) than the more commonly assessed anticipatory affective reactions to a threat (current affect evoked by considering a future threat). Thus, our findings may not be conceptually comparable to prior work on affective risk perceptions.

Implications

Our tradeoff scenario aimed to mimic clinical equipoise where there is no objectively or universally superior option. Thus, neither greater nor less willingness was perceived as a "better" decision in this study. Because a universal course of action cannot be recommended for all individuals, it is important to understand how tradeoff risks are perceived, how they influence decision making, and how emotions affect these processes so that interventions can be developed. If treatment decisions made in strong emotional states are found to be inconsistent with one's long-term goals or values, then delaying decision making until emotions have subsided, promoting effective emotion regulation, relying on others for decision-making support, or strategically framing the risks and benefits, may be advantageous.

Although observed effects of emotion were small, they were evoked despite variability in beliefs about the health conditions and by an induction much milder than the intense emotional states that these high-stakes medical decisions often evoke. Even these small one-time individual-level effects may translate into considerable differences in medication adherence and treatment decision making at the population level and over time. Intervening to reduce (or leverage) small unwanted (or advantageous) effects of emotions on decision making may justify the costs if they, too, are small.

This study had several strengths, including its experimental design, use of conditional risk perception scales, and large diverse sample. As one of the first studies to examine the role of emotion in tradeoff decision making, the current findings extend our understanding of how fear and anger influence such decisions and have implications for decision sciences, as well as interventions aimed at improving patient decision making and care experiences.

Note

Some individual difference scales were assessed as exploratory moderators (goal conflict, response efficacy, regulatory focus), but none was central to the research question, nor did any serve as moderators. Thus, they are not discussed in the manuscript.

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