

How Anxiety Leads to Suboptimal Decisions under Risky Choice Situations

By: [Zhiyong Yang](#), Ritesh Saini, and Traci Freling

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Abstract:

The current research proposes that situationally activated anxiety—whether incidental or integral—impairs decision making. In particular, we theorize that anxiety drives decisionmakers to more heavily emphasize subjective anecdotal information in their decision making, at the expense of more factual statistical information—a deleterious heuristic called the *anecdotal bias*. Four studies provide consistent support for this assertion. Studies 1A and 1B feature field experiments that demonstrate the role of incidental anxiety in enhancing the anecdotal bias in a choice context. Study 2 builds on these findings, manipulating individuals’ incidental anxiety and showing how this affects the anecdotal bias in the context of message evaluations. Study 2 also provides direct evidence that only high-arousal negative emotions such as anxiety/worry enhance the anecdotal bias, not just any negative emotion (e.g., sadness). While the first three studies examine how *incidental anxiety* impacts choice, the last study demonstrates the effect of *integral anxiety* on decision making, manipulating anxiety by intensifying participants’ perceived risk. Our results show that—consistent with findings from our first three studies—the anecdotal bias is enhanced when anxiety is heightened by individuals’ perception of risk.

Keywords: anecdotal bias | anxiety | suboptimal decisions

Article:

1. INTRODUCTION

Suppose you have decided to undergo elective knee surgery after years of discomfort. In researching your options of where to have this surgery, you come across a *US News & World Report* hospital ranking that ranks Hospital A as the best in your city. This ranking is based on a statistical analysis of death rates for patients and patient safety (based on hard data), as well as reputation (based on physician surveys). However, you remember a compelling advertisement for Hospital B—which is ranked lower on the *US News & World Report* list. This ad features an actual patient who had knee surgery performed at Hospital B, and who gushes about its “compassionate and capable” doctors and staff. Further, she goes on to thank Hospital B for “helping me walk pain free for the first time in twenty years!” Which information do you weigh more heavily: the fact that the Hospital A is ranked more favorably, or the compelling narrative provided by one satisfied customer?

Decisions like this—which involve uncertainty and risk—often require evaluating and prioritizing different pieces of information before making a final choice. Such information can be broadly classified as statistical or anecdotal. Not always—but often—statistical information is superior to anecdotal evidence. In such situations, a judicious decisionmaker would ignore the latter evidence in favor of the former. But there is something in us that often hinders our discrimination between these two types of information.

In this article we examine the impact of anxiety on a decisionmaker's tendency to overutilize anecdotal information, even when more reliable statistical information is available—a tendency called the *anecdotal bias*. We focus on the role of anxiety, a negative high-arousal emotion, in our exploration of the anecdotal bias because risky choices are often made in contexts riddled with high decision anxiety. Anxiety is a strong emotion and is shown to have potent effects on perceptions and decisions in risky situations.^{1,2}

In four studies, we investigate how enhanced anxiety—both incidental and integral—influences individuals' reliance on anecdotal information. Studies 1A and 1B examine the role of incidental anxiety in enhancing the anecdotal bias in a choice context. Study 2 replicates these findings by showing that when individuals' incidental anxiety is manipulated, it affects their message evaluations. Study 2 also provides direct evidence that only high-arousal negative emotions (i.e., anxiety/worry) enhance the anecdotal bias—not just any negative emotion (e.g., sadness). While the first three studies explore the impact of incidental anxiety on decision making, Study 3 manipulates integral anxiety by increasing perceived risk, and shows how this leads to anecdotal bias. Taken together, our results show that anecdotal bias is enhanced when anxiety is heightened.

2. THEORETICAL BACKGROUND

2.1. Narratives Versus Numbers

Anecdotal evidence consists of a specific historical instance, while statistical evidence is a numerical summary of a series of instances.³ Philosophers, journalists, advertisers, and decision scientists have pondered the power of narrative and anecdotal information even when

countervailing statistical information points in the other direction. A striking demonstration of this was the case of “Baby Jessica,” whose accidental fall into a well near her home in Texas, and the ensuing highly publicized rescue, elicited over \$700,000 in donations from sympathetic donors.⁴ Interestingly, the same potential donors largely ignored the disturbing statistics about a famine in northeast Africa a few years later that affected millions of children. While other factors may also have been at play, researchers have largely attributed this sympathy gap to the visceral and vivid mental imagery evoked by Baby Jessica in contrast to the bland abstractness of the famine statistics.⁵

Another salient example of how descriptive qualitative information can sometimes supersede quantitative information is the classic study demonstrating the representativeness heuristic by Kahneman and Tversky.⁶ This study demonstrates how overuse of anecdotal information can lead to violations of Bayesian reasoning. Participants in one experimental condition were told that a team of psychologists performed personality tests on 100 professionals—30 engineers and 70 lawyers. Then they were given a general description of one of these professionals, including information about his personality traits and hobbies, and asked to assess the probability of this person being an engineer. In another condition, participants were given the exact same task and description, but were told that there were fewer (30) lawyers and more (70) engineers. If participants were astute and discriminating users of information, one would expect that their final response would emerge from their weighted consideration of this quantitative information (i.e., the distribution of engineers vs. lawyers) and the qualitative information. However, the assessed probability response from both groups was uncannily similar, indicating absolutely no use of the base-rate statistical information.

Such neglect of statistical information is called the *anecdotal bias*. Often, the anecdotal bias persists even when statistical information objectively dominates the available anecdotal information.⁷ Heuristics and biases like availability and representativeness, including base-rate neglect, are also manifestations of insensitivity to numerical information and the overuse of more visceral and vivid cues.^{8,9} Similarly, research with professionals in medicine, the law, management, and other fields documents a preference for clinical reports over more accurate actuarial judgments.^{10,11}

In the assessment of risk, individuals are also often influenced more by the anecdotal recall of a single event at the expense of statistical information. In fact, warnings about risky behavior are generally more effective when presented in the form of anecdotes rather than relative frequency.¹² In a comprehensive overview of this issue, Slovic *et al.*¹³ attribute this “anecdotal advantage” to the fact that more vivid and visceral representations of risks evoke a much stronger response, as described by the risk-as-feelings framework.

Other researchers concur that anecdotes and exemplars are more effective and persuasive because they are more vivid and easy to process.¹⁴⁻¹⁶ In contrast, statistical information is usually more pallid and entails more cognitively taxing processing. These differences imply dual routes for the processing of anecdotal versus statistical information, where a more emotionally aroused mindset is likely to reflexively favor the use of anecdotal evidence, while greater cognitive functioning will more heavily weigh statistical evidence. Such duality is reflective of the dual-process theories of persuasion and decision making, which posit that while the more engaged,

deliberative processing style emphasizes information quality, the more emotional, intuitive approach is less discriminating and is influenced by trivial information in addition to relevant, central cues.^{17, 18} This body of work suggests that relatively uninformative anecdotal evidence is likely to influence the decision outcome when the latter processing style dominates, often at the expense of more diagnostic statistical evidence. This is particularly likely when the more visceral and vivid anecdotal information evokes greater engagement.^{19, 20} Such advantages of vividness have been shown for narratives and anecdotes, and also for graphical representations of information.²¹

While significant evidence of the superiority of anecdotal or narrative evidence exists, this advantage is neither absolute nor universal. In several studies, statistical evidence has been found to be more persuasive.²² This calls for an investigation of potential contextual moderators that may influence the magnitude of the anecdotal bias across different situations. The next section discusses why anxiety may be one such significant factor.

2.2. The Role of Anxiety in Decision Making

In this research, we expect that activating decisionmakers' anxiety about negative outcomes will increase the impact of anecdotal information on decision making. Anxiety is a common emotion that signals the presence of a potential threat or negative outcome, promotes pessimistic appraisals of future events, and impairs affect regulation.²³⁻²⁶ Additionally, worry and anxiety are believed to evoke high levels of autonomic arousal, which impairs working memory capacity and executive functioning.^{27, 26} Thus, anxious individuals are more likely to (1) process persuasive arguments less thoroughly,²⁸ (2) scan alternatives in a more haphazard fashion,²⁹ (3) exhibit lower recall and organization of information in memory,^{30, 31} (4) succumb to framing effects,³² and (5) select an option without considering all alternatives.²⁹ Hartley and Phelps²⁶ assert that such deficiencies occur because anxiety damages affect regulation processes, reducing one's ability to modulate these processing tendencies. This interruption of affect regulation is likely to make an anxious individual less discriminating about information quality, more influenced by the visceral and vivid nature of the evidence, and thus more susceptible to the anecdotal bias.

This rationale finds support in research demonstrating that high anxiety leads to greater aversion to ambiguous stimuli.³³ It could be argued that statistical information—while favoring one option over another—is not unequivocal. For instance, research may report that one drug worked better than another drug on a majority of the test patients—but not on a 100% of them. In contrast, anecdotal information—which typically has a sample size of one—is always unequivocal and is not depicted in shades of gray. This could lend an air of pseudocertainty to the anecdotal information, thereby leading anxious individuals to favor it over the seemingly more ambiguous statistical information.

Anxiety can be triggered by any uncertain or novel situation that has the potential for adverse consequences.³⁴ For example, a marine going on his first tour of duty or a teenager going on her first date may both feel anxious. While *integral anxiety* is stimulated by some aspect of the decision context itself (e.g., high risk of a negative outcome), *incidental anxiety* is activated by a prior situation or problem that is unrelated to the current decision. For example, a person who

recalls a stressful social encounter might be influenced by incidental anxiety when the event is recalled, which may in turn make the individual more risk averse in a subsequent decision scenario.³⁵

In the sections that follow, we gather evidence for this proposed effect of anxiety on the anecdotal bias in four consecutive experiments. In a choice setting, Studies 1A and 1B examine the role of *incidental anxiety* in enhancing the anecdotal bias. Study 2 replicates these findings by manipulating individuals' incidental anxiety. While the first three studies deal with incidental anxiety, the last study examines the effect of *integral anxiety* on the anecdotal bias, where anxiety is manipulated by enhancing risk of a negative outcome. The results show that, consistent with the findings of the first three studies, the anecdotal bias increases when anxiety is heightened due to enhanced risk.

3. STUDY 1A

3.1. Participants and Procedures

Study 1A was a natural experiment, in that we did not directly manipulate anxiety but rather had respondents complete a simple choice task on one of two occasions across which anxiety was expected to vary substantially and predictably. Specifically, we randomly assigned 100 undergraduate students (46.0% females; $M_{\text{age}} = 24.9$, $SD = 4.49$) taking a marketing course to one of two conditions that involved them participating in an experiment either (1) prior to an ordinary class meeting when anxiety was expected to be low, or (2) prior to a scheduled exam in the class when anxiety should have been higher.

In both conditions, participants were asked to “*imagine that you are traveling for work to a foreign country. This is a 30-day assignment that will require you to drive to and from work while you are there.*” Immediately following this imagination, they were exposed to a decision scenario, where they were asked to choose between two different automobile insurance policies for extended travel in a foreign country: one option was statistically superior, while the other was anecdotally superior. Statistical information took the form of customer satisfaction ratings, while a traveler's personal experience provided contrary anecdotal information: “*Company A has the highest customer satisfaction ratings (90%) of all companies offering international automobile insurance coverage. Company B has a relatively lower overall customer satisfaction rating (65%). Despite such a difference in customer satisfaction ratings, the travel magazine cites another traveler's personal experience with these two insurance companies. He has traveled to the city several times and has used both insurance companies. A recent experience he had with Company A was very negative. When he had a collision in a foreign country, it took months to get reimbursed for his medical expenses and—contrary to his expectations—many of his expenses were not covered. But he has not had any negative experiences with Company B.*” The purpose of using an unknown traveler to deliver the anecdotal information was to minimize potential confounds caused by the source of information.^{36, 37}

After making a choice, participants responded to a state-anxiety scale adopted from Spielberger *et al.*³⁸ comprised of the following three items: (1) *How emotionally engaged were you while making this decision?* (2) *How worried were you while making this decision?* and,

(3) *How anxious were you while making this decision?* (1 = not at all; 7 = a lot). We averaged these three items to create an index for situationally activated anxiety ($\alpha = 0.86$). In addition, participants responded to the following two items: (1) *How involved were you in making this decision?* and (2) *How much thought did you put into making this decision?* (1 = not at all; 7 = a lot). We averaged these two items to create an index for task involvement ($\alpha = 0.83$). Our objective was to show that participants would not differ in task involvement, but would exhibit different levels of state anxiety, due to the field experimental conditions.

3.2. Results

3.2.1. Manipulation Checks

An ANOVA on task involvement ($F(1, 99) = 0.70, p > 0.50$) showed no significant difference in task involvement of respondents participating in the experiment on an exam day ($M = 3.65$) versus on a regular class day ($M = 3.89$). However, their state anxiety on a regular class day ($M = 3.06$) was significantly lower than that on an exam day ($M = 4.62; F(1, 99) = 26.73, p < 0.001$), suggesting that participants' anxiety varied in the expected manner.

3.2.2. Effects of Anxiety on Anecdotal Bias

Separate ANOVAs on respondents' choices revealed significant differences across anxiety conditions. Consistent with our expectations, 63% of the respondents in the high anxiety condition (i.e., on an exam day) chose the anecdotally superior option, whereas only 35% did so on a regular class day when anxiety was lower ($F(1, 99) = 7.45, p = 0.01$), as shown in Fig. 1. This supports our assertion that incidental anxiety can augment the anecdotal bias even when situational involvement remains unchanged. Notably, such an effect exists when anxiety is situationally activated by events or factors unrelated to the focal decision.

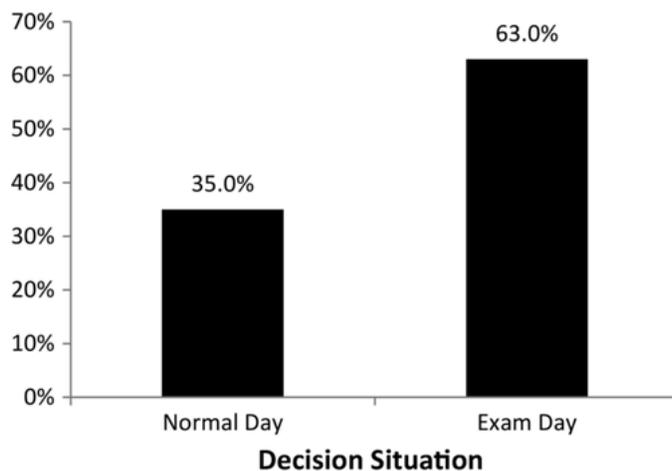


Figure 1. Study 1A: Percent of respondents choosing anecdotally superior insurance option.

4. STUDY 1B

To assess the generalizability of results from Study 1A, we readministered this experiment using a different choice task with a second sample of undergraduate students ($N = 96; 52.1%$

females; $M_{\text{age}} = 23.57$, $SD = 3.39$). The research design, procedures, and measures in this study were identical to those in Study 1A, except for two differences. First, instead of the international travel scenario employed in Study 1A, we designed a decision scenario in which participants were asked to choose between two different medications for a stomach virus that sometimes affects tourists in a particular foreign country. Specifically, they were asked to “*imagine that you are traveling for work to a foreign country where your company recently set up new operations. A few days before you are to leave, your company sends a memo which informs you that the country you are heading to is experiencing a stomach flu infection which causes mild symptoms including a few days of diarrhea.*” The choice task was between a statistically superior option (i.e., *Drug X was effective for 85% of those who tried it vs. Drug Y was effective for 70%*) and an anecdotally superior option (i.e., *Drug X did not work for a co-worker who was afflicted with the virus when he was abroad, but Drug Y did the trick and cured him*). The other important difference is that, to control for information source across statistical and anecdotal conditions, we framed both types of evidence as being from the respondents’ company website, indicating that a summary report on the website provided effectiveness ratings for each drug (statistical information), along with a personal account from a co-worker who had tried both drugs (anecdotal information).

4.1. Results

4.1.1. Manipulation Checks

An ANOVA on task involvement ($F(1, 95) = 0.03$, $p > 0.50$) showed no significant difference in task involvement of respondents participating in the experiment on the exam day ($M = 3.08$) versus on a regular class day ($M = 3.34$). As expected, participants’ state anxiety on a regular class day ($M = 3.41$) was significantly lower than that of participants on an exam day ($M = 5.02$; $F(1, 95) = 29.91$, $p < 0.001$). These findings replicate results obtained in Study 1A.

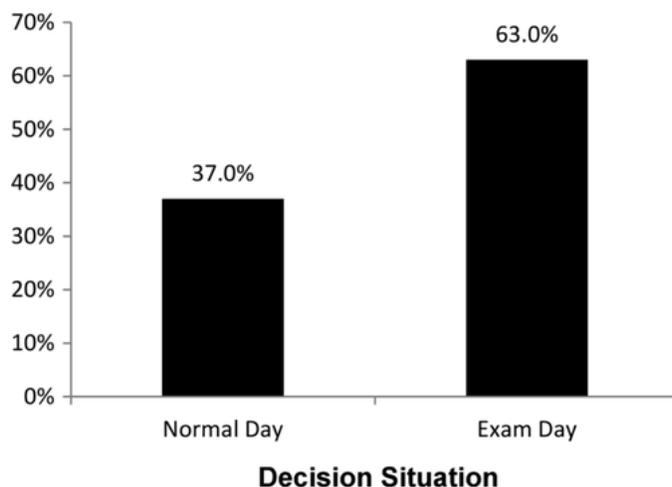


Figure 2. Study 1B: Percent of respondents choosing anecdotally superior drug option.

4.1.2. Effects of Anxiety on Anecdotal Bias

Planned contrasts on participants' choices revealed significant differences across the anxiety conditions. As expected, 63% of participants in the high anxiety condition (i.e., on an exam day) chose the anecdotally superior option while only 37% did so on a regular class day when anxiety was lower ($F(1, 95) = 8.13, p < 0.01$). These results are presented in Fig. 2.

4.1.3. Discussion

While Studies 1A and 1B demonstrated that situationally activated incidental anxiety enhances the anecdotal bias, these results beg the question of whether it is just anxiety—or *any* negative emotion—that causes this aggravation. Previous literature exploring the influence of affective states on decision making generally contrasts affective states of different valence, comparing “positive” versus “negative” versus “neutral” emotions.³⁹⁻⁴¹ The underlying assumption in these evaluations is that all positive emotions, or all negative emotions, are essentially equivalent. More recently, literature on specific emotions has demonstrated that, even within similarly valenced affective states, behavior can vary considerably. Raghunathan and Pham³⁵ demonstrated that, while anxiety leads to greater risk aversion, sadness reduces it. Similarly, Tiedens and Linton⁴² reported differences in decision processes evoked by disgust versus fear (both negative affective states) and happiness versus hopefulness (both positive affective states). In a similar vein, our next study will demonstrate that, while anxiety significantly increases individuals' reliance on anecdotal information, other negative emotions characterized by lower arousal (e.g., sadness) do not enhance the anecdotal bias.

This investigation is pertinent because past literature has strongly hinted that negative affect leads to more systematic processing and reduces susceptibility to affective and peripheral cues.^{43, 44} Our theorizing is contrary to these results. While a negative mood—when it is evoked devoid of enhanced arousal—may lead to more systematic processing, we argue that high arousal will increase decisionmakers' susceptibility to the anecdotal bias.

In the next experiment we investigate the influence of anxiety on the anecdotal bias and attempt to rule out the possibility that negative emotions in general lead to this propensity. This study also diverges from Studies 1A and 1B in other important aspects. While those studies examined the relative choice share of anecdotal (versus statistical) options when both were presented together, this study examines the role of anxiety in a decisionmaker's susceptibility to the anecdotal bias when anecdotal and statistical information are presented separately. This is a critical methodological distinction because several researchers have demonstrated a preference reversal for the same options when they are presented separately versus jointly.⁴⁵ Another important difference characterizing Study 2 is that while prior studies in this article examine the issue of choice, this study examines the persuasive impact of a message. Also, although we controlled for the source of anecdotal and statistical information in Study 1B, there was another distinction between these two types of information: While anecdotal information came from an individuated source, statistical information originated from an aggregated source, which could have potentially led to differential trust and credibility across sources. Our next study controls for this difference as well by ensuring both anecdotal and statistical information come from the same source.

5. STUDY 2

5.1. Participants and Procedures

Study 2 used a 3 (Affect Type: anxiety vs. sadness vs. control) \times 2 (Message Type: anecdotal vs. statistical) between-subjects design. Besides the focal emotion of *anxiety*, we chose to study *sadness* in this experiment because it is another well-studied negative emotion.^{46, 32} Our sample was comprised of 226 nonstudent participants (50.4% females; $M_{\text{age}} = 39.78$, $SD = 14.52$) on a nationwide online panel in the United States that is commercially available from Amazon M-Turk. We restricted our sample to U.S. residents, who were recruited by promoting the online survey as a study on consumer decision making. Participants completed the experiment online for financial compensation (\$0.50).

In the first stage of the experiment, we manipulated Affect Type by asking participants to recall a previous event in their life. All participants were randomly assigned to one of the three Affect Type conditions: anxiety, sadness, and control. In the anxiety and sadness conditions we asked participants to recall an anxiety-provoking or a sadness-provoking event, while those in the control condition were asked to recall a typical evening in their life. In all Affect Type conditions, participants were asked to write down the description so that any reader could understand their emotional state. Such recall tasks have been shown to successfully induce desired emotions in participants.⁴⁷ The average length of participants' descriptions across all Affect Type conditions was 441.6 characters ($SD = 253.8$; $median = 399$). Description length did not vary significantly across conditions ($p > 0.50$).

Following this task, participants in all conditions rated four statements (1 = *Strongly Disagree*; 6 = *Strongly Agree*) relating to their current emotional state: (1) *The experience evokes no particular emotion in me*; (2) *The experience is very vivid and easy to recall*; (3) *The experience makes me feel anxious*; and (4) *The experience makes me feel sad*. These items were designed to serve as manipulation checks for the Affect Type manipulation.

Next, participants were exposed to the Message Type manipulation. In each condition, participants read a letter written by a cattle farmer to a newspaper editor in response to an article recently published in that newspaper that discussed the issue of additional regulation in the cattle farming industry, following the leak of an undercover video showing inhumane practices while handling cattle.⁴⁸ The letter in the statistical Message Type condition employed multiple types of numerical information to make a favorable case for cattle farmers (and against additional government regulation). An excerpt of the statistical letter reads: "*The beef produced in U.S. is safe and wholesome. The incidence of E. coli in ground beef declined more than 80 percent between 2000 and 2006, according to USDA's Food Safety and Inspection Service (FSIS).*" The letter in the anecdotal Message Type condition made a similar case but used only narratives and anecdotes and featured no numerical information (e.g., "*The beef produced in U.S. is safe and wholesome. I have never had a problem with E. coli in my livestock and neither has any producer I know. In fact, I'm so sure of my product's safety, the beef we send to the grocery store is the same meat I feed my family.*"). Care was taken to ensure that both letters were similar in length, format, and tone. A pretest ($N = 40$) also ensured that these letters had similar levels of

credibility ($M_{\text{anecdotal}} = 4.68$; $M_{\text{statistical}} = 4.57$; $p = 0.65$) and persuasiveness ($M_{\text{anecdotal}} = 4.16$; $M_{\text{statistical}} = 4.14$; $p = 0.96$).

In the final stage of the experiment, participants expressed their degree of agreement with several statements designed to measure the degree of influence the letter had: (1) *The message is written by someone who knows the topic*; (2) *The message is sincere*; (3) *The message is believable*; (4) *The message is trustworthy*; (5) *The message is dynamic*; (6) *My opinion is consistent with the writer's message*; (7) *I believe the message conclusion*; (8) *I agree with the writer's conclusion*; and (9) *I accept the conclusion of this message*. As a manipulation check for Message Type we also included two questions assessing participants' perception of the nature of the information presented in the letter: (1) *The letter mostly consists of "anecdotes" and narratives*"; and (2) *The letter mostly consist of "statistics" and "facts."* All the items listed above were anchored at 1 = *Strongly Disagree* and 6 = *Strongly Agree*.

5.2. Results

5.2.1. Manipulation Checks

As expected, participants perceived the emotionality of the experience to be lower in the control condition ($M_{\text{anxiety}} = 5.15$; $M_{\text{sadness}} = 5.26$; $M_{\text{control}} = 3.62$; $p < 0.001$) and equal across the anxiety and sadness conditions of Affect Type ($p = 0.66$; two-condition means test). Recall and perceived vividness of the experience did not vary significantly across Affect Type conditions ($M_{\text{anxiety}} = 5.19$; $M_{\text{sadness}} = 5.22$; $M_{\text{control}} = 4.98$; $p = 0.30$). Experience-induced sadness was the highest in the sadness condition and the lowest in the control condition ($M_{\text{anxiety}} = 3.18$; $M_{\text{sadness}} = 5.10$; $M_{\text{control}} = 1.81$; $p < 0.001$). Similarly, experience-induced anxiety was the highest in the anxiety condition and the lowest in the control condition ($M_{\text{anxiety}} = 4.46$; $M_{\text{sadness}} = 3.47$; $M_{\text{control}} = 1.79$; $p < 0.001$).

As anticipated, participants perceived the anecdotal condition letter as consisting mostly of "anecdotes" and "narratives" ($M_{\text{anecdotal}} = 4.43$; $M_{\text{statistical}} = 3.00$; $p < 0.001$), and the statistical condition letter as comprised mostly of "statistics" and "facts" ($M_{\text{anecdotal}} = 2.64$; $M_{\text{statistical}} = 4.04$; $p < 0.001$).

5.2.2. Effects of Anxiety on Anecdotal Bias

All nine statements measuring the letter's influence on the participant formed a highly reliable ($\alpha = 0.94$), unidimensional Influence Index, which served as our key dependent variable. A 3 (Affect Type) \times 2 (Message Type) ANOVA revealed no significant main effects of Affect Type ($p = 1.00$) or Message Type ($p = 0.20$) on the Influence Index, but did yield a significant interaction effect ($F(2, 226) = 4.25$, $p = 0.015$). Planned contrasts revealed a significant difference in the Influence Index only across the anxiety condition ($M_{\text{anecdotal}} = 4.71$; $M_{\text{statistical}} = 4.07$; $p = 0.015$), but not across the sadness condition ($M_{\text{anecdotal}} = 4.44$; $M_{\text{statistical}} = 4.37$; $p = 0.71$) or the control condition ($M_{\text{anecdotal}} = 4.28$; $M_{\text{statistical}} = 4.51$; $p = 0.23$), as shown in Fig. 3. These results confirm our principal hypothesis that it is indeed negative emotional arousal, specifically anxiety—and not just any negative emotion—that causes the enhanced preference for anecdotal information.

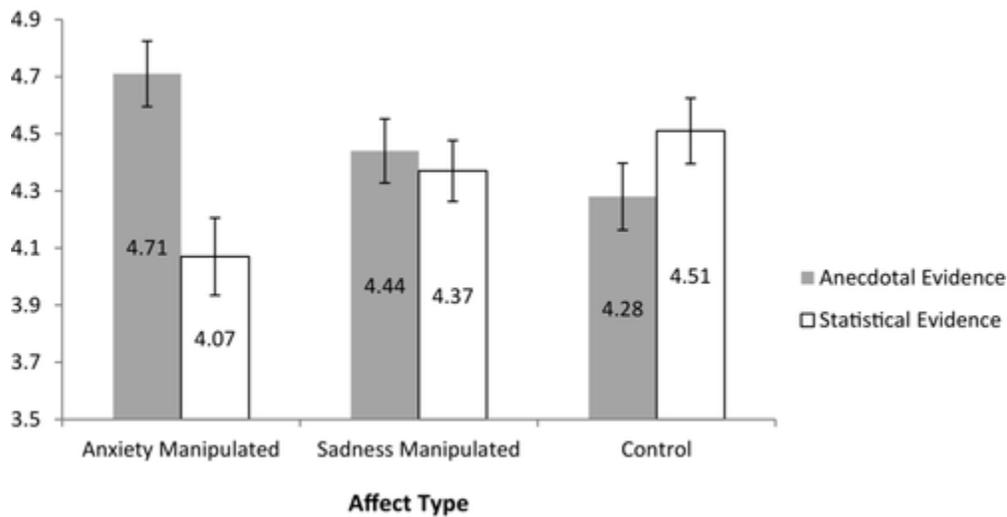


Figure 3. Study 2: Persuasion through anecdotal versus statistical evidence.

5.3. Discussion

In a between-subjects design in which anecdotal and statistical information were separately presented, Study 2 replicated the findings of Studies 1A and 1B. Taken together, these results provide strong evidence that heightened anxiety—even when it is unrelated to the decision scenario—leads to suboptimal choices. Another significant contribution of Study 2 lies in its examination of a situation where anecdotal evidence was not objectively inferior to statistical evidence. In that sense, paying heed to anecdotal evidence is not strictly suboptimal. In a departure from Studies 1A and 1B, the experimental stimuli in Study 2 featured anecdotal evidence that was not incontrovertibly dominated by statistical evidence. This is often the case in real life, where statistics do not always overrule anecdotes in terms of their evidentiary value. Our Study 2 results indicate that anxiety favors anecdotal evidence even when it is not clearly dominated by statistical evidence, and even when it is evaluated in isolation of such contrary statistical evidence.

As mentioned earlier, anxiety can be integral or incidental. While our previous studies dealt with *incidental anxiety*, the next study examines the role of *integral anxiety* in enhancing the anecdotal bias. In particular, this research investigates the role of anxiety caused by probabilistic risk (i.e., the likelihood that a person will encounter an unwanted event) in influencing individuals' suboptimal decisions. When the cost of making a poor decision is high—as in the domain of high-stakes medical decision making or high-risk foreign travel—and the decisionmaker perceives high risk and/or fear, the decision process is often accompanied by higher arousal and negative affect, specifically in the form of anxiety and worry. An additional contribution of our final study is that we directly test for the mediating role of anxiety, something that was not done in our previous studies.

6. STUDY 3

6.1. Participants and Procedures

One hundred and two undergraduate students (48% females; $M_{\text{age}} = 23.6$, $SD = 3.58$) from a major university in the southern United States participated in this experiment to satisfy a class requirement. The research design, procedures, and measures in this study were identical to those in Study 1B, with one exception: instead of using the exam day to naturally heighten anxiety, this study experimentally manipulated the probabilistic risk of being infected by a contagious disease.

Following Freling, Saini, and Yang,⁴⁹ participants were told that the risk of infection was low (high), and were then asked to make a choice between two medication options: one medication was anecdotally superior, while the other was statistically superior.

6.2. Results

6.2.1. Manipulation Checks

An increase in manipulated risk of infection was accompanied by greater state anxiety ($M_{\text{high}} = 3.96$ vs. $M_{\text{low}} = 2.94$, $F(1, 100) = 12.68$, $p < 0.001$), indicating the manipulation of anxiety using probabilistic risk was successful.

6.2.2. Effects of Risk on Anecdotal Bias

Consistent with our expectations, the anecdotal bias increased with higher risk (from 30.0% to 57.7%, $\Delta M = +27.7\%$; $Z = 2.82$, $p_{\text{one-tailed}} < 0.001$), as presented in Fig. 4.

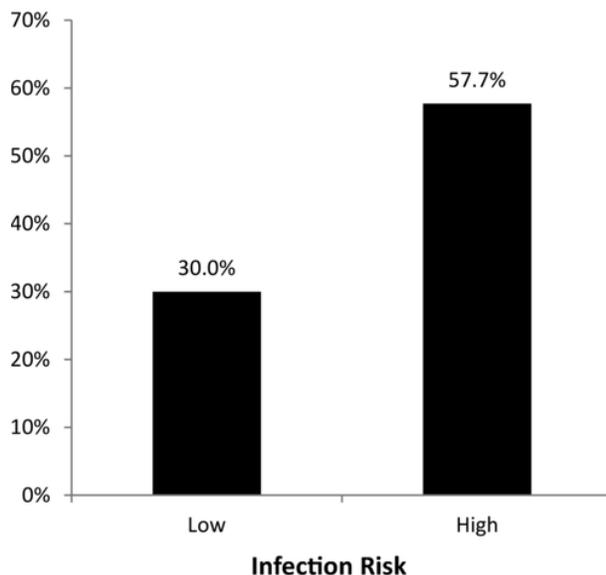


Figure 4. Study 3: Percent of respondents choosing anecdotally superior drug option.

6.2.3. Mediating Role of Anxiety in the Effects of Infection Risk on Anecdotal Bias

We now present evidence that anxiety elicited by infection risk mediates the effect of risk on decisionmakers' preference for anecdotal (vs. statistical) information. First, risk was found to be positively related to the preference for the anecdotally superior option over the statistically superior option (Wald $\chi^2 = 7.70$, $\beta = 1.16$, $\exp(\beta) = 3.18$, $p < 0.01$). Next, risk was also found to be positively associated with state anxiety ($\beta = 0.74$, $p < 0.05$). In addition, a greater level of state anxiety led to a greater preference for the anecdotally superior option (Wald $\chi^2 = 6.97$, $\beta = 0.32$, $\exp(\beta) = 1.38$, $p < 0.01$). Finally, when risk and state anxiety were both included in the model to predict the anecdotal bias, the effect of state anxiety became nonsignificant (Wald $\chi^2 = 2.21$, $\beta = 0.21$, $\exp(\beta) = 1.23$, $p = 0.14$), while the effect of risk remained significant (Wald $\chi^2 = 7.25$, $\beta = 1.18$, $\exp(\beta) = 3.26$, $p < 0.01$). The significance of the indirect effect was tested using bootstrapping procedures.⁵⁰ The procedures generated a 95% confidence interval around the indirect effect with zero falling outside of the confidence interval (95% CI = 0.13–0.78), indicating that the mediating pathway was significant. These results confirmed that, consistent with our expectations, the observed effect of infection risk on preference for the anecdotally superior medication was driven by participants' levels of state anxiety.

7. GENERAL DISCUSSION AND RECOMMENDATIONS

Our results provide converging evidence that anxiety enhances decisionmakers' propensity for using anecdotal evidence, adding to the emerging body of evidence that highlights the role of emotions in risk communication.^{51, 52} This investigation is inspired by, and builds upon, extant literature suggesting that risky choice situations can lead to suboptimal decision outcomes. For instance, Ashcraft and Kirk⁵³ demonstrate that higher stakes in educational testing are almost always associated with worse performance. Similarly, Kahn and Luce⁵⁴ show that stress leads to suboptimal decisions in the context of mammograms. In the current research we provide evidence that anxiety enhances the anecdotal bias in risky choice scenarios. Our selection of anxiety as the primary independent variable was driven by the fact that most consequential decisions involving risk and uncertainty increase the decisionmaker's level of worry, stress, and anxiety. Therefore, examining the role of this emotion in decision making is critical.

In a choice setting, Studies 1A and 1B examine the role of naturally occurring incidental anxiety in enhancing the anecdotal bias. Study 2 replicates the findings of these two studies by manipulating individuals' incidental anxiety. While the first three studies deal with incidental anxiety, the last study examines the effect of integral anxiety on the anecdotal bias, where anxiety is manipulated by enhanced risk of a negative outcome. Our results show that the anecdotal bias is more pronounced when anxiety is heightened by probabilistic risk.

It is important to note that we designed our stimuli in all studies to exclude certain factors extraneous to our core theory from influencing our results in any manner. As noted previously, studies examining the effectiveness of anecdotal information often attribute its persuasive impact to the fact that such information is typically highly vivid and personally experienced, as compared to statistical information—which is often externally generated. The anecdotal information in all of our studies, however, was kept minimally vivid, and its source was always external. In this manner, our results provide a more conservative test of the proposed theory. In the real world—where anecdotal information is often more vivid and personal—anxiety is likely to have an even stronger influence on the anecdotal bias.

Our results are congruent with research examining the deleterious role of arousal on decision making. Loewenstein⁵⁵ proposes a hot-cold dichotomy in the decisionmaker's mindset, where the hot state is characterized by a higher state of arousal due to hunger, thirst, sexual arousal, excitement, or anger, while an absence of these sensations leads to an unaroused cold state. There is an enormous disconnect between these two states. While the hot state is beset by lack of willpower, moral impropriety, and irrational decision making, the cold-state decisionmaker is more calm, collected, patient, and rational. Our results suggest that an elevated level of anxiety may also transport a decisionmaker to a hot state, leading to less rational decisions and lower discrimination of information quality.

Our research also points to an interesting possibility of how high-stakes risky decisions may be influenced by anxiety. It has been widely assumed that higher stakes and incentives benefit decision accuracy. The elaboration likelihood model literature postulates a perpetually positive role of high situational involvement in enhancing decision accuracy.¹⁷ While individuals in high-involvement situations are thought to invest considerable resources in extensive and deliberate processing of information before making judgments and decisions, those operating under low involvement may rely on peripheral cues and other fast, intuitive reactions. Adopting a similar view, economics research often embraces a dismissive attitude toward evidence of decision errors in the behavioral literature by suggesting that most of them will disappear when the stakes are meaningful.⁵⁶ Economists and decision scientists widely agree that stronger incentives for better task performance induce greater effort and result in higher output.⁵⁷ Similarly, the presence of observers induces "social facilitation," which has been proposed to make participants more alert and, as a consequence, better performers.⁵⁸ But our results suggest that this may not always be the case. When high stakes make an individual anxious, high involvement may actually hinder decision efficiency. Our findings build upon the nascent literature stream presenting a counterintuitive view of the rationalizing role of high stakes and incentives in enhancing human performance. Recent evidence suggests that high stakes or social cues that intensify stress, pressure, and "choking" can have a detrimental effect on output,⁵⁹⁻⁶¹ and can, in fact, reduce task performance and creativity.^{57, 59}

Our results are strongly supportive of communication strategies that utilize anecdotal and narrative evidence to promote alternatives in situations plagued by higher decision anxiety. This is congruent with several findings in the behavioral literature in general, and the health communication literature in particular, that demonstrate the efficacy of anecdotal evidence.⁷ The findings in our studies suggest that even when statistical evidence is objectively superior, high anxiety may make decisionmakers more susceptible to anecdotal information. Our findings do not advocate the use of communication based on statistical information, but rather suggest that, in creating such messages, it might be optimal to utilize narratives and anecdotes to reinforce statistical information.

7.1. Limitations and Future Research

Despite the valuable contributions of this research, our findings must be interpreted in the context of certain limitations. First, our research only examines situations where anxiety is caused by unwanted events (e.g., disease afflictions). Future research could explore if one's

probability of experiencing a positive event characterized by uncertainty similarly influences that individual's susceptibility to the anecdotal bias. It may also be worth investigating whether high stakes, which often arouse anxiety, can enhance decisionmakers' sensitivity to the anecdotal bias. Second, in the current project, we were interested in studying how anxiety enhances the anecdotal bias. Future research can further explore how information vividness interacts with information type (e.g., affect-rich statistical information vs. affect-poor anecdotal information) to affect individuals' decision making under high anxiety situations.

Additionally, we separately examined the role of incidental and integral anxiety in our studies; however, in some situations, these sources of anxiety could coexist. It may be worthwhile to explore how incidental and integral anxiety may interact to influence the anecdotal bias in such situations. Previous literature has also examined the impact of trait anxiety—a relatively stable personality characteristic—on decision making.³⁸ This is somewhat akin to the investigated effects of incidental anxiety in our studies. Future research can examine whether trait anxiety similarly influences decision making.

Finally, our findings hint at the possibility that, in addition to the anecdotal bias, several other biases may also be similarly influenced by anxiety. This is due to similarities between the anecdotal bias and various other heuristics and biases that have been the focus of behavioral research in the area of risky decision making. A classic explanation for the persuasive effect of anecdotal evidence may be derived from the notion of the availability heuristic,⁶² which holds that vividly presented information (e.g., a personal case history) is more likely to come to mind. Several other behavioral and perceptual biases emanating from availability and representativeness, including base rate neglect, can also be viewed as manifestations of a tendency to be insensitive to statistical information in the presence of more visceral, vivid, anecdotal cues. For example, Small and Loewenstein⁶³ demonstrate an “identifiable victim effect” where greater altruism is displayed toward an identified recipient versus a larger, nonspecific—but arguably more deserving—group of victims. Similarly, Rottenstreich and Hsee⁶⁴ and Ditto *et al.*⁶⁵ have shown how visceral stimuli can blind decisionmakers to relevant quantitative information. Our findings suggest that such neglect of numerical information may be exacerbated for anxious individuals. Future research could examine the impact of anxiety on such behavioral heuristics and biases.

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REFERENCES

1. Beck AT, Emery G, Greenberg RL. *Anxiety Disorders and Phobias: A Cognitive Perspective*. New York: Basic Books, 2005.

2. Nakayachi K. The unintended effects of risk-refuting information on anxiety. *Risk Analysis*, 2013; **33**(1): 80– 91.
3. Hornikx J. A review of experimental research on the relative persuasiveness of anecdotal, statistical, causal, and expert evidence. *Studies in Communication Sciences*, 2005; **5**(1): 205– 216.
4. Thomas E. “Baby Jessica” grows up. *Newsweek*, October 26, 1997.
5. Small DA, Loewenstein G, Slovic P. Sympathy and callousness: The impact of deliberative thought on donations to identifiable and statistical victims. *Organizational Behavior and Human Decision Processes*, 2007; **102**(2): 143– 153.
6. Kahneman D, Tversky A. On the psychology of prediction. *Psychological Review*, 1973; **80**: 237– 251.
7. Bar-Hillel M. The base-rate fallacy in probability judgments. *Acta Psychologica*, 1980; **44**(3): 211– 233.
8. Locksley A, Hepburn C, Ortiz V. Social stereotypes and judgments of individuals: An instance of the base-rate fallacy. *Journal of Experimental Social Psychology*, 1982; **18**(1): 23– 42.
9. Sloman SA, Over D, Slovak L, Stibel JM. Frequency illusions and other fallacies. *Organizational Behavior and Human Decision Processes*, 2003; **91**(2): 296– 309.
10. Dawes RM, Corrigan B. Linear models in decision making. *Psychological Bulletin*, 1974; **81**(2): 95– 106.
11. Dawes RM, Faust D, Meehl PE. Clinical versus actuarial judgment. *Science*, 1989; **243**(4899): 1668– 1674.
12. Hendrickx L, Vlek C, Oppewal H. Relative importance of scenario information and frequency information in the judgment of risk. *Acta Psychologica*, 1989; **72**(1): 41– 63.
13. Slovic P, Finucane ML, Peters E, MacGregor DG. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 2004; **24**(2): 311– 322.
14. Hamill R, Wilson TD, Nisbett RE. Insensitivity to sample bias: Generalizing from atypical cases. *Journal of Personality and Social Psychology*, 1980; **39**(4): 578– 589.
15. Kazoleas DC. A comparison of the persuasive effectiveness of qualitative versus quantitative evidence: A test of explanatory hypotheses. *Communication Quarterly*, 1993; **41**(1): 40– 50.
16. Baesler EJ. Persuasive effects of story and statistical evidence. *Argumentation and Advocacy*, 1997; **33**(4): 170– 175.
17. Petty RE, Cacioppo JT. *Communication and Persuasion: Central and Peripheral Routes to Attitude Change*. New York: Springer-Verlag, 1986.
18. Kahneman D. *Thinking, Fast and Slow*. New York: Macmillan, 2011.
19. Cox D, Cox AD. Communicating the consequences of early detection: The role of evidence and framing. *Journal of Marketing*, 2001; **65**(3): 91– 103.
20. Reisberg DE, Hertel PE. *Memory and Emotion*. New York: Oxford University Press, 2004.
21. Schirillo JA, Stone ER. The greater ability of graphical versus numerical displays to increase risk avoidance involves a common mechanism. *Risk Analysis*, 2005; **25**(3): 555– 566.
22. Allen M, Preiss RW. Comparing the persuasiveness of narrative and statistical evidence using meta-analysis. *Communication Research Reports*, 1997; **14**(2): 125– 131.
23. Butler G, Mathews A. Anticipatory anxiety and risk perception. *Cognitive Therapy and Research*, 1987; **11**(5): 551– 565.

24. Butler G, Mathews A. Cognitive processes in anxiety. *Advances in Behaviour Research and Therapy*, 1983; **5**(1): 51– 62.
25. Barlow DH. Causes of sexual dysfunction: The role of anxiety and cognitive interference. *Journal of Consulting and Clinical Psychology*, 1986; **54**(2): 140– 148.
26. Hartley CA, Phelps E. A. Anxiety and decision making. *Biological Psychiatry*, 2012; **72**(2): 113– 118.
27. Darke S. Anxiety and working memory capacity. *Cognition and Emotion*, 1988; **2**(2): 145– 154.
28. Sanbonmatsu DM, Kardes FR. The effects of physiological arousal on information processing and persuasion. *Journal of Consumer Research*, 1988; 379– 385.
29. Keinan G. Decision making under stress: Scanning of alternatives under controllable and uncontrollable threats. *Journal of Personality and Social Psychology*, 1987; **52**(3): 639– 644.
30. Mueller JH. The effects of individual differences in test anxiety and type of orienting task on levels of organization in free recall. *Journal of Research in Personality*, 1978; **12**(1): 100– 116.
31. Mueller JH. Test anxiety, input modality, and levels of organization in free recall. *Bulletin of the Psychonomic Society*, 1977; **9**(1): 67– 69.
32. Lauriola M, Levin IP. Personality traits and risky decision making in a controlled experimental task: An exploratory study. *Personality and Individual Differences*, 2001; **31**(2): 215– 226.
33. Eysenck MW. *Anxiety: The Cognitive Perspective*. Chicago: Psychology Press, 1992.
34. Brooks AW, Schweitzer ME. Can Nervous Nelly negotiate? How anxiety causes negotiators to make low first offers, exit early, and earn less profit. *Organizational Behavior and Human Decision Processes*, 2011; **115**(1): 43– 54.
35. Raghunathan R, Pham MT. All negative moods are not equal: Motivational influences of anxiety and sadness on decision making. *Organizational Behavior and Human Decision Processes*, 1999; **79**(1): 56– 77.
36. Hovland CI, Weiss W. The influence of source credibility on communication effectiveness. *Public Opinion Quarterly*, 1951; **15**(4): 635– 650.
37. Hovland CI, Irving LJ, Kelley HH. *Communication and Persuasion: Psychological Studies of Opinion Change*. New Haven, CT: Yale University Press, 1953.
38. Spielberger CD, Gorsuch RL, Lushene RE. *Manual for the State-Trait Anxiety Inventory*, 1970.
39. Labroo AA, Patrick VM. Psychological distancing: Why happiness helps you see the big picture. *Journal of Consumer Research*, 2009; **35**(5): 800– 809.
40. Isen AM, Geva N. The influence of positive affect on acceptable level of risk: The person with a large canoe has a large worry. *Organizational Behavior and Human Decision Processes*, 1987; **39**(2): 145– 154.
41. Isen AM. An influence of positive affect on decision making in complex situations: Theoretical issues with practical implications. *Journal of Consumer Psychology*, 2001; **11**(2): 75– 85.
42. Tiedens LZ, Linton S. Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology*, 2001; **81**(6): 973– 988.
43. Bodenhausen GV, Kramer GP, Süsler K. Happiness and stereotypic thinking in social judgment. *Journal of Personality and Social Psychology*, 1994; **66**(4): 621– 632.

44. Schwarz N, Bless H, Bohner G. Mood and persuasion: Affective states influence the processing of persuasive communications. *Advances in Experimental Social Psychology*, 1991; **24**: 161– 199.
45. Hsee CK, Loewenstein GF, Blount S, Bazerman MH. Preference reversals between joint and separate evaluations of options: A review and theoretical analysis. *Psychological Bulletin*, 1999; **125**(5): 576– 590.
46. Keltner D, Ellsworth PC, Edwards K. Beyond simple pessimism: Effects of sadness and anger on social perception. *Journal of Personality and Social Psychology*, 1993; **64**(5): 740– 752.
47. Lerner JS, Keltner D. Fear, anger, and risk. *Journal of Personality and Social Psychology*, 2001; **81**(1): 146– 159.
48. Good C. Persuasive effect of narrative and statistical evidence combinations. Doctoral dissertation, Kansas State University, 2010.
49. Freling T, Ritesh S, Yang Z. Do higher stakes lead to better choices? Pp. 926– 927 in Z Gürhan-Canli, C Otnes, R Zhu (eds). *NA—Advances in Consumer Research, Vol. 40*. Duluth, MN: Association for Consumer Research, 2012.
50. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 2008; **40**(3): 879– 891.
51. Keller C, Siegrist M, Gutscher H. The role of the affect and availability heuristics in risk communication. *Risk Analysis*, 2006; **26**(3): 631– 639.
52. Xie XF, Wang M, Zhang RG, Li J, Yu QY. The role of emotions in risk communication. *Risk Analysis*, 2011; **31**(3): 450– 465.
53. Ashcraft MH, Kirk EP. The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, 2001; **130**(2): 224– 237.
54. Kahn BE, Luce MF. Understanding high-stakes consumer decisions: Mammography adherence following false-alarm test results. *Marketing Science*, 2003; **22**(3): 393– 410.
55. Loewenstein G. Emotions in economic theory and economic behavior. *American Economic Review*, 2000; 426– 432.
56. Hertwig R, Ortmann A. Experimental practices in economics: A methodological challenge for psychologists? *Behavioral and Brain Sciences*, 2001; **24**(03): 383– 403.
57. Prendergast C. The provision of incentives in firms. *Journal of Economic Literature*, 1999; 7– 63.
58. Guerin B. *Social Facilitation*. Cambridge, MA: Cambridge University Press, 1993.
59. Ariely D, Gneezy U, Loewenstein G, Mazar N. Large stakes and big mistakes. *Review of Economic Studies*, 2009; **76**(2): 451– 469.
60. Zajonc RB. Social facilitation. *Science*, 1965; **149**(3681): 269– 274.
61. Dohmen TJ. Do professionals choke under pressure? *Journal of Economic Behavior & Organization*, 2008; **65**(3): 636– 653.
62. Tversky A, Kahneman D. Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 1973; **5**(2): 207– 232.
63. Small DA, Loewenstein G. Helping a victim or helping the victim: Altruism and identifiability. *Journal of Risk and Uncertainty*, 2003; **26**(1): 5– 16.
64. Rottenstreich Y, Hsee CK. Money, kisses, and electric shocks: On the affective psychology of risk. *Psychological Science*, 2001; **12**(3): 185– 190.

65. Ditto PH, Pizarro DA, Epstein EB, Jacobson JA, Macdonald TK. Visceral influences on risk taking behavior. *Journal of Behavioral Decision Making*, 2006; **19**: 99– 113.