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Can Overconfidence be Debiased by Low-Probability/ High-Consequence Events?

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During the first half of 2008, China suffered three natural disasters: a heavy snow storm, an outbreak of hand-foot-mouth disease, and a severe earthquake. The aim of the present study is to explore how low-probability/high-consequence events influence overconfidence. In Study 1, opportunity samples were obtained by recruiting residents in three different types of disaster-hit areas to answer a peer-comparison probability judgment questionnaire about 1 month after the corresponding disaster occurred. The performance of 539 participants in disaster-hit areas was compared with that of 142 residents in a nondisaster area. The findings indicate that residents in disaster-hit areas were less overconfident than those in the nondisaster area on both positive and negative events. In Study 2, we surveyed a total of 336 quake-victims 4 and 11 months after the earthquake to examine whether the impact of disasters on overconfidence would decay with time. The resulting data indicate that the disaster victims became more overconfident as time elapsed. The overall findings suggest that low-probability/high-consequence events could make people less overconfident and more rational and seem to serve as a function of debiasing.

KEY WORDS: Disaster; optimistic bias; overconfidence; rationality; time-decay

1. INTRODUCTION

During the first half of 2008, China suffered three natural disasters: a heavy snow storm in Hunan Province, a severe outbreak of hand-foot-mouth disease (HFMD) in Anhui Province, and a major magnitude 8.0 earthquake in Sichuan Province.

In January and February 2008, southern China suffered "the coldest winter in 100 years," where it seldom snows in winter (e.g., in the worst snow-hit province, Hunan, there are usually fewer than 10 days below 0 °C each year and the mean temperature is usually above 4 °C in a typical winter season[(1)]). A heavy snow storm led to deaths, structural collapses, blackouts, transport accidents and problems, and livestock and crop losses. More than 100 million people were affected and at least 60 people died in the severe weather. In the worst-hit area, Chenzhou City of Hunan Province, 4 million people were affected by power supply outages and water supply shortages for more than a week. Experts said the cost of damage from the severe snow storm was likely to reach at least $7.5 billion.[(2)]

In April and May 2008, there was an outbreak of HFMD[1] among young children in China's Anhui Province. The EV71 and Cox A16 viruses were identified as the most common causes of HFMD in this

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[1] The epidemic was first recorded on March 20, 2008 (http://english.gov.cn/2008-05/06/content_962324.htm). According to Health Ministry reports, the outbreak in the worst-hit city was under control on May 11, 2008 (http://english.sina.com/china/p/1/2008/0511/157969.html).

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outbreak.[3] Patients with EV71 infection usually display serious symptoms. Infection by EV71 has led to meningitis, encephalitis, pulmonary edema, and paralysis in some cases with children. HFMD is very contagious and spreads through direct contact with nose and throat secretions, saliva, blister fluid, or stool of an infected person and there is currently no vaccine available. Fuyang City of Anhui Province, the worst hit, registered 5,513 cases of infection and 22 cases of death according to the Ministry of Health as of May 8, 2008.[3]

On May 12, 2008, a major earthquake measuring 8.0 on the Richter Scale jolted Sichuan Province and neighboring areas. This earthquake affected an area of 100,000 km^2, caused 69,227 deaths and more than 374,000 injuries, with 17,923 missing as of September 25, 2008, according to Chinese official figures.[4] For the first time in history, China declared 3 days (May 19 to May 21) of national mourning for the earthquake victims.

These disasters attracted the attention of the whole nation and of the world. Entering the Chinese key words "Hunan (湖南)" and "snow storm (雪灾)" in a search engine (www.google.cn) in February 2009 resulted in about 654,000 hits; "Anhui (安徽)" and "HFMD (手足口)" 644,000 hits; and "Sichuan (四川)" and "earthquake (地震)" 20,700,000 hits.

Disasters (e.g., the 9/11 terrorist attacks, technological hazards) are often described as "low-probability/high-consequence events."[5,6] Recent debate has arisen regarding whether people become more rational or irrational after a disaster.[5,7–9] For example, after the 9/11 terrorist attacks, Americans avoided flying due to a perceived dreaded risk and instead chose to drive to some of their destinations rather than fly. As a result, there were more car accidents than usual; the number of Americans who lost their lives on the road by avoiding flying during this time was higher than the total number of passengers killed on the four fatal flights of 9/11.[5] As flying is generally considered safer than driving,[10] Gigerenzer argues that people become more irrational after disasters and that informing the public about psychological research concerning postdisaster irrationality could possibly save lives.[5] Sacco *et al.*, however, reported that the events of 9/11 caused outcomes of the decision-making process to move closer to those expected from rational choices and that people had a tendency to look for certainty and to avoid bigger losses.[7]

The consecutive natural disasters in China in 2008 presented an opportunity for us to study how human rationality is influenced by a low-probability/high-consequence event.

In the words of one popular text on judgment: "No problem in judgment and decision making is more prevalent and more potentially catastrophic than overconfidence."[11] Most researchers consider overconfidence a form of miscalibration: over a wide range of conditions, subjects' average probability judgments exceed the proportions of general knowledge items they answer correctly.[12] Overconfidence also occurs when people believe themselves to be better than others, such as when a majority of people rate themselves better than the median. Lee *et al.* call this peer comparison overconfidence.[13] Overconfidence is seen as a major impediment to good decision making.[14] The cognitive bias account of overconfidence can be seen in theoretical proposals suggesting that biases in probabilistic judgment occur as a consequence of the strategies by which evidence is evaluated.[15–17] Even though lone individuals do not debias themselves, they are surrounded by cultural mechanisms that compensate for their shortcomings.[18,19] Overconfidence may be debiased by some social events.

This study explores whether people's rationality was influenced by the disasters that occurred in China in 2008.

2. STUDY 1

This study aims to explore how disasters influence people's overconfidence in disaster-hit and nondisaster areas.

2.1. Method

2.1.1. Materials and Procedure

We employed two future life events: a positive event and a negative event. The two future life events were adapted from Weinstein.[20] According to Weinstein, to get a job is a positive event; to be infected by a disease is a negative one.[20]

We administered booklets that contained peer-comparison problems to the participants. The peer-comparison problems were adapted from Lee *et al.*,[13] and read as follows:

> *A: Job Scenario (positive event):*
>
> *Imagine a random sample of people, the same gender, the same age, and the same work experience as you. Assume that you yourself are one of the 100 persons. Suppose that all 100 persons in the sample are looking for a job and all*

Table I. Demographic Characteristics of the Study Samples

Area	Snow Storm ($N = 190$)	HFMD ($N = 173$)	Earthquake ($N = 176$)	Nondisaster ($N = 142$)
Gender				
Male	96(50.5%)	85(49.1%)	96(54.5%)	58(40.8%)
Female	92(48.4%)	84(48.6%)	80(45.5%)	75(52.8%)
Unknown	2(1.1%)	4(2.3%)	0	9(6.3%)
Age				
Range	23–50	20–50	20–50	24–50
Mean[*SD*]	34.6[5.7]	33.1[7.3]	29.5[7.9]	34.6[6.7]
Missing cases	3	10	8	10

are ranked according to the date that they get a job. What is your best estimation of the number in the sample (1–100) that indicates your rank in getting a job?_______

B: Disease Scenario (negative event):

Imagine a random sample of people, the same gender, the same age, and the same health condition as you. Assume that you yourself are one of the 100 persons. Suppose that there is presently a severe infectious disease and all 100 persons in the sample are ranked according to the date that they get infected. What is your best estimation of the number in the sample (1–100) that indicates your rank in getting infected by the disease?_______

The problems were presented to participants on paper-pencil questionnaires. The participants were asked to estimate their own rank number between 1 and 100 inclusive and put the number in the blanks as required. Once participants completed the survey, they were thanked and debriefed. All the data in the disaster devastated areas were collected 1.0–1.5 months after the corresponding disaster. The data for the nondisaster area were collected a month after the heavy snow storm, but before the occurrence of the HFMD outbreak and the May 12 earthquake. The study was approved by the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences. Oral consent was obtained from the study participants.

2.1.2. Samples

Opportunity samples were obtained by recruiting adult residents (nonstudent samples) in both nondisaster and disaster-hit areas. Entry criteria included an age of at least 20 years, literacy, and an oral consent. An additional entry criterion for the disaster-hit areas was that the participant was living in the area when the disaster occurred. The survey was conducted door-to-door on an individual basis. Participants were paid a small fee (about ¥10) for each completed questionnaire. The sample of the heavy snow storm area included 190 residents of Chenzhou City (worst hit), Hunan Province. The sample of the HFMD outbreak area was 183 residents of Fuyang City (worst hit), Anhui Province. The sample of earthquake areas was 85 residents of Wenchuan County and 99 residents of Deyang City (two among the most devastated areas), Sichuan Province. The sample of the nondisaster area was 148 residents of Lianyungang City, Jiangsu Province. Since it was irrelevant to ask those over retirement age to estimate their percentile rank relative to their peers in getting a job, respondents aged above 50 years[2] (6 persons in nondisaster area, 10 in HFMD, and 8 in earthquake areas) were excluded from the analyses. Our final sample for Study 1, therefore, consisted of 681 participants of legal working age. Their gender and age information is presented in Table I.

2.2. Results and Discussion

According to Lee *et al.*,[13] if participants are neither overconfident nor underconfident, their average estimates of their percentile rank relative to their peers should be in the 50th percentile. For Lee's problem of ability estimation, any estimate over the 50th percentile is an indication of overconfidence, whereas an estimate below the 50th percentile reflects underconfidence. The higher the percentage quoted by a participant, the higher the level of confidence exhibited, and vice versa. To be comparable to a general knowledge bias, peer-comparison overconfidence (or possibly underconfidence, if negative) is computed by the following bias equation:[13]

$$\text{mean bias}_{\text{Peer Comparison}} = \text{mean percentile estimated} - 50\%.$$

[2] According to law in China, men should retire at 60, women cadres at 55, and women workers at 50.

Table II. Participants' Mean Estimation of Their Own Percentile Rank on Positive and Negative Scenarios

	Disaster Condition			
	Snow Storm ($N = 190$)	HFMD ($N = 173$)	Earthquake ($N = 176$)	Nondisaster ($N = 142$)
Job scenario (positive event)	20.35(24.80)	21.62(21.45)	27.74(26.72)	15.31(19.24)
Reverse coding of job scenario	79.65(24.80)	78.38(21.45)	72.26(26.72)	84.69(19.24)
Disease scenario (negative event)	85.78(22.48)	72.13(30.56)	70.43(34.21)	82.82(26.39)

Notes: For consistency of data presentation across scenarios, reverse coding was used for the job scenario so that a higher percentile rank always indicated a higher level of overconfidence exhibited.

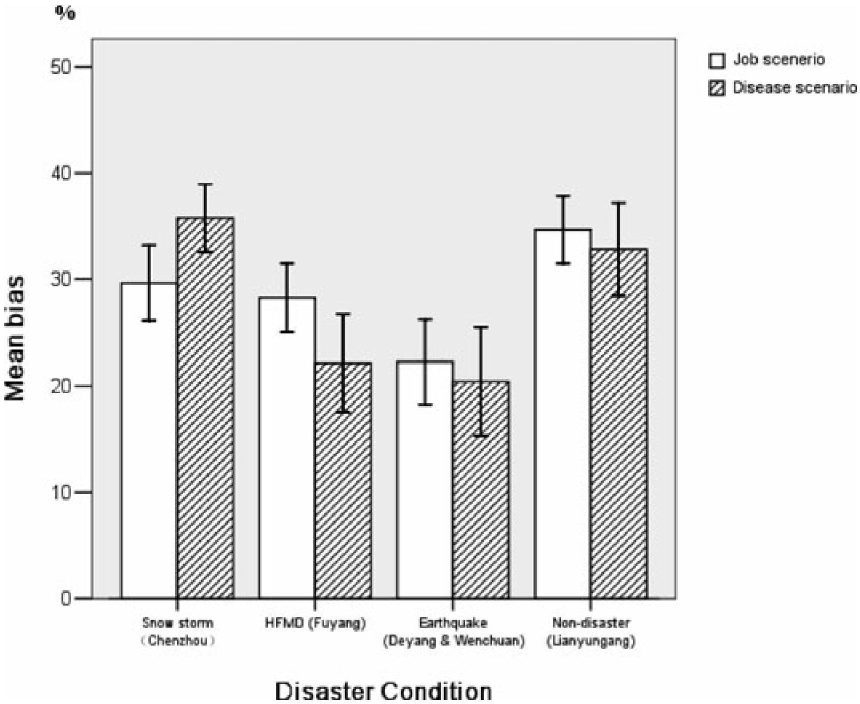

Fig. 1. Participants' mean bias on positive (job scenario) and negative (disease scenario) events under different disaster conditions.

In this study, if participants were neither overconfident nor underconfident, their average estimates of their percentile rank relative to their peers should have been in the 50th percentile as well. For the negative event (disease scenario), responding with a higher number implied a higher level of overconfidence. The rank number of being infected by a disease typically has a positive relationship with the level of overconfidence and any estimate over the 50th percentile is an indication of overconfidence.

In this study, for the positive event (job scenario), responding with a higher number implied a lower level of overconfidence. Therefore, the rank number of a participant getting a job would have an inverse relationship with the level of overconfidence. Any estimate below the 50th percentile would be an indication of overconfidence. For consistency of data presentation across scenarios, reverse coding was used for the job scenario. Thus, a higher percentile rank always indicated a higher level of overconfidence exhibited in both scenarios.

The residents' estimates of their own percentile rank in the job and disease scenarios, as well as the results of reverse coding in the job scenario, are presented in Table II. The mean bias on positive (job scenario) and negative (disease scenario) events are shown in Fig. 1.

The four disaster conditions (snow storm, HFMD, earthquake, and nondisaster conditions), gender (male vs. female), and the three age groups (20–29, 30–39, 40–50) constituted the levels of the three between-subjects factors. Residents' mean ranks of NOT getting a job under different disaster conditions were compared using a one-way analysis of variance (ANOVA). ANOVA analysis for the estimates of participants' percentile ranks yielded a significant effect of disaster condition, $F(3, 621) = 4.878$, $p < 0.01$. Fisher's least significant difference (LSD) post hoc tests ($p < 0.05$) revealed that residents in the nondisaster condition tended to estimate their rank of NOT getting a job significantly higher than that of those in the heavy snow storm condition, the HFMD condition, and the earthquake condition. The estimate of the residents in the earthquake condition was the lowest. There was no significant difference between the heavy snow storm and HFMD conditions. These findings indicate that people who have experienced a disaster tend to be less optimistic about getting a job than those who have not experienced a disaster.

ANOVA analysis for the estimates of participants' percentile ranks of being infected by a disease yielded a significant effect of disaster condition, $F(3, 620) = 8.976$, $p < 0.001$. Fisher's LSD post hoc tests ($p < 0.05$) revealed that residents in the nondisaster condition tended to estimate that their rank of being infected by the disease significantly higher than that of the HFMD and earthquake conditions. There was no significant difference between the heavy snow storm and nondisaster conditions. These findings indicate that people who had experienced the HFMD outbreak or earthquake tended to be more pessimistic about being infected by the disease than those who had not experienced either of these particular disasters. There was no significant estimate difference between those who had experienced a heavy snow storm and those who had not.

There was no gender (job scenario: $F(1, 621) = 1.659$, $p > 0.05$; disease scenario: $F(1, 620) = 1.498$, $p > 0.05$) nor age (job scenario: $F(2, 621) = 1.096$, $p > 0.05$; disease scenario: $F(2, 620) = 1.148$, $p > 0.05$) difference found.

The findings suggest that after a low-probability/high-consequence event people's confidence that positive future life events will happen to them decreases, while confidence that negative future life events will happen to them increases. Respondents' rankings of themselves moved closer to the 50th percentile, the median level, on both positive and negative events. People's overconfidence decreased significantly after all three types of disasters surveyed in both the job and disease scenarios, except that overconfidence failed to decrease significantly in the disease scenario after the heavy snow storm. A possible explanation for this exception is that the snow-hit seems to have no relationship to the infectious disease described in the disease scenario.

3. STUDY 2

In Study 1, we found that residents in disaster-hit areas were less overconfident than those in the nondisaster area. It could be argued that the lower overconfidence level in devastated areas might reflect differences in the location in which the surveys took place rather than the disaster experience *per se*. Nonetheless, most would agree that, if a lower overconfidence level is due to a disaster, then the impact of disasters should decay over time.

Bearing this in mind, we conducted follow-up surveys in areas devastated by the May 12 earthquake (the most severe and latest catastrophe in Study 1) to investigate whether overconfidence would rebound with time. Specifically, in Study 2, we hypothesized that, with time ticking away, victims' optimism about positive future life events happening to them would increase, while their pessimism about negative future life events happening to them would decrease.

3.1. Method

3.1.1. Materials and Procedure

Two follow-up surveys were conducted 4 months (second wave: September, 2008) and 11 months (third wave: April, 2009), respectively, after the May 12 earthquake. The materials and procedure were the same as in Study 1.

3.1.2. Samples

As in Study 1, a survey was conducted door-to-door on an individual basis for adult residents (nonstudent samples) in quake-devastated areas. Entry criteria were the same as those in Study 1. The additional entry criterion was that the participant was living in the area when the earthquake occurred and still living there when the follow-up survey was conducted. We excluded 8 respondents aged above 50 years (2 persons of the second wave and 6 of the third wave) from the study samples for the same reason as in Study 1. Finally, the second wave sample of the earthquake area was 131 residents (nonstudent) in Deyang City, Sichuan Province, aged 20–50 years (mean = 32.6, $SD = 7.3$). One hundred thirty (130) participants disclosed their gender: 44 (33.8%) were

Table III. Participants' Mean Estimation of Their Own Percentile Rank on Positive and Negative Scenarios

	Wave of Survey		
	First Wave (Study 1) ($N = 176$)	Second Wave ($N = 131$)	Third Wave ($N = 205$)
Job scenario (positive event)	27.74(26.72)	22.31(22.35)	21.19(24.38)
Reverse coding of job scenario	72.26(26.72)	77.69(22.35)	78.81(24.38)
Disease scenario (negative event)	70.43(34.21)	66.90(35.60)	76.83(29.46)

Notes: For consistency of data presentation across scenarios, reverse coding was used for the job scenario so that a higher percentile rank always indicated a higher level of overconfidence exhibited.

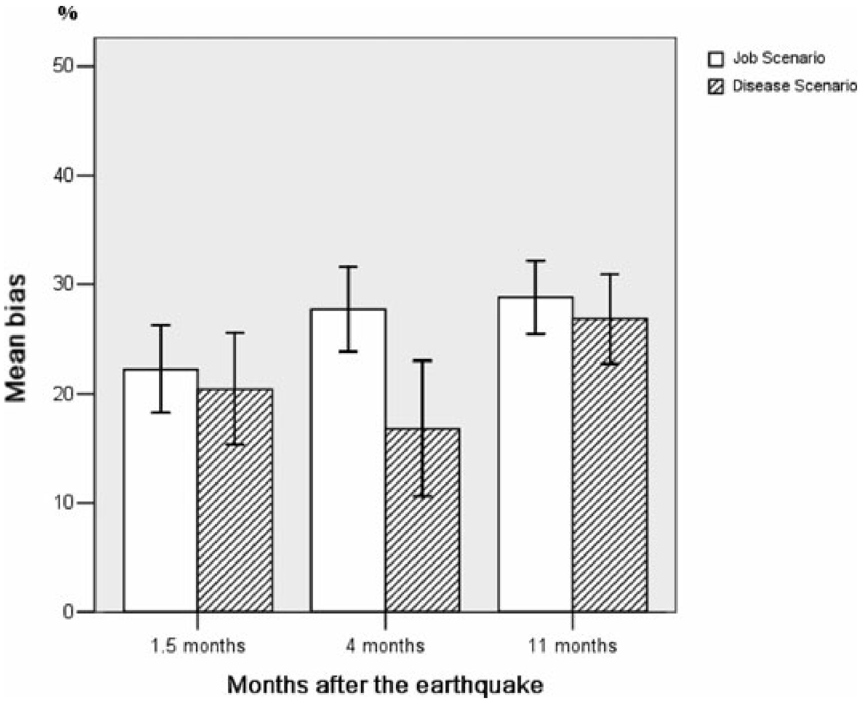

Fig. 2. Participants' mean bias on positive (job scenario) and negative (disease scenario) events since May 12 earthquake.

male, 86 (66.2%) female. The third wave sample of earthquake area was 205 residents (nonstudent) in Deyang City, aged 20–50 years (mean = 33.0, SD = 7.7), 65 (31.7%) male and 140 (68.3%) female.

3.2. Results and Discussion

As in Study 1, reverse coding was also used for the job scenario for consistency of data presentation across scenarios so that a higher percentile rank always indicated a higher level of overconfidence exhibited.

The residents' estimates of their own percentile rank in job and disease scenarios from the second and third waves of survey are presented in Table III. The mean bias on positive (job scenario) and negative (disease scenario) events are shown in Fig. 2. In order to examine how people's overconfidence changes with time after a disaster, we included the data from the first survey wave (previously reported in Study 1) in the earthquake-devastated area as a baseline.

The three waves (first, second, and third waves), gender (male vs. female), and the three age groups (20–29, 30–39, 40–50) constituted the levels of the three between-subjects factors. ANOVA analysis yielded significant differences in residents' mean ranks of NOT getting a job across the three waves of the survey, $F(2, 483) = 3.200$, $p < 0.05$. Fisher's LSD post hoc tests ($p < 0.05$) revealed that residents in the third wave tended to estimate their rank of NOT getting a job significantly higher than in the first wave. Residents' mean ranks of NOT getting a job failed to reach statistical difference between the first and the second waves and between the second and the third waves. Consistent with our hypothesis, victims appeared to become more optimistic about getting a job as time elapsed.

ANOVA analysis for the estimates of participants' percentile ranks of being infected by the disease yielded a significant effect of wave, $F(2, 484) = 3.446$, $p < 0.05$. Fisher's LSD post hoc tests ($p < 0.05$) revealed that residents from the third wave of the survey tended to estimate their rank of being infected by a disease significantly higher than that from the second and the first waves. The mean estimate did not differ statistically between the first and the second waves. The results support our hypothesis that victims' pessimism about negative future life events happening to them decreases with time.

There was also no gender (job scenario: $F(1, 483) = 0.327$, $p > 0.05$; disease scenario: $F(1, 484) = 0.369$, $p > 0.05$) nor age (job scenario: $F(2, 483) = 2.280$, $p > 0.05$; disease scenario: $F(2, 484) = 1.962$, $p > 0.05$) difference found.

Taken together, our data suggest that the lower overconfidence level in the devastated areas in Study 1 was more likely to be attributed to the disaster, given that the impact of disasters on overconfidence decayed over time in Study 2.

4. GENERAL DISCUSSION

People routinely demonstrate unrealistic optimism when judging their own vulnerability to negative events or prospects of positive events.(20,21) They believe they are less likely to experience negative events than others, but more likely to experience positive events. Lee *et al.* call this tendency peer-comparison overconfidence.(13) As it is logically impossible for most people to be better than others, this perception is considered to be an irrational cognitive bias in judgment, which has been labeled by some researchers as "positive illusion" or "optimistic bias."(22–25)

In our Study 1, the findings interestingly reveal that disaster victims' optimistic bias was significantly smaller than that of residents in the nondisaster area, suggesting that people became less overconfident and more rational after a low-probability/high-consequence event. In Study 2, data from follow-up surveys in the earthquake-devastated areas indicate that disaster victims ranked themselves further from the 50th percentile, the median level, as time elapsed, suggesting that their optimistic bias had somewhat rebounded. Study 2 provides evidence to illustrate that the difference in overconfidence levels between the residents in the disaster-hit and nondisaster areas in Study 1 was more likely due to the disasters themselves rather than a difference in location. The overall finding suggests that disasters influence overconfidence levels: experiencing a disaster will likely give rise to less overconfidence.

Prior studies on gender difference in overconfidence have produced mixed results.(26–28) Some studies have found no gender differences(26) and others have reported that men are more overconfident than women.(27,28) In our study there was no gender difference found.

Additionally, some researchers have reported that older individuals display greater overconfidence compared to younger ones.(29,30) Using a sample of 1,583 between 14 and 87 years of age, Renner *et al.*(31) found that up to the age of 50 there was no significant increase in optimistic health beliefs and that, above 50 years old, confidence increased with age. Our findings of no age difference in overconfidence among participants aged 50 and younger are consistent with the results of Renner *et al*.

The influence of disasters on overconfidence might be accounted for by the perceived event frequency. It has been reported that the perceived frequency of an event is correlated with the magnitude of the optimistic bias,(20,32–35) though the correlation found has been inconsistent. Some research suggests that events perceived as more frequent elicit a larger optimistic bias,(32) whereas other research suggests that events perceived as less frequent elicit a larger optimistic bias.(33,36,37) For example, Weinstein investigated the susceptibility to health problems of a community-wide sample and reported that the magnitude of the optimistic bias was larger for less frequent events.(33) As people gave more weight to the recency of an event,(35,38–40) vivid, singular information,(41) and individual experience,(42) a recently experienced disaster was more likely to influence the perception of event frequency than a generally described or earlier experienced disaster. The perceived frequency account proposed by Weinstein(18) might provide a possible and simple explanation for our findings.

Thirty years of decision research has used rational theories from economics, statistics, and logic to argue that descriptive behavior falls systematically short of normative ideals. Classical decision theory assumes that people are essentially rational and any errors are random and nonsystematic. The existence of systematic biases is now largely accepted by decision researchers and increasingly by researchers in other disciplines. But this apparent gap between the normative and the descriptive has provoked much debate: Is there, in fact, a gap? And, if so, can it be closed—that is, can biases be "debiased"?[43–47] Even though lone individuals do not debias themselves,[48] they are surrounded by cultural mechanisms that compensate for their shortcomings.[18,19] The present study suggests that major social and environmental events, such as the three disasters discussed, can serve as a function of debiasing.

The present results highlight some influence of disasters on rationality. However, there remain a number of unresolved problems. At present, it is unclear which of the two attributes of the disasters—low probability, high consequences, or a combination of the two—is more responsible for the confidence calibration. On Tversky and Kahneman's availability view that individuals estimate the likelihood of an event "by the ease with which instances or associations come to mind,"[49] the mere occurrence of a low-probability event should be sufficient to affect overconfidence. On the other hand, according to Tversky and Kahneman's representativeness heuristic that individuals evaluate probabilities "by the degree to which A is representative of B,"[41] the mere fact that so many people (including participants and/or people they know) have been devastated should also be sufficient to affect overconfidence. It is, in principle, possible that the effect was caused by the combination of the two attributes of the disasters. This problem is definitely worth further investigation and study.

It is possible to speculate that using an opportunity sample of equal size rather than a victim-population-based sample might lead to an underestimation of the calibration in the snow storm and earthquake conditions in Study 1, which, in turn, may contribute to the little sign of a dose-response effect[50] (e.g., the most severe disaster, the May 12 earthquake, has not led to a significantly greater calibration than any of the other two events). It also could be argued that some social and economic consequences of the low-probability/high-consequence event, rather than the event itself, could have affected the responses of residents in our current study (e.g., those in the samples collected in the disaster areas showing a reduced confidence in finding a job might be due to the fact that the disasters made the job market more competitive). Clearly, further research is needed to determine whether the consequences of these natural disasters upon decision making are direct or indirect.

Furthermore, it should be noted that the Lee *et al.* (1995) protocol appears to have some limitations with regard to real-life situations,[51] even though it has been previously used in other research.[52,53] In future studies, other overconfidence measurement (e.g., general knowledge overconfidence measurement[12]) should be conducted to confirm any effect. Additional research is also necessary to clarify the effect of involvement on participants' reduction of overconfidence. Disentangling the roles of kinship/similarity relation between the devastated people and participant is critical, and may enable us to predict under what conditions a reduction in overconfidence is likely to occur after a low-probability/high-consequence event.

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