

(The Lack of) Optimistic Biases in Response to the 1994 Northridge Earthquake: The Role of Personal Experience

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The tendency to believe that one's risk is less than that of one's peers is a well-documented and pervasive tendency. This optimistic bias is reduced in certain circumstances, such as when people have personal experience with an event, although it may reappear with time. University students who experienced the 1994 Northridge, CA earthquake were asked 1 week after the quake about their optimistic biases concerning earthquakes and a variety of other events. Students were followed every 2 weeks over the next 5 months. In addition, two new groups of students were surveyed at 2 and 4 months after the earthquake. As expected, no optimistic bias for earthquakes was present immediately after the earthquake (but other events did show the bias). Contrary to previous research, no bias for earthquakes was present even 5 months after the earthquake. Those who had personal experience with injury or monetary loss as a result of the earthquake showed less optimism about injury in future earthquakes than those with no personal experience of injury or loss. Results are discussed in terms of the moderators of the optimistic bias.

Often the appraisals that people make when comparing themselves to others appear logically impossible. When they compare their abilities, traits, and health risks, people tend to be self-serving. People think they are smarter than others (Wylie, 1979); college students think that they are more likely than their peers to like their postgraduation jobs, own their homes, or travel to Europe (Weinstein, 1980). In one study, 94% of university professors thought that they were better at their jobs than their average colleagues ("I'm OK, you're not," 1996). This tendency is particularly pervasive with respect to health-related risks. People acknowledge that a given negative event can happen, but believe that it is less likely to happen to them, personally. This optimistic bias (thinking that one is less at risk than one's peers) has been demonstrated with a variety of populations. For example, in a community-wide representative sample, participants thought they were less at risk than their peers for drug addiction, drinking problems, suicide, asthma, and food poisoning (Weinstein, 1987). Similarly, college students believe that they are less likely than the average student to have an unplanned pregnancy or heart attack, or to get a sexually trans-

mitted disease, HIV, cancer, or hypertension (Burger & Burns, 1988; Helweg-Larsen, 1998; Perloff & Fetzer, 1986; Weinstein, 1980, 1984). People about to bungee jump also believe that their risk of injury is smaller than the risk of the typical bungee jumper (Middleton, Harris, & Surman, 1996).

The optimistic bias has proven extremely resistant to experimental manipulations. For example, Weinstein and Klein (1995) reported four unsuccessful attempts at reducing the optimistic bias in college students. In fact, people may misreport the frequency of their risky behaviors or see risky behaviors as less important to good health in order to maintain their claim of being less at risk than their peers (Klein, 1996). Despite the difficulty of experimentally reducing optimism, there are some circumstances under which the optimistic bias appears to be reduced. One such situation, to be examined in more depth here, is personal experience.

PERSONAL EXPERIENCE

Much research supports the notion that personal experience moderates the optimistic bias. Perloff (1983) argues that a victimizing event shatters the perception of personal invulnerability, and leaves the victim with a new and unpleasant sense of being vulnerable. People who have been victims of crime, for example, feel more vulnerable to future crime situ-

ations than nonvictims do. Weinstein (1980) also found that prior experience with a given negative event led college students to feel more vulnerable to that event than the average college student. These findings have been replicated in a community-wide sample, in which experience with illness decreased the tendency to hold optimistic biases for that illness (Weinstein, 1987), and in a Dutch group of clinic patients, in which patients who had previously had a sexually transmitted disease were less optimistically biased about not contracting that sexually transmitted disease in the future (Van der Velde, Hooykaas, & Van der Pligt, 1992).

Thus, there is relatively strong evidence that people who have experienced a negative event are less optimistic about that event occurring in the future than people who have not experienced the event (although there is relatively little work on examining the difference between high and low impact experiences). Several factors might simultaneously explain the effect of experience on optimistic beliefs, including perceived control over the event and negative affect.

PERCEIVED CONTROL

Experiencing a negative event may influence perceived control, as well as optimistic biases. People may be more successful in maintaining their sense of invulnerability when they have no direct evidence to the contrary. Once such knowledge becomes available, it is more difficult to deny personal vulnerability. A review of the research shows that perceived control is clearly related to increased optimistic bias (Harris, 1996). For example, Quadrel, Fischhoff, and Davis (1993) found greater optimism for controllable events (auto accident injury, alcohol dependency, unplanned pregnancy, and mugging) than for uncontrollable events (sickness from air pollution, injury in a fire explosion, sickness from pesticides, and sickness from radiation poisoning). Van der Velde et al. (1992) and Weinstein (1980) also found that people were considerably more optimistic about their chances of experiencing a controllable event than a noncontrollable event. Thus, experience with an event may lead to reduced perceived control over the event, as well as a reduction in the optimistic bias for that event.

NEGATIVE AFFECT

Experiencing a negative event such as a crime, serious illness, or natural disaster might lead to anxiety, negative mood, and even depression (e.g., Nolen-Hoeksema & Morrow, 1991). Studies show that each of these three states influences perceived risk. In terms of anxiety, studies show that high levels of anxiety lead to greater perceived risk (Dewberry, Ing, James, Nixon, & Richardson, 1990). This appears to be true for both trait and state anxiety (Butler & Mathews, 1987). With respect to mood, Salovey and Birnbaum (1989) induced

happy, sad, or neutral mood and found that, although all participants displayed the optimistic bias, the bias was much more pronounced for happy individuals than for sad individuals. Similarly, depression appears to be associated with less optimistic bias (Alloy & Ahrens, 1987). For example, Pietromonaco and Markus (1985) found that the depressed were more likely than the nondepressed to believe that a variety of negative events would happen to them, and were able to imagine themselves experiencing these situations with greater ease (but see Dunning & Story, 1991).

In sum, personal experience with an event may influence negative affect, as well as reduce perceptions of invulnerability. These effects can be broadly explained by cognitive processing effects (Salovey & Birnbaum, 1989). First, negative affect leads to increased focus on the self and away from others or external stimuli. Second, when a particular mood is present, one is more likely to recall mood-congruent information. The availability heuristic would suggest that events that are more easily recalled are judged as being more likely to occur. In other words, negative affect may increase the ease of recall of previous or similar negative events, which leads to ease of imagining these and other negative situations.

THE RECOVERY OF OPTIMISTIC BIAS ACROSS TIME

Current research thus provides some information about the process by which personal experience leads to reductions in the optimistic bias. However, it is still not clear what cognitive changes occur as people recover from an immediate loss in optimistic bias (for example, does perceived control, stress, or worry moderate the change in the optimistic bias?). It is also not clear *when* people return to their regular levels of optimistic bias following a negative experience. Burger and Palmer (1992) directly assessed the time interval after which the optimistic bias returned to pre-event levels. Immediately after the 1989 Loma Prieta, CA earthquake, participants showed no optimism about being hurt in a natural disaster (but showed the bias for other events), but 3 months later the participants showed the optimistic bias for natural disasters (and again for other events as well). Burger and Palmer speculated that the change in the optimistic bias for natural disasters can be explained by the fact that people are motivated to maintain their optimism whenever possible, in order to feel in control and reduce anxiety. However, when the situational information suggests that they may be at risk (such as immediately after actually experiencing a disaster, in this case a major earthquake), people adjust their optimistic beliefs accordingly, albeit temporarily.

The Burger and Palmer study is of particular interest, because it shows that people adjust their optimistic beliefs in response to personal experience. In addition, it suggests that this effect is relatively short lived. It appears that people may

bounce back relatively quickly from a major experience, such as an earthquake, and return to their usual optimistic biases. However, no other studies have been published that show a similar quick return to pre-event optimistic levels. In addition, the Burger and Palmer study has a number of limitations that make this conclusion questionable. First, Burger and Palmer did not directly ask participants about the risk of earthquakes, but rather about the risk of being seriously hurt in a natural disaster (defined as "flood, earthquake, or storm"). Because people appear to be motivated to maintain optimistic biases, the students may have selectively interpreted the question to emphasize floods or storms as opposed to earthquakes, especially 3 months after the earthquake, when it presumably was less salient. Second, Burger and Palmer used a quasiexperimental comparison group. That is, the students immediately after the quake (who showed no optimistic bias) were different from those students who reported an optimistic bias 3 months later. Third, it was not possible to pinpoint at what time the optimistic bias returned in Burger and Palmer's study, because no measures were taken between the time immediately after the earthquake and the 3-month follow-up.

This study was intended to reexamine the relation between personal experience and the optimistic bias, by addressing both when the optimistic bias returns after personal experience with the event, as well as examining moderators of the bias (personal experience, control, anxiety, and stress). Participants responded to a series of questions about their risk perceptions immediately after the 1994 Northridge earthquake. The earthquake occurred in Northridge, CA (outside Los Angeles) on January 17, 1994, at 4:31 a.m. Pacific Standard Time. The earthquake measured 6.7 on the Richter scale, and lasted about 20 sec. More than 1,500 aftershocks were recorded in the 5 days following the main quake, including two aftershocks that measured between 5.0 and 5.9 on the Richter scale. The earthquake left 61 people dead, 9,000 injured, and 25,000 homeless. Thirty thousand houses, apartments, and businesses were seriously damaged, and another 250,000 suffered minor damage ("Insurance," 1995). It was the nation's most costly earthquake, with a final toll at \$12.5 billion (Noble, 1996).

This study improved on the Burger and Palmer study in several areas. First, one question directly assessed the optimistic bias regarding risk of injury from earthquakes. Second, data were collected over time from the same students (within-participants design). In addition, a new sample of students were surveyed at various other times (between-participants element). Third, participants were asked to give their risk estimations every 2 weeks following the Northridge earthquake, permitting an examination of change over time. Finally, this study examined the moderating effects of personal experience, perceived control, stress, and worry.

I predicted that students at all times would be optimistically biased about most of the non-earthquake-related events.

Examining the change of bias over time, I expected that students would show no bias for earthquake injury immediately after the earthquake. If Burger and Palmer's findings are accurate, the bias should return at some point before 3 months. In addition, I expected that participants who had more direct experience with the earthquake (experienced personal injury or monetary loss) would show less optimistic bias than those with little or no direct experience. That is, the optimistic bias would return more slowly among those with direct experience. Finally, measures of perceived control, as well as stress and worry (serving as proxies for negative affect), were expected to covary with the optimistic bias. Thus, if the optimistic bias increased over time, I would expect that perceived control would increase over time and stress/worry would decrease over time.

METHOD

Overview

Three different groups of University of California, Los Angeles (UCLA) undergraduates participated. Group 1 (G1) was asked about their optimistic biases four times during in-class sessions (1, 3, 5, and 7 weeks after the earthquake) and four times over the phone (11 to 12, 12 to 14, 15 to 16, and 17 to 19 weeks after the earthquake). The initial sample size declined from 100 at T1 to 24 at T8.¹ Group 2 (G2) participants were asked the same questions only once during an in-class session 8 weeks after the earthquake ($n = 43$). Group 3 (G3) participants were also asked these questions only once during an in-class session 16 weeks after the earthquake ($n = 60$).

Participants

At the first point of measurement (1 week after the earthquake) participants consisted of 100 undergraduate students (47% men and 53% women), ages 18 to 49 (mean age = 23, median age = 21) recruited from a psychology course at

¹To examine if those who dropped out over the course of the study were different from those who did not, those participating at T1 were split into two subsamples: those who were still in the study at T8 and those who were not. Results showed that there were no differences among these subsamples at T1 with respect to how stressed they currently felt about earthquakes or how worried or in control they felt about possible future earthquake injury (all $t < .20$, all $p \geq .84$). However, those who participated at both T1 and T8 were marginally more optimistically biased about their risk of earthquake injury ($M = 3.83$, $SD = 0.82$) than those who participated only at T1 ($M = 4.11$, $SD = 0.79$), $F(1, 97) = 2.11$, $p = .15$, $\eta^2 = .02$. If any bias was introduced by participant attrition it appears that those who stayed in the study for the duration were more optimistically biased than those who dropped out. That is, if anything the results at later time periods were biased toward finding evidence of optimistic bias.

UCLA. Forty-seven percent of the participants were White, 6% Black, 22% Asian, 16% Chicano or Hispanic, and 9% other ethnicities. As for their experience with injury during this earthquake, 67% knew of no one who had been injured, 12% knew of injured acquaintances, 15% knew of injured family and friends, and 6% had been injured themselves. The majority of students (69%) suffered no financial loss as a result of the earthquake (dollar amount lost: median \$0, mean \$413, range \$0–\$10,000). Forty-three students participated in Group 2 (40% men and 60% women), ages 20 to 34 (mean age = 22, median age = 21). Fifty percent knew of no one who had been injured, 21% knew of injured acquaintances, 28% knew of injured family and friends, and 2% had been injured themselves. The majority of students (51%) suffered no financial loss during the earthquake (dollar amount lost: median \$0, mean \$239, range \$0–\$3000). Sixty students participated in Group 3 (27% men and 73% women), ages 19 to 31 (mean and median = 22). Sixty-two percent knew of no one who had been injured, 21% knew of acquaintances, 14% knew of family and friends, and 3% had been injured themselves. Again the majority of students (63%) experienced no financial loss as a result of the earthquake (dollar amount lost: median \$0, mean \$356, range \$0–\$10,000).

Materials

After supplying demographic information (i.e., gender, age, ethnic/racial background, and major), students rated their relative risk for each of 10 events. The item concerning earthquakes read: "Compared to the typical UCLA college student of my gender, my chances of getting seriously injured in an earthquake in the future are ..." The 7-point scale ranged from 1 (*much less than the typical UCLA student's chances*) to 4 (*the same as the typical UCLA student's chances*) to 7 (*much more than the typical UCLA student's chances*). The other nine risks used the same wording and were (in order): getting a drinking problem, getting seriously injured in a fire, getting a heart attack, getting a divorce, getting seriously injured in a flood, getting HIV, getting hypertension, getting mugged, and having (or causing) an unplanned pregnancy. The earthquake question was always seventh in this list of 10 events.

Participants were also asked specific questions about the Northridge earthquake pertaining to their personal experience ("Who do you know who was injured in the earthquake?") Choices: no one, acquaintances, close friends or relatives, me), the amount of monetary damage ("How much money did you personally lose as a result of damage caused by the earthquake?"), and the amount of damage in the area they lived (5-point scale from 1, *none*, to 5, *a great deal*). This same scale was also used to assess how much their daily lives had been inconvenienced as a result of the earthquake; how much stress they experienced because family members or friends in the area were injured in the earthquake, had their

homes damaged, or could not be reached; and how much stress they were currently experiencing as a result of the earthquake. Finally, items asked how worried they were about being injured in a future earthquake (scale from 1, *not at all worried*, to 5, *extremely worried*) and how much control they felt they had over whether they would be injured in a future earthquake (scale from 1, *no control at all*, to 5, *a great deal of control*). Students in Group 1 also received the Life Orientation Test (LOT) at T2. The LOT is an 8-item measure of dispositional optimism (Scheier & Carver, 1985), ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).²

Procedure

For the data collected during in-class sessions (T1–T4 for Group 1, Group 2, and Group 3), students took part in the study during their regular class periods. The experimenter informed participants that their responses were anonymous and that if they did not wish to participate, they could turn in a blank or partially completed questionnaire. To encourage privacy all participants were told that they should not discuss the questions with anyone or look at anyone's responses. These instructions were stated verbally by the researcher and repeated on the first page of the questionnaire. To be able to keep answers anonymous but connect the Group 1 responses over time, students generated a unique code number at T1 that they reconstructed for every subsequent session.

For the data collected via phone interviews (T5–T8 for Group 1), students participating during class at T4 were asked on the last page of the survey if they were interested in continuing to participate in the study. If they agreed, they were asked to supply their phone numbers (but not their names). Trained interviewers contacted participants on the phone and asked to speak to the person who "had Political Psychology last quarter." As before, students were reminded that their answers were anonymous, that they did not have to answer any questions they did not wish to answer, and that they could terminate the interview at any time.

RESULTS

Overview

The analyses are presented in four sections. The first section examines the predictions pertaining to the level of optimism for earthquake injury and other risks in addition to examining the change in risk perceptions over time. The second section examines the hypothesis that participants with more direct personal experience would show less evidence of optimism.

²The LOT was not correlated with any measures of optimistic bias, so it is not discussed further.

The third section examines the hypothesis that perceived control would be positively correlated with optimism, such that the greater the perceived control (over earthquake injury), the greater the optimism (with respect to earthquake injury). The fourth section examines the hypothesis that participants who were stressed and worried would report greater risk ratings.

Optimistic Bias

The comparative risk questions were assessed on a 7-point scale, such that an average of 4 indicates no optimistic bias, an average below 4 indicates optimism, and an average greater than 4 indicates pessimism. To determine if the group as a whole showed evidence of an optimistic bias, the optimistic bias score for each time period was compared to the midpoint of the scale. If the score was significantly different from the midpoint it would indicate that participants showed a bias. Thus one-tailed *t* tests were performed to compare each mean to the midpoint of the scale. To control for Type I error, only results significantly different at $p < .005$ were reported. As is evident in Table 1, and consistent with Burger and Palmer's findings, students did not show the optimistic bias for getting injured in an earthquake immediately after the earthquake (T1, $M = 4.04$). In addition, and contrary to Burger and Palmer's findings, students fairly consistently displayed *realistic* beliefs about their relative risk of future earthquake injury across the 10 time periods. Thus across all the time periods participants consistently reported realistic beliefs about their risk of future earthquake injury.

Because the participants consistently reported realistic beliefs across the 10 time periods, it seems unlikely that an analysis comparing the means across time would reveal any differences. In fact, a within-participants analysis of variance across the 8 within-participants time periods (T1–T8) revealed no significant differences, $F(7, 84) = 0.73$, $\eta^2 = .06$. Because repeatedly asking the optimistic bias questions of the same participants could lead to a set response, a between-groups comparison was also performed. Comparing the risk scores at T1 ($M = 4.04$), G2 ($M = 4.07$), and G3 ($M = 3.93$) revealed no significant differences, $F(2, 199) = 0.65$, $\eta^2 = .01$. Thus, as expected, students did not show the bias immediately after the earthquake. However, they also did not show the bias 3 months after the earthquake (the point at which the Palmer and Burger's participants showed the bias) or 5 months after the earthquake.³

With respect to the other events for which optimistic bias was assessed (see Table 2), the results were consistent with expectations and with previous research (e.g., Weinstein,

1980, 1982). Participants showed a consistent optimistic bias for getting injured in a flood (one of the examples of a natural disaster included in the Burger and Palmer "natural disaster" question). Most of the other events also showed the optimistic bias, such as drinking, injury during a fire, divorce, HIV, and pregnancy.

Effect of Experience

Because all the participants were in Los Angeles during the earthquake, they all had some personal experience with the earthquake. The analyses therefore compared participants who had experienced more personal consequences as a result of the earthquake (direct experience) with those who experienced few or no personal consequences (indirect experience). Participants were asked how much money they personally lost as a result of the earthquake. This variable showed considerable range (\$0–\$10,000), and it was decided that a reasonable comparison between no loss and some loss would include only those who lost nothing versus those who lost \$100 or over. Thus this variable was split into two groups: those who experienced zero dollars in personal loss (69% at T1, 54% at G2, and 63% at G3), as opposed to those who experienced \$100 or more in loss (this analysis excluded participants who lost from \$1 to \$99: 9 participants at T1, 8 at G2, and 9 at G3). Independent *t* tests comparing optimism for these two groups showed that at T1 those who had experienced no personal loss were more optimistic ($M = 3.97$, $SD = .67$) than participants who experienced a personal loss of \$100 or more ($M = 4.38$, $SD = 1.12$), $t(86) = -2.06$, $p < .05$, $\eta^2 = .05$. This same analysis at G2 and G3 revealed no significant difference between those who had experienced no loss and some loss at G2 or G3, $t(33) = -1.29$, $\eta^2 = .05$ and $t(51) = -1.17$, $\eta^2 = .03$, respectively. However, this lack of replication is likely entirely due to the smaller sample size. The pattern of means was similar in that those who had not experienced a personal loss were more optimistic (G2: $M = 3.86$, $SD = 0.94$; G3: $M = 3.82$, $SD = 0.77$) than those who experienced a personal loss of \$100 or more (G2: $M = 4.27$, $SD = 0.65$; G3: $M = 4.15$, $SD = 1.21$), although not significantly so.

Experience was also operationalized in terms of whether participants had been injured or knew of someone who had. Two groups were created comparing those who knew of no one who had been injured during the quake with those who had themselves been personally injured. Independent *t* tests revealed that at T1 participants who were not injured and did not know of anyone who was injured were more optimistic ($M = 3.94$, $SD = 0.72$) than participants who had personally been injured ($M = 4.67$, $SD = 1.21$), $t(71) = -2.24$, $p < .03$, $\eta^2 = .07$. Similar results were obtained at G3 (the n was too small at G2 to make this comparison). Participants who knew of no one who was injured were more optimistic ($M = 3.81$, $SD = 0.79$) than those who had personally been

³Burger and Palmer (1992) had 23 students at T1 and 41 students at T2. This study had larger sample sizes across most of the time periods (see Table 1). Therefore, this lack of replication is not likely a result of sample size differences in the two studies.

TABLE 1
Change in Optimistic Bias, Current Stress, Worry, and Perceived Control

Demographic	T1		T2		T3		T4		G2		T5		T6		G3		T7		T8			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD		
Group	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	3	1	1	1	1		
Total n	100	75	72	56	72	56	7	7	43	28	11-12	13-14	15-16	17-19	60	28	15-16	24	24	17-19		
Weeks after quake	1	3	5	7	5	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
Variable	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Optimistic bias for future earthquake injury ^a	4.04	0.80	3.85	0.67	3.97	0.71	3.79	0.68	4.07	0.88	4.00	0.80	3.85	0.82	3.87	0.85	3.75	0.70	3.92	0.65	3.92	0.65
Current stress	2.56	1.31	2.08	1.04	1.90	0.89	1.70	0.89	2.12	1.03	1.72	0.75	1.70	0.99	1.77	0.98	1.61	0.69	1.33	0.57	1.33	0.57
Worry about future earthquake injury	2.75	1.16	2.40	0.88	2.32	0.98	2.16	0.89	2.81	1.12	2.45	1.09	2.37	1.01	2.38	0.78	2.25	0.97	2.00	0.83	2.00	0.83
Control over future earthquake injury	2.29	1.00	2.37	1.02	2.23	0.90	2.25	1.01	2.54	1.05	2.03	1.12	2.00	0.78	2.02	1.07	2.07	0.98	1.67	0.92	1.67	0.92

Note. Optimistic bias was measured on a 7-point scale ranging from 1 (much less than the typical UCLA student's chances) to 7 (much more than the typical UCLA student's chances). Stress, worry, and control were measured on 5-point scales ranging from 1 (less stress, worry, or control) to 5 (more stress, worry, or control).

^aAn optimistic bias score below 4 indicates a belief that one's risk is less than average. T-tests were used to test whether this mean was significantly different from 4 (which none were; all $t_s \leq 2.04$, $\eta_s \leq .12$, $p < .005$).

injured ($M = 5.00$, $SD = 1.41$), $t(36) = -2.03$, $p < .05$, $\eta^2 = .10$.

Contrary to predictions, there was no evidence of an interaction between time and experience (based on monetary loss), $F(2, 166) = 0.03$, $\eta^2 < .01$, nor between time and experience (based on injury), $F(2, 127) = 1.29$, $\eta^2 = .02$. That is, those with experience did not have different optimistic beliefs over time compared with those without experience. Thus, although experience did make a difference in optimistic bias, it did not do so differentially over time.

At T1 participants were also asked other questions regarding their experiences, such as how much damage there was in the participant's area of residence, how inconvenienced participants were as a result of the quake, or how much stress participants experienced as a result of worrying about others. Examining the correlations at T1 between the risk ratings for quakes and these three other measures of personal experience revealed no significant correlations (range of $r_s = -.02$ to $-.18$, average = $.12$). At G2 and G3 only the first of these additional experience questions were asked, and analyses also revealed no significant relation between how much damage there was to the participant's area of residence and the risk ratings for earthquakes, G2: $r(41) = .18$, ns ; G3: $r(58) = .16$, ns . These measures were likely too indirect to tap personal experience and therefore did not covary with the risk ratings.

Effect of Control

I predicted that over time perceived control would covary with the risk ratings. Because the optimistic bias (for earthquakes) remained stable over the 10 time periods, I expected that perceived control would also remain stable over time. Comparing perceived control over injury in future earthquake for T1 ($M = 2.29$), G2 ($M = 2.54$), and G3 ($M = 2.02$) did not reveal any differences (all $r_s < 0.20$, all $\eta^2 < .01$). Similarly, perceived control did not change significantly over the 8 within-participants time periods, $F(7, 84) = 1.28$, $\eta^2 = .10$. Thus perceived control did not change as a function of time since the earthquake.

Although perceived control did not change over time, within a given time period very optimistic individuals might be more likely to believe that they could control future earth-

quake injuries. To examine this hypothesis the correlation between the risk ratings (for earthquakes) and control were calculated for each of the 10 time periods (see Table 3). First, looking at the three between-participants time periods, results showed no significant relation, T1: $r(98) = -.00$, ns ; G2: $r(41) = -.02$, ns ; G3: $r(58) = -.19$, ns . The within-participants time periods showed significant correlations at T3 and T4, in that those who were more optimistic were more likely to believe that they could control injury in future quakes. The correlations for the other time periods were in the same direction but were not significant. In sum, there appeared to be a weak or inconsistent relation between optimism and perceived control.

Effects of Stress and Worry

Consistent with prior research on affect, I expected that participants who were more stressed or worried would show less optimism. Computing the correlations between stress, worry, and optimism showed consistent results for all 10 time periods: Neither correlations between optimism and stress (ranges of r_s from $-.03$ to $.29$, average = $.13$) nor correlations between optimism and worry were significant (ranges of r_s from $-.02$ to $.30$, average = $.16$). For all 10 time periods the correlation between worry and stress was always significant (range of r_s from $.40$ to $.77$, average = $.55$, $p_s < .05$). Thus, although people who were more stressed were also more worried, neither worry or stress were related to optimistic beliefs about future earthquakes. It is possible that a single item measure of stress or worry was insufficient or that a more direct assessment of affect (such as anxiety or mood) is necessary to show the impact on optimistic beliefs.

In addition, as is evident in Table 1, stress and worry declined over time. Current stress declined both as measured within participants over the 8 time periods, $F(7, 84) = 5.86$, $p < .001$, $\eta^2 = .33$, and between participants when comparing scores at T1, G2, and G3, $F(2, 199) = 9.87$, $p < .001$, $\eta^2 = .09$. Worry about future earthquakes similarly declined over time, both for within participants, $F(7, 84) = 3.77$, $p < .001$, $\eta^2 = .24$ and between participants when comparing scores at T1, G2, and G3, $F(2, 199) = 3.30$, $p < .05$, $\eta^2 = .03$.

TABLE 3
Correlations Between Optimistic Bias for Earthquakes and Perceived Control

Demographic	T1	T2	T3	T4	G2	T5	T6	G3	T7	T8
Group	1	1	1	1	2	1	1	3	1	1
Total <i>n</i>	100	75	72	56	43	28	27	60	28	24
Weeks after quake	1	3	5	7	8	11-12	13-14	16	15-16	17-19
Optimistic bias	.00	-.29	-.37*	-.37*	-.02	-.28	-.30	-.19	-.16	-.41

Note. "Optimistic bias" refers to optimistic bias for future earthquake injury and control over future earthquake injury. Scales were scored so higher numbers would indicate less optimistic bias and more control.

* $p < .01$.

DISCUSSION

The primary results in this study indicated that participants showed no optimistic bias regarding their risks of getting injured in a future earthquake. No bias was present shortly after the earthquake, and no bias appeared during the nine periods of follow-up. This was true for the group that was followed over 5 months and for the new groups recruited at other time periods. Thus Burger and Palmer's (1992) finding that an optimistic bias for earthquakes returned 3 months after the earthquake was not replicated. As expected, participants did show an optimistic bias for most of the nonearthquake-related events assessed.

The most likely explanation for this lack of replication is that the critical earthquake question used by Burger and Palmer was too ambiguous. The question asked about being seriously hurt in a "natural disaster (flood, earthquake or storm)" (Burger & Palmer, 1992, p. 41), and no question directly asked about earthquake risk. Immediately after the earthquake, students may have focused on the earthquake part of the question. However, after 3 months the earthquake may no longer have been salient to the students in the Burger and Palmer study and they may have focused on the other events in the question (i.e., floods and storms). In this study, students generally appeared to be optimistically biased with respect to risk of personal injury due to floods. Although the data are consistent with this interpretation, a question using Burger and Palmer's wording was not included. If such a question had replicated Burger and Palmer's rebound effect, it would have provided further support of the fact that their results were obtained due to a measurement problem.

One other study has examined longitudinally the effect of personal experience on the optimistic bias after a disaster. Weinstein examined the effects of indirect experience with respect to tornadoes (personal communication, November 21, 1996). Participants who lived in tornado-prone areas showed the optimistic bias with respect to the risk of tornado injury. Following exposure to a tornado (but without experience of personal monetary loss or injury), participants were significantly less optimistically biased (i.e., more realistic) immediately after the tornado. At a 14-month follow-up, no change in the optimistic bias was found. That is, even after 14 months the optimistic bias about tornadoes had not returned. Said differently, participants were initially optimistically biased about tornadoes. Then they experienced a tornado (but did not suffer personal loss). Immediately after the tornado they showed no optimistic bias about tornadoes. Even after more than 1 year participants still showed no optimistic bias about tornadoes. This general pattern is consistent with the data from this study. Both studies show a long time period for the bias to return in contrast to the quick return of the bias in Burger and Palmer's (1992) study.

It should be noted that because I did not have the fortuity to ask the students about their earthquake beliefs *prior* to the

earthquake, there were no pre-earthquake measures in this study. However, there is evidence that people typically have optimistic beliefs about earthquakes. Lehman and Taylor (1987) surveyed UCLA students living in on-campus residences and found a general pattern of ignorance and denial with respect to the risk of a major earthquake. Interestingly, students who lived in worse seismically rated buildings were more likely to hold such beliefs than those in better rated buildings. Jackson (1981) interviewed residents in earthquake-prone areas (Los Angeles, Vancouver and Victoria, and Anchorage) and found that 23% believed that they were unlikely to experience an earthquake in their area at all, whereas another 33% said that although they expected to experience an earthquake it would not result in any personal damage. Although these studies did not use the same measures of optimism as this study, it appears that individuals living in earthquake-prone areas do typically exhibit optimism about their risk of personal loss or damage as a result of an earthquake.

Other findings in this study point to the relative importance of each of several factors that routinely are found to moderate the optimistic bias (experience, control, and affect). It is important to note that in this study these factors were examined under circumstances in which everyone had experience with the earthquake. It is thus possible that the variables studied here would be more powerful predictors of the optimistic bias if they appeared without the presence of experience as well. That is, control and affect may not have shown the expected patterns because everyone in the study had experience with the event (a case of restricted range). However, experience did prove itself as a moderator of the optimistic bias, even when comparing those with various degrees of personal experience.

Experience

Both direct experience (for example, the person experiences the event him or herself) and indirect experience (for example, the person knows of someone who experienced the event) alter perceptions of risk. Direct experience is usually more powerful (Weinstein, 1989), but indirect experience may be just as powerful if the information provided by the indirect experience is vivid and self-relevant (Stapel & Velthuisen, 1996). In support of the impact of indirect experience, Perloff (1983) found that those who had a friend or family member who had cancer or had been mugged were more likely to have an increased sense of vulnerability with respect to these events. Similarly, college students felt more at risk when it was a close friend or relative who had experienced the negative event (Weinstein, 1980). However, if the indirect experience is relatively minor, one is removed from the immediate care situation, or the person differs on important characteristics from oneself, indirect experience may not influence risk perceptions. For example, Prohaska, Albrecht,

Levy, Sugrue, and Kim (1990) found in a sample of 1,100 adults from the Chicago area that knowing someone with AIDS did not have any influence on one's own AIDS risk perception.

This research is consistent with previous research on experience and optimistic bias. Research shows that it is relatively impactful to experience a major earthquake, even if one does not personally suffer injury or monetary loss (Nolen-Hoeksema & Morrow, 1991; Wood, Boozin, Rosenhan, Nolen-Hoeksema, & Jourden, 1992). After the Northridge earthquake people were bombarded with earthquake-relevant information for weeks as well as stories about those who did personally suffer. There were also many visual reminders of the damage. Several freeways were closed due to damage, and many buildings on the UCLA campus suffered superficial but visually apparent cracks. Thus all the students in this study experienced the earthquake (in a vivid and self-relevant way), and this experience was associated with a lack of bias for future earthquake injury. In addition, the participants who were directly influenced by the earthquake (because they suffered monetary loss or personal injury) were less optimistic than those with no such direct experience. However, it is worth noting that participants judged their relative risks to be around "average"—that is, they showed little absolute bias, although they did differ significantly from each other.

Control

Measures of perceived control over injury in future earthquakes were not consistently correlated with the optimistic bias. In fact, only at 2 out of the 10 time periods were perceived control and optimistic bias correlated. Although there is ample evidence that greater perceived control is associated with greater optimistic bias (Harris, 1996), in this study control appeared to have little effect. It is not surprising that a weak or inconsistent relation was found in this study. Weinstein (1982) suggests several possible mechanisms that explain the (usual) link between control and the optimistic bias, all focusing on the lack of information people have about the behaviors of other people: People might not be aware of what others do to control the behavior, they might not think carefully about what others do, they might overestimate the effectiveness of their own actions and underestimate the effectiveness of others' actions, and they might selectively recall their own positive behaviors. However, typically following a major earthquake there is an immense exchange about earthquake-related information both between friends, between strangers, and from the media, with everyone sharing personal experiences and thoughts. Such massive information exchange may reduce the controllability-optimistic bias link by providing ample information about others and how their behavior compares to one's own behavior.

Conclusion

This study showed that experience with a natural disaster (such as an earthquake) leads to realistic perceptions for risk of future injury for that event. In addition, participants with direct experience (due to injury or monetary loss) are even more realistic than those who have only indirect experience (experienced the quake but no injury or loss). Finally, contrary to research by Burger and Palmer, optimistic beliefs regarding earthquakes did not return quickly. In fact they had not returned 5 months after the earthquake.

One interesting and related question concerns the function of optimistic biases. Presumably, the beliefs in invulnerability serve an important protective function. It would be difficult to function effectively if we were constantly preoccupied with the many dangers of our daily living. This particularly makes sense if the risk is one inherent in living in a certain part of the county (earthquakes, floods, tornadoes, etc). But this evidence suggests that people may not engage in this protective function for certain events. Thus questions to be explored in future research concern what characteristics are uniquely shared for events that do not show the optimistic bias and what sort of coping mechanisms replace the function of the optimistic bias for such events. That is, if people typically cope by holding illusory beliefs about their risks, how do they cope with stressful situations when such illusory beliefs are no longer possible?

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