

# Effects of the 1989 San Francisco Earthquake on Frequency and Content of Nightmares

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In a systematic evaluation of the effects of a natural disaster on nightmares, nightmare frequency was found to be about twice as high among 92 San Francisco Bay area college students as among 97 control subjects in Tucson, Arizona, after the 1989 Loma Prieta earthquake. Subjects in California had not only more nightmares in general but substantially more nightmares about earthquakes. Over a 3-week period, about 40% of those in the San Francisco Bay area reported one or more nightmares about an earthquake, as compared with only 5% of those in Arizona. However, nightmares about earthquakes were not more emotionally intense than other nightmares. These findings support the long-held view that the experience of a potentially traumatic event can result in more frequent nightmares, particularly about the event itself, but contradict the common opinion that nightmares about such events are unusually intense.

At 5:04 p.m. on October 17, 1989, an earthquake that registered 7.1 on the Richter scale shook the greater San Francisco Bay area. The earthquake, centered near Loma Prieta Peak in the Santa Cruz mountains, was the most powerful tremor to have struck a major city in the continental United States since the great San Francisco earthquake of 1906. It destroyed \$5.6 billion worth of property and killed 62 people, including 42 who were crushed when the Nimitz Freeway in Oakland, California, collapsed on them.

For scientists this tragic event potentially constituted an experiment of nature: That is, the horrifying action of natural geological forces provided a setting for study that could never be ethically duplicated in the laboratory. For us the earthquake presented the opportunity to better understand the aftereffects of unusual and potentially traumatic stressors on psychological functioning, particularly sleep. Our focus was on nightmares, the frightening, often elaborate dreams which sometimes occur during rapid eye movement (REM) sleep (Fisher, Byrne, & Edwards, 1968; Kales et al., 1980).

Although nightmares are widely assumed to follow traumatic experience and in motion pictures they are regularly portrayed as occurring in the aftermath of combat (*Born on the Fourth of July*), car accidents (*Dead Calm*), or criminal violence (*Carrie*), empirical evidence on the subject is remarkably scanty. Not a single controlled study has studied nightmares in the period immediately after rape, crime victimization, accidents, or natural disaster. Two studies have found elevated nightmare reports among combat veterans (DeFazio, Rustin, & Diamond, 1975; van der Kolk, Burr, Blitz, & Hartmann, 1981) but were marred

by inadequate reporting, poor measurement, and unsatisfactory sampling procedures.

Perhaps the greatest problem with existing studies on nightmares and trauma is their reliance on retrospective reports. Invariably subjects have been asked to estimate the number of nightmares they had over some period in the past. Researchers have long known that such reports are subject to distortion from a variety of sources, and Wood and Bootzin's (1990) research showed that retrospective reports may misestimate nightmare frequency by as much as 50%.

In this study we attempted to maximize the accuracy of reports by asking subjects who had experienced the Loma Prieta earthquake to make written records of their nightmares every morning for 3 weeks after the earthquake. Subjects in another geographic area, who had presumably been exposed to the media descriptions but had not experienced the earthquake, served as a comparison group. Our aim was to learn whether the California students would report frequent and intense nightmares about their experiences in the earthquake. The results would provide stronger empirical evidence with regard to the relation between nightmares and potentially traumatic experience than that currently available.

## Method

The subjects were undergraduates from Stanford University (Stanford, CA), San Jose State University (San Jose, CA), and the University of Arizona (Tucson, AZ). The Stanford subjects were recruited from two upper-level undergraduate psychology courses and a freshman residential hall, with no monetary incentive or class credit for participation. San Jose State and Arizona subjects were recruited from undergraduate introductory psychology classes, and their participation fulfilled part of their class requirements.

Before the subjects agreed to participate, they were told (a) the study was examining the psychological aftereffects of the San Francisco earthquake and (b) they would spend about 1 hr filling out a questionnaire and about 1 min each day for 3 weeks recording behaviors in a

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diary. To avoid a self-selection subject bias that favored the experiencing of nightmares, no mention of sleep or nightmares was made until after subjects had agreed to participate.

The subjects were administered a questionnaire that asked for basic demographic information and the following: (a) Whether they were in one of the areas affected by the earthquake when it occurred; (b) whether they had realized the earthquake was occurring while it was still going on; (c) objectively, how dangerous their situation had been during the earthquake (1 = *not at all*, 2 = *slightly*, 3 = *moderately*, 4 = *very*, or 5 = *extremely*); (d) whether they had suffered any injury as a result of the earthquake; (e) whether any of their friends or immediate family had suffered injury as a result of the earthquake; (f) how anxious they had been during the earthquake, the day after the earthquake, and in the 24 hr before they filled out the questionnaire (ratings on the same 5-point scale used to measure danger during the earthquake); (g) how many nightmares they had during the year before the earthquake; and (h) how many nightmares they had during the week before they completed the questionnaire.

Twelve potential subjects from San Jose State and 18 from Stanford were excluded from the study because they reported that they had not been in the area affected by the earthquake at the time it occurred. Two persons from Arizona were excluded for the opposite reason. Consistent with the definition of nightmares by the American Sleep Disorders Association (1990), *nightmares* were defined in the questionnaire as frightening dreams with visual content and an elaborated story. They were contrasted with *night terrors*, which were described as one's awakening during the night with feelings of intense fear or terror but no memory of a dream that might have elicited these emotions. Two brief questions assessed understanding of these definitions. Four persons from Stanford and two from Arizona were excluded from the study because they answered one or both questions incorrectly. In addition, four students from San Jose State and three from Stanford were excluded because they made clerical errors on questionnaires or logs.

All subjects were given 21-page dream logs to fill out each morning for 3 weeks. They were asked to record in the log on waking (a) whether they had a nightmare the previous night, (b) how many nightmares they had, (c) which nightmares were about an earthquake or its aftermath, and (d) how intense each nightmare had been (1 = *not intense*, 2 = *slightly intense*, 3 = *moderately intense*, 4 = *very intense*, or 5 = *extremely intense*). Subjects were told that a nightmare was intense if it woke them up and left them frightened, sweating, with their heart pounding, and unable to get back to sleep for a long time.

To encourage honest reporting, we told the subjects that we were interested in those persons who did not have nightmares as well as those who did, that credit for participating in the experiment would be given whether a subject reported no nightmares or many (except for Stanford students, who received no credit at all), and that the most important factor was honesty. To encourage accurate reporting, we required subjects to hand in reports twice a week rather than at the end of the 3-week period. To gain information about nightmare content, at the end of the study, the subjects were asked to write a narrative of the last nightmare they had had during the 21-day study period.

Because of disruptions after the earthquake and the time consumed in organizing data collection, the subjects in the three universities did not begin logs on the same day. The first night of recording was October 24–25 (the 8th night after the earthquake) for Stanford students, October 26–27 (the 10th night) for Arizona students, and October 31–November 1 (the 15th night) for San Jose State students. The questionnaires were completed the day before the first night of recording.

## Results

### *Subject Characteristics*

Subjects were not included in the data analysis if they handed in log pages for fewer than 18 of the 21 study nights. Five (12.5%)

of the 40 San Jose State students admitted to the study, 33 (36.7%) of the 90 Stanford students, and 10 (9.4%) of the 107 Arizona students did not complete the log adequately. The high attrition rate among Stanford students suggests that data from this group must be viewed with caution.

A two-way analysis of variance was performed with 1-year retrospective nightmare frequency as the dependent variable, and university and completion of the study (yes or no) as the independent variables. Subjects who completed the study did not report significantly more nightmares during the previous year ( $F = 0.93$ ), nor was a significant interaction found between university and study completion ( $F = 0.01$ ). Thus there was no evidence of selective attrition for persons with low or high nightmare frequencies.

Demographic information on subjects who completed the study is given in Table 1. Subjects from the three universities differed significantly in respect to gender and age. Specifically, the subjects from San Jose State were older and more likely to be female than were subjects from the other two universities. In part, these differences reflect differences in the student bodies of the three universities. The percentages of women at each university are 51.7%, 44.5%, and 48.3% for San Jose State, Stanford, and Arizona, respectively. Likewise, the mean ages are 24.7, 19.8, and 22.2 years, respectively. In addition, the San Jose State sample appears representative of psychology classes at that school. In 1991, 79% of San Jose State graduates in psychology were female, and those graduates had a mean age of 29.5.

### *Experience During and After the Earthquake*

As expected, subjects from the three universities differed in respect to their experience during and after the earthquake. Students from San Jose State and Stanford were more likely than those from Arizona to have been aware the earthquake was occurring at the time it was going on, to have been injured during the earthquake, to have been in danger when it occurred, and to have experienced anxiety while it was going on, on the day after it, and during the 24 hr before they filled out the questionnaire. Students from San Jose State were about twice as likely to report injuries among friends or relatives, but the difference was not statistically significant.

### *Nightmare Frequency After the Earthquake*

Nightmares were most frequent among subjects close to the earthquake. During the 3 weeks after the earthquake that logs were kept, 74.3% of San Jose State students, 64.9% of Stanford students, and 53.6% of Arizona students reported having at least one nightmare. As shown in Table 1, San Jose State students reported about twice as many nightmares, and Stanford students about 1½ as many nightmares, as the Arizona students. A Kruskal-Wallis test revealed the between-universities effect to be significant.

Figure 1 shows nightmare frequency as a function of time after the earthquake and indicates the percentage of students at each university who reported having one or more nightmares on a particular night. The data has been smoothed with Tukey's (1977) 3RSH method.

The percentage of subjects who reported a nightmare was

Table 1  
Summary of Data and Statistical Tests

Measure	San Jose State	Stanford	Arizona	Test	<i>p</i>
Subject characteristics					
Gender					
Men	6	17	40	Fisher's exact	.031
Women	29	39	57		
Mean age	31.1	19.4	19.1	$F(2, 185) = 85.9$	<.001
Nightmare frequency					
1-year retrospective	5.46	7.42	7.11	Kruskal-Wallis = 0.63	.729
Experience during and after quake					
Realized quake was occurring					
Yes	35	55	16	Fisher's exact	<.001
No	0	2	81		
Level of danger	2.28	2.26	1.08	$F(2, 186) = 78.10$	<.001
Injured					
Yes	2	2	0	Fisher's exact	.047
No	33	55	97		
Friend or relative injured					
Yes	5	3	8	Fisher's exact	.321
No	30	54	89		
Mean anxiety					
During quake	3.17	3.61	1.88	$F(2, 185) = 39.59$	<.001
Day after quake	3.54	3.37	2.74	$F(2, 186) = 9.83$	<.001
Previous 24 hr	2.49	2.28	1.72	$F(2, 186) = 11.26$	<.001
Nightmare frequency					
Mean nightmare frequency					
1-week retrospective	1.09	0.72	0.25	Kruskal-Wallis = 16.64	<.001
3-week log	3.06	2.47	1.50	Kruskal-Wallis = 7.23	.027
Nightmare content and intensity					
Mean nightmare intensity	1.98	2.15	2.25	Kruskal-Wallis = 1.52	.468
Nightmare about quake					
Yes	14	21	5	Fisher's exact	<.001
No	21	36	92		

regressed on subjects' university and the number of days since they began keeping logs. The multiple correlation was .596 ( $p < .001$ ), and the standardized slope for number of days was  $-.39$ ,  $t(59) = -3.75$ ,  $p < .001$ , which indicates a significant decline in reported nightmare frequency over time. The decline may indicate that the earthquake's effect on nightmares, reinforced by aftershocks, was concentrated in the weeks immediately after the earthquake. On the other hand, because a similar, less marked decline occurred among Arizona students, it may re-

fect a reporting artifact. The very act of keeping a log may have caused a transient elevation in nightmare frequency at the study's beginning, or careless reporting may have caused a decline at its end.

A sudden increase in nightmare frequency among San Jose State subjects occurred on the 34th and 35th nights after the earthquake. This does not appear to be due to the effect of aftershocks. Although aftershocks were common in the 3 weeks after the earthquake (National Earthquake Information Center, 1989a, 1989b), the last large aftershock (Richter scale  $> 4.0$ ) during the recording period occurred on Day 22, 12 days before the increased frequency of nightmares in San Jose State University subjects.

Although subjects from the three universities differed in respect to age, it is unlikely that this variable accounted for the differences in nightmare frequency. When nightmare frequency was regressed on university and age, the standardized beta weight for age was only .02 ( $p = .806$ ). Furthermore, studies (Salvio, Wood, Schwartz, & Eichling, in press; Wood, Bootzin, Quan, & Klink, 1991) have indicated that nightmare frequency declines in adulthood, so the older San Jose State students would have been expected to report fewer nightmares than other subjects, not more.

The observed differences in nightmare frequency also appeared independent of gender, with the highest mean nightmare frequency at San Jose State, the second highest at Stan-

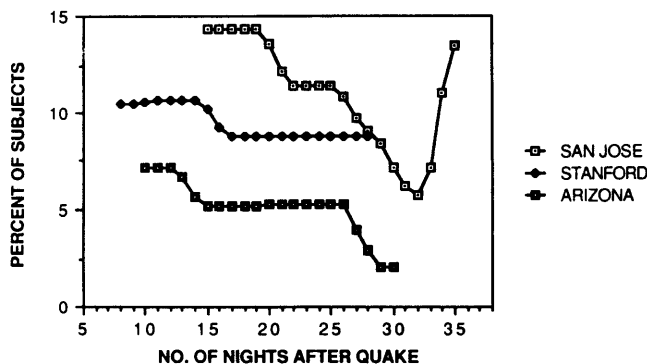


Figure 1. Subjects at each university with one or more nightmares. (Smoothed data.)

ford, and the lowest at Arizona, for both women (3.2, 3.0, and 1.8) and men (2.3, 1.3, and 1.1).

Two additional measures of nightmare frequency were collected. First, on the same day the subjects began logs, they were asked how many nightmares they had during the past week. Because in all cases the past week was in the period after October 17, this question elicited retrospective estimates of post-earthquake nightmare frequency. As shown in Table 1, a significant between-universities difference was found on this measure ( $p < .001$ ).

Subjects were also asked how many nightmares they had during the year before the earthquake. The differences on this measure were not statistically significant ( $p = .729$ ). Because San Jose State students did not reveal an indiscriminate tendency to inflate estimates of nightmare frequency on 1-year retrospective reports, this finding strengthens the credibility of their postearthquake reports.

The relationship of nightmare frequency to subjects' level of danger and anxiety during and after the earthquake was also examined. In none of the universities was nightmare frequency significantly related either to subjects' self-rated level of objective danger during the earthquake or to their level of anxiety during the 24 hr before they filled out the questionnaires. However, nightmare frequency was correlated with anxiety during the earthquake among subjects at San Jose State ( $r = .29$ ,  $p = .08$ ), Stanford ( $r = .38$ ,  $p = .004$ ), and Arizona ( $r = .23$ ,  $p = .02$ ). These results suggest that nightmare frequency is not simply a function of general anxiety or exposure to danger. Rather, the extent to which persons react emotionally to an event, whether experienced vicariously or in person, is related to nightmare frequency after that event.

### *Nightmare Content and Intensity*

Proximity to the earthquake affected not only the frequency of nightmares but their content as well. As shown in Table 1, 40% of San Jose State students and 37% of Stanford students reported at least one nightmare about an earthquake during the 3-week log period, whereas only 5% of Arizona students did so. Twenty-seven percent of the nightmares reported by San Jose State students and 28% of those reported by Stanford students were about an earthquake, as compared with only 3% for Arizona students.

At the end of the study, 20 subjects from San Jose, 31 from Stanford, and 38 from Arizona handed in narrative descriptions of their last nightmare during the study period. Two judges independently rated the nightmares with 98% agreement. Approximately 42% of the narratives from San Jose, 27% from Stanford, and 5% from Arizona, were rated as earthquake nightmares. Three sample narratives from San Jose State students are given in the Appendix.

Although nightmares were more frequent among students who experienced the earthquake, they were not more emotionally intense. As shown in Table 1, there were no significant differences in the intensity of log-recorded nightmares across the three sites. Earthquake nightmares were not found to be significantly more intense than other nightmares in either within-subjects,  $F(1, 24) = 2.39$ ,  $p = .14$ , or between-subjects,  $F(1, 36) = 0.15$ ,  $p = .70$ , analyses with only California subjects.

Even in the San Jose group, the earthquake nightmares were rated as only slightly to moderately intense.

### Discussion

This is the first published study to have examined nightmare prevalence immediately after a natural disaster. We found that nightmare frequency was higher among San Francisco Bay area college students after the San Francisco Loma Prieta earthquake. San Jose State students reported twice as many nightmares and Stanford students  $1\frac{2}{3}$  as many as control subjects in Arizona. Over a 3-week period, about 40% of San Jose State and Stanford students reported one or more nightmares about an earthquake, as compared with only 5% of Arizona students.

These findings support the long-held view that the experience of a potentially traumatic event can result in more frequent nightmares, particularly about the event itself. However, contradicting previous opinion, this study did not find that the nightmares after such an event are unusually intense or that those about the event are significantly more intense than other nightmares.

Surprisingly, the average nightmare was described as slightly to moderately intense. Apparently, most frightening dreams are accompanied by minimal physiological arousal. If *intensity* had been defined in nonphysiological terms perhaps different findings would have emerged. We note that these findings probably would not have been much different if, like some researchers, we had asked subjects to report only those nightmares that awakened them. Dreams are only rarely remembered unless the sleeper awakens during them or very soon afterwards (see Goodenough, 1991). Thus, nearly all the nightmares reported by our subjects were probably accompanied by awakening and would have been counted as nightmares even with more restrictive criteria.

Our study represents a rare attempt to do psychological research on an experiment of nature and, as such, must be viewed as an informative but imperfect first step. One imperfection of the study is the lack of baseline data. Without such data one cannot rule out the possibility that California residents have more nightmares about earthquakes than do Arizona residents even when no earthquake has recently occurred. Nevertheless, the probability appears small that California residents normally have as many earthquake nightmares as were observed.

The possibility also exists that the logs acted as reactive measures, in that answering questions about earthquake nightmares every morning caused California subjects to have more than they would have otherwise. Future studies can avoid this problem by using an open-ended question that simply requests a brief description of nightmare content.

Another imperfection is the high attrition in the Stanford sample. It is possible that particularly traumatized persons in this group refused participation or dropped out of the study or that untraumatized persons found it trivial and discontinued participation. The data from San Jose appear more valid, insofar as subjects there constituted all members of a single psychology class, and their attrition was comparable to that seen in the Arizona group and in previous nightmare studies (Wood & Bootzin, 1990).

Despite these imperfections, among studies that have looked

at the psychological aftereffects of potentially traumatic stressors, ours is distinguished by four features: (a) the use of controls, (b) the collection of data almost immediately after the event, (c) the reliance on daily logs rather than retrospective reports, and (d) the use of subjects for whom the prospect of monetary compensation and the corresponding motivation to exaggerate psychological problems were both low. Researchers may wish to incorporate these features when investigating other commonly reported sequelae of trauma, including flashback experiences, intrusive memories, startle reactions, psychological numbing, and social withdrawal (American Psychiatric Association, 1987).

Further questions about nightmares after potentially traumatic events remain to be explored. For example, what happens to the prevalence of such nightmares over time? Our study followed subjects for a maximum of 5 weeks after the earthquake. Did the California students eventually return to a normal level of nightmare frequency, or will some students still be having nightmares about their experience years afterwards, as has been reported for some Vietnam veterans (DeFazio et al., 1975; van der Kolk et al., 1981) and children who have been kidnapped (Terr, 1981)?

Also compelling is the question of why such events cause nightmares. Some insight may be gained from past research on dreams. Hall and Nordby (1972) reported that in 1945 immediately after the explosion of the first atom bomb over Hiroshima, the dreams of U.S. college students failed to depict this momentous event. By contrast, subjects spending their first uneasy night in a sleep laboratory frequently have dreams in which they are spied on or harassed by unsavory persons who often wear white coats (Dement, Kahn, & Roffwarg, 1965; Domhoff & Kamiya, 1964), and patients awaiting surgery have been found to have dreams in which the upcoming operation is depicted directly or indirectly (Breger, Hunter, & Lane, 1971).

Apparently dream content can reflect personal concerns and is particularly likely to incorporate recent events that involve an immediate threat to the safety or self-esteem of the dreamer (see also Cartwright, 1990). Thus, the high frequency of nightmares among San Francisco Bay area students after the earthquake may represent not a psychological disorder but a manifestation of the normal dreaming process and its tendency to incorporate recent stress-inducing or threatening experience.

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## Appendix

Sample Narrative Nightmare Reports About Earthquakes  
From Subjects at San Jose State University

"While lying in a bed, my bed, but in a large strange room—although I never saw a ceiling. The bed lifted up to [about] 45 degrees and slammed back down. Three or four people walked into the room and I told them I survived a 7.2 earthquake. They said nothing. And then I woke up abruptly with heart pounding and stayed awake for 2 hours—unable to get back to sleep." (Intensity rating of 4 [very intense])

"I was at a clothing store when there was a big [earth]quake. Everything was moving, it was about a 7.1—things were falling off the shelves. I could see the ground move. I saw a little girl standing in the middle of the confusion. I grabbed her and held her close to me. I didn't want her to get hurt. Unfortunately, I woke up as soon as the [earth]quake did. (The little girl was unknown to me.)" (Intensity rating of 3 [moderately intense])

"I dreamed that the house I was living in (although it was not my house in real life, I knew it was mine in this dream). All my family was there [and] all of the sudden we heard a rumble, [and] I think my husband yelled, 'It's another earthquake, get in the door ways!' I was looking out the window [and] I saw the earthquake coming. It was a great big split in the road and it came right up to my house [and] through the living room. A great big trench. We were all ok. But we all sat there amazed at this incredible hole in our home." (Intensity rating of 1 [not intense])

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