

Erroneous Beliefs and Earthquake Preparedness

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## Abstract

This study investigated the prevalence of erroneous earthquake-related beliefs among 234 Southern California college students, the relationship between their endorsement of erroneous beliefs and seismic hazard adjustments, the effects of an experimental earthquake education program, and the impact of *need for cognition* on this program. The data revealed a significant degree of agreement with earthquake myths, a generally low level of correlation between earthquake beliefs and the level of hazard adjustments, and a significant effect of hazard information on the endorsement of accurate earthquake beliefs and increases in hazard adjustment. Compared to the “Fact only” format, a “Myth vs. fact” format was slightly more useful for dispelling erroneous beliefs and increasing hazard adjustment. Similarly, there was a tendency for those who were high in need for cognition to have more accurate earthquake beliefs and higher levels of hazard adjustment. Finally, there was weak support for the hypothesis that those who were low in need for cognition would develop more accurate earthquake beliefs and higher levels of hazard adjustment in the “Myth vs. fact” information condition.

Despite years of warnings of the seismic threat, residents of the Los Angeles area are little better prepared for a major earthquake than residents of the Seattle area—an area whose population has experienced many fewer damaging earthquakes (Lindell & Prater, 2001). Research on the adoption of seismic hazard adjustments—intentional or unintentional actions taken to reduce the vulnerability of persons and property—has found significant correlations with demographic variables, fault proximity, seismic experience, social influence, past adjustment adoption, and personality characteristics (see Lindell & Perry, 2000, for a review).

More recent research has found that other variables such as hazard intrusiveness (Lindell & Prater, 2000) and perceived characteristics of hazard adjustments (Lindell & Prater, in press; Lindell & Whitney, 2000) also have significant correlations with hazard adjustment. These results reveal the need for a better understanding of the cognitive processes underlying the hazard adjustment process and, especially, the ways in which risk area residents' beliefs about seismic hazard can be changed in ways that increase the adoption of seismic hazard adjustments.

The importance of understanding perceptions of hazards and hazard adjustments is underscored by many theoretical models of self-protective action. Since the 1950s, the *Health Belief Model* has been one of the most popular theoretical frameworks for promoting and maintaining health-related behaviors. This model argues that the likelihood of adopting a recommended protective action is dependent upon one's perceptions of the threat and of the perceived benefits and barriers to implementation of that action. Perceptions of the threat, in

turn, are influenced by demographics, cues to action, and perceptions of perceived susceptibility and perceived seriousness of the event (Becker, Drachman, & Kirscht, 1974).

Similarly, Rogers' (1983) *Protection Motivation Theory* posits that perceptions of the severity of the threat and one's vulnerability to it, the effectiveness of response options, and one's self-efficacy influence behavioral intentions and, in turn, actual behavior (see Neuwirth, Dunwoody & Griffin, 2000, for a recent review). The *Person relative to Environment Theory* (Mulilis & Duval, 1995) and the *Protective Action Decision Model* (Houts, Lindell, Hu, Cleary, Tokuhata & Flynn, 1984; Lindell & Perry, 1992) also emphasize the role of such beliefs.

Moreover, these models are consistent with research showing only modest levels of seismic hazard adjustment (e.g., Lindell & Prater, 2000; Mileti & Darlington, 1997; Mileti & Fitzpatrick, 1993) and a widespread prevalence of inaccurate beliefs about earthquakes. Regarding the latter, Turner, Nigg, and Paz's (1986) survey of a representative sample of 1,450 Southern California residents found that 67.5% of the respondents thought unusual animal behavior could be used to predict earthquake occurrence, another 43.5% thought that unusual weather might act as a predictor of an earthquake, and over 38% indicated that premonition, instinct, or extrasensory perception could predict earthquake occurrence. None of these beliefs has any scientific support.

In another survey of 536 adult residents of Los Angeles County, Turner et al. found that 72.4% of the respondents gave a high degree of credence to unusual animal behavior—a level that was nearly identical to the credibility accorded to a well-known scientist (73.1%), and higher than that given to a self-educated individual who had spent a lot of time studying earthquakes

(49.2%), a strong personal premonition or feeling (48.7%), the mayor of their city or governor of California (37.7%), a well-known psychic or astrologer (25.8%), long-time residents who agreed we were having earthquake weather (25.7%), or a well-known religious leader (18.2%). Thus,

*H1a: Beliefs regarding the probability of earthquake occurrence, its potential severity and the efficacy of preparedness will be positively related to adoption of earthquake hazard adjustments.*

*H1b: Beliefs regarding the provision of a personal earthquake warning, the ability to predict earthquake occurrence, and personal invulnerability to earthquake risk will be negatively related to adoption of earthquake hazard adjustments.*

#### *Sources of Earthquake Beliefs*

Beliefs, which are defined as “associations or linkages that people establish between the attitude object and various attributes” (Eagly & Chaiken, 1993, p. 11), have long been recognized to originate in both physical reality and social reality. Given that the occurrence of a major earthquake is (thankfully) a relatively rare event, even individuals who have lived all their lives in earthquake-prone areas are likely to have limited first-hand experience with these events. Moreover, physical reality provides equivocal evidence even when it does occur. As Shermer (1997) has observed:

Humans evolved the ability to seek and find connections between things and events in the environment..., and those who made the best connections left behind the most offspring. We are their descendants. The problem is that causal thinking is not infallible. We make connections whether they are there or not (pp. 7).

To deal effectively with an over-abundance of information, we tend to use heuristics that permit us to use limited information to make quick judgments that are reasonably accurate in simple situations (Kahneman, Slovic, & Tversky, 1982). Unfortunately, heuristics can also lead to erroneous judgments on complex issues. When using the availability heuristic, for example, people base estimates of probability upon the ease of bringing an event to mind. Thus, someone who experienced the early morning Northridge earthquake might be led to believe that earthquakes are more likely to occur in the wee hours of morning.

Given the dearth of direct evidence from physical reality and the limits of our cognitive processes, most risk area residents' beliefs are likely to be based upon information (or misinformation) transmitted by others. Friends, relatives, neighbors, and coworkers are common sources of informal hazard communication (Perry & Lindell, 1990), but government officials typically use more formal methods such as Public Service Announcements (PSAs) and printed brochures to disseminate information about seismic hazard threats. Such formal communications frequently are designed to remind risk area residents of the seismic hazard, provide recommendations about how to prepare for earthquakes, and advise people how to obtain additional information (Sorensen & Mileti, 1987). This approach is consistent with research on risk communication, which has found warning messages to be most effective when they emanate from credible sources, are communicated over channels that the target audience monitors, include specific information about the hazard and what should be done for protection, and are repeated often (Mileti & Sorensen, 1987; Tierney, Lindell & Perry, 2001).

Two of the most thorough examinations of the effectiveness of seismic risk communication program were conducted by Mileti and his colleagues in Central California (Mileti & Fitzpatrick, 1993) and in the San Francisco Bay area (Mileti & Darlington, 1997). Both studies found that the information brochures had positive effects on earthquake beliefs and increased the level of hazard adjustment. These findings lead to the following hypothesis.

*H2: Provision of accurate earthquake information will increase the accuracy of participants' earthquake beliefs and their levels of hazard adjustment.*

Some of the findings by Mileti and his colleagues suggest that the conventional methods of risk communication can be improved by using an alternative format for presenting earthquake hazard information. Specifically, Mileti and Fitzpatrick found that most Central California residents receiving the special earthquake brochure recalled official guidance about what actions to take but only a minority recalled specific information about the nature of the earthquake hazard. Similarly, Mileti and Darlington found that Bay area residents were most likely to adopt only those actions that had long been recommended. Only a very few members of the population adopted newer earthquake hazard adjustments that were introduced in the pamphlet.

One interpretation of these results is that conventional methods of risk communication have little influence because they are perceived to lack novelty, validity, or relevance (Turner, 1991). In particular, risk area residents might believe that they already know everything necessary about earthquake risk, so any additional information on this topic is “old news” that can be safely ignored. According to McGuire’s (1969) stages of processing model, they might fail to *expose*

themselves to opportunities to receive the information, fail to *attend* to the messages they are exposed to, fail to *comprehend* the conflict between the message content and their pre-existing beliefs, or fail to *retain* the information because of superficial cognitive processing.

By contrast, risk area residents might be more likely to attend to new information, comprehend its conflict with their existing beliefs, retain it over time, and adopt seismic hazard adjustments if that information is presented in a format that *explicitly* challenges prevailing misconceptions about earthquakes. Such a procedure is especially likely to be effective to the extent that they have acquired erroneous earthquake beliefs through peripheral processes (Petty & Cacioppo, 1986), rather than as a result of some strong personal conviction. Under such conditions, credible, counter-attitudinal information will be more readily accommodated (Eagly & Chaiken, 1995; Wood, Rhodes, & Bick, 1995), thus dispelling beliefs in earthquake myths. This rationale leads to the following hypothesis.

*H3: Use of a "Myth versus Fact" format will be more effective than a "Fact only" format in increasing accurate earthquake beliefs and seismic hazard adjustment.*

#### *Need for Cognition*

Need for cognition (NFC) refers to an individual difference construct originally proposed by Cohen, Stotland, and Wolfe as "a need to structure relevant situations in meaningful, integrated ways. It is a need to understand and make reasonable the experiential world" (1955, p. 291). This construct was popularized by Cacioppo and Petty (1982) who found that individuals high in NFC enjoy thinking and are likely to organize, elaborate upon, and evaluate information to which they



are exposed. Similarly, Ahlring and Parker (1989) found that such individuals are more likely to engage in, and expend effort in, information processing, which makes them less likely to be influenced by primacy effects. Moreover, those who are high in NFC are more likely to moderate their attitudes and experience reduced attitude polarization when provided a brief reflection period (Leone & Ensley, 1986). Finally, newly formed attitudes for those who are high in NFC have been found to both persist longer and be more resist to change than the attitudes of individuals low in NFC (Haugtvedt & Petty, 1992).

Given these findings, one would expect those who are high in NFC to be less likely to endorse common misconceptions regarding earthquakes because they question earthquake myths more thoroughly. Similarly, those who are high in NFC are more likely to carefully consider the available seismic hazard adjustments and adopt the adjustments that are feasible for them. Thus,

*H4: NFC will be positively correlated with accurate beliefs about earthquakes and high levels of seismic hazard adjustment.*

Presentation of information in a format designed to dispel earthquake myths is expected to have a greater impact on those who are low in NFC because they tend to engage in relatively superficial cognitive processing unless aided by the information format itself. By contrast, those who are high in NFC are expected to process seismic hazard information thoroughly regardless of the information format. Therefore,

*H5: The increase in earthquake belief accuracy and seismic hazard adjustment will depend upon an interaction between NFC and earthquake information condition, with*

*recipients who are low in NFC benefitting more from the "Myths vs. facts" condition than from the "Facts only" condition and those who are high in NFC showing no difference between conditions.*

## Method

### *Sample*

During the year 2000, 234 students enrolled at a university in the Los Angeles area were recruited to fill out a questionnaire during the pretest phase of the study. The sample had a mean age of 21.66 years ( $SD = 6.59$ ) and was culturally diverse; Whites represented 36% of the sample, Latinos 23%, Asians 15%, Filipino/Pacific Islander 10%, and African Americans 5%. An additional 6% reported a bicultural ethnicity and 5% declined to respond. Approximately 68% of the sample was female, and 66% reported living in a household without children under the age of 16. Forty-seven percent reported living in the home of a parent, 19% rented an apartment, 16% lived in dorms, 9% rented a house or condominium, while only 8% owned their own home. Few of the participants were homeowners and the median number of months in their current residence was 36 ( $M = 81.70$ ,  $SD = 98.90$ ).

Two hundred of the initial participants were randomly selected to receive follow-up surveys approximately one month after completing the pretest questionnaire. One hundred twenty-six of these participants responded to the mailed survey, for a response rate of 63%. The demographic characteristics of post-test respondents were very similar to those of the initial sample.

### *Measures*

Pretest measures were administered in the following order: Earthquake Actions Checklist, Need for Cognition scale, Earthquake Belief Survey, and a demographic information sheet. The Earthquake Actions Checklist (EAC) contained 36 items intended to assess the individual's adoption of seismic preparedness and mitigation activities (see Appendix A). The scale is based on the Mulilis-Lippa Earthquake Preparedness Scale (Mulilis & Lippa, 1990), but includes additional residential preparedness actions often recommended by governmental agencies and seismic experts. Questions were organized into three major categories: items possessed in the home (such as a flashlight or transistor radio), mitigation/preparedness activities accomplished at home (e.g., securely anchoring tall furniture to the wall), and earthquake-related safety behavior and knowledge (e.g., knowing where and how to turn off the gas valve at home). Participants were asked to check all applicable items and scores were computed by summing the number of items checked. Participants received the same scale again during the post-test.

Need for cognition (NFC) was assessed using Epstein, Pacini, Denes-Raj and Heier's (1996) 19-item version of Cacioppo and Petty's (1982) original scale. Using a Likert-type response format, participants indicated the degree to which they enjoy and engage in, or dislike and avoid, cognitive activities. The internal consistency reliability of this scale in the present sample was  $\alpha = .82$ , which is similar to the Epstein et al. (1996) value of  $\alpha = .87$ .

The Earthquake Belief Scale (EBS) was created to assess participants' agreement with a variety of accurate and erroneous statements regarding seismic causation, prediction, and risk, as

well as the efficacy of general earthquake planning and hazard adjustments. The EBS was developed by administering a free-response interview to a pre-test sample of 50 college students. The interview included 17 broad questions such as “What causes an earthquake?” and “Have you ever had a feeling an earthquake was going to occur before it actually happened?” Responses were recorded by the researcher and later reviewed for common themes. These ideas, along with both accurate and mythological information found on earthquake web sites (e.g., Center for Earthquake Research and Information, n.d.; Southern California Earthquake Center, n.d.) served as the basis from which the closed-ended items were constructed.

The EBS consists of 51 statements (see Appendix B), to which participants indicated their level of agreement using a 5-point Likert response scale. All 51 items in the scale were administered to participants during the pretest and post-test. After data collection, the variables were correlated and a factor analysis with Varimax rotation yielded 8 interpretable factors. These factors include beliefs regarding the (1) availability of a personal warning prior to earthquake occurrence (5 items), (2) predictability of earthquakes (5 items), (3) potential for earthquake damage (3 items), (4) efficacy of personal seismic planning (2 items), (5) likelihood of earthquake occurrence (3 items), (6) efficacy of building codes (2 items), (7) personal invulnerability (4 items), and (8) potential damaging effects of aftershocks (2 items).

The final page of the questionnaire packet assessed demographic information including sex, age, ethnicity, residence, total household income, and the number of children in the household who are under the age of 16.

### *Earthquake Information Conditions*

Research participants were randomly assigned to receive either a pamphlet entitled “Earthquake Facts” or a pamphlet entitled “Earthquake Myths vs. Facts” (see Appendix C). Both pamphlets were exactly three pages in length and were similar in font size and attractiveness of appearance. Each paragraph in the “Earthquake Facts” pamphlet presented scientific information regarding an aspect of seismic hazard, local long-term earthquake probabilities, or safety procedures to follow in an earthquake. Special emphasis was placed on seismic risk in the local area, and potential earthquake magnitudes were compared to the 1994 Northridge earthquake.

Each paragraph in the “Earthquake Myths vs. Facts” pamphlet began with a common myth about the earthquake causes, predictability, or appropriate behavior during an earthquake and was followed by a longer section containing factual earthquake information refuting the myth.

Both conditions concluded with information about how to obtain information from the local Red Cross or the Southern California Earthquake Center, and all participants received a four-page pamphlet entitled *Earthquake Preparedness Recommendations* (see Appendix D), which contained detailed information about emergency supplies to store in the home and car, and ways to prevent personal injury and property damage in the home and at the office.

### *Experimental Procedure*

Participants were recruited on campus through an extra-credit subject pool and scheduled for the experiment in groups ranging in size from 1-3 members. Upon reporting for the experiment and signing a consent form, each participant was assigned a unique code number.

Each participant then completed a questionnaire packet containing the Earthquake Actions Checklist, Need for Cognition scale, Earthquake Belief Scale, and the demographic information sheet. They also provided their names and addresses so they could be contacted for the post-test.

Once each participant had completed the pretest questionnaires, the researcher randomly assigned either the *Earthquake Facts* or the *Earthquake Myths vs. Facts* information pamphlet to all participants in that session. Beginning with the researcher, each individual took turns reading the passages aloud. After the entire pamphlet had been read, the researcher distributed the *Earthquake Preparedness Recommendations* pamphlet that was read aloud using the same procedure. At the end of the session, participants took the earthquake information and earthquake preparedness recommendations pamphlets with them.

Two hundred of the participants who completed the pretest were randomly selected for a follow-up questionnaire that was sent to them one month after the initial session. These participants received a second Earthquake Actions Checklist and Earthquake Belief Scale along with an addressed, stamped return envelope.

## Results

Table 1 presents the variable means, standard deviations, reliabilities and intercorrelations. Although most of the earthquake belief scales demonstrated good internal consistency reliability (measured by coefficient  $\alpha$ ), there was only marginal reliability for the “personal invulnerability” and “aftershock damage” scales in the pretest sample. Inspection of the corresponding scale means indicates that on average, participants had already implemented nearly 14 of the 36

seismic hazard adjustments. Further, beliefs regarding the potential damage that an earthquake could cause, efficacy of planning, and efficacy of good building codes were all well above the scale midpoint. Although this evidence would seem to confirm a high level of hazard awareness, it is important to note that the scale means for all eight earthquake belief dimensions are closer to the scale midpoints than they are to the scale end points.

Appendix B presents the mean level of endorsement for each of the individual Earthquake Belief Scale items, arranged in order of greatest endorsement on the pretest. Inspection of these data provides some reassurance to those hoping to promote household seismic hazard adjustment. The most strongly endorsed item assesses the efficacy of basic hazard adjustments. Further, several items related to perceptions of earthquake risk had relatively high levels of endorsement. Overall, the pattern of endorsement across items was consistent with expectations—higher levels of endorsement for scientifically sound statements and lower levels of endorsement for fallacious statements.

There were exceptions, however. The pretest data showed relatively high levels of endorsement for several earthquake myths, including the idea that earthquake occurrence can be related to identifiable weather patterns ( $M = 3.06$ ) and the outdated recommendation that people should protect themselves by standing in a doorway during a quake ( $M = 4.15$ ). Even though they tended to endorse erroneous beliefs less frequently than factual statements, participants did not reject erroneous statements altogether. Many erroneous beliefs received a level of endorsement near the midpoint of the scale, which frequently is interpreted as indicating

uncertainty among the respondents. However, the level of interrater agreement on the pretest ranged from  $.14 < r_{WG} < .83$  with a mean of  $\bar{r}_{WG} = .55$  (the corresponding values on the post-test were  $-2.89 < r_{WG} < .78$  and  $\bar{r}_{WG} = .44$ ), indicating a moderate degree of agreement among the raters (Lindell & Brandt, 1999).

Inspection of Table 1 and Appendix B reveals no support for the first hypothesis, which asserted that earthquake beliefs would be related to the adoption of seismic hazard adjustments. Correlations for the individual items in the pretest ranged from  $-0.12 < r < 0.20$ , with an average of  $\bar{r} = .04$  and the corresponding correlations in the post-test ranged from  $-0.17 < r < 0.21$ , with an average of  $\bar{r} = .03$ . Beliefs regarding the scales measuring the expectation of personal warning and of perceived personal invulnerability were slightly related to adoption of earthquake hazard adjustments ( $r = .13$  and  $.16$ , respectively), but these were the only two of the eight Earthquake Belief scales having statistically significant correlations with hazard adjustment and both of these were in the direction opposite to the hypothesis.

### *Hypothesis 2*

Regardless of the type of earthquake information provided, the post-test data showed increased agreement with accurate statements (See Appendix B). Paired samples t-tests conducted across time for each of the eight Earthquake Belief scales indicated a significant improvement in belief accuracy over time for six of the eight Earthquake Belief scales: earthquake warning, earthquake predictability, planning efficacy, likelihood of earthquake



occurrence, personal invulnerability, and the potential for damage due to aftershocks. Further, participants adopted significantly more seismic hazard adjustments over time. Table 2 presents the mean differences between each of these groups.

Consistent with the proposition that the “Myths vs. facts” condition would be more effective than the “Facts only” condition in promoting more accurate earthquake beliefs and an increased level of seismic hazard adjustment, a mixed design repeated-measures analysis of variance revealed a significant difference between earthquake information groups across time regarding two scales: beliefs related to provision of a personal warning ( $F(1,124) = 11.87, p < .01$ ) and beliefs related to the predictability of earthquakes ( $F(1,124) = 22.98, p < .01$ ). Figures 1 and 2 present graphs of the respective time by experimental group interactions. In both cases, participants exposed to the “Myths vs. facts” condition had a greater reduction in endorsement of the false belief than those who were exposed to the “Facts only” condition. However, there were no significant differences between the two conditions for any of the remaining earthquake belief scales or for the adoption of seismic hazard adjustments.

Inspection of Table 1 reveals that NFC was indeed associated with more accurate beliefs regarding earthquake predictability ( $r = -.25$ ), the efficacy of building codes ( $r = .18$ ), and aftershock damage potential ( $r = .16$ ), but NFC had no significant relationships with the remaining five earthquake belief scales. Consistent with the hypothesis, there was a significant positive relationship ( $r = .17$ ) between NFC and the adoption of seismic hazard adjustments.

The fifth hypothesis examined the impact of NFC on the impact of different earthquake information programs. Accordingly, individuals were classified as either low or high in NFC by use of a median split. A mixed design repeated measures analysis of variance revealed a significant 3-way interaction between experimental group and NFC across time for belief in a personal earthquake warning ( $F(1,122) = 5.52, p < .05$ ). This finding, which is displayed in Figure 3, indicates that for those individuals who are high in NFC, the “Myths vs. facts” and the “Facts only” conditions were equally effective in reducing endorsement of the erroneous belief that a warning would precede earthquake occurrence. By contrast, those who are low in NFC clearly benefited significantly by presentation of the “Myths vs. facts” condition. Those who are low in NFC and who received the “Facts only” condition did not change their erroneous belief regarding provision of a personal warning. Support for Hypothesis 5 is weakened by the fact that the predicted interactions were not obtained for any of the remaining seven earthquake belief scales or for the adoption of seismic hazard adjustments.

### Discussion

This study examined the prevalence of erroneous earthquake beliefs in a sample of Southern California college students, as well as the effects of those beliefs on adoption of earthquake preparedness and mitigation activities. A reliable multi-dimensional inventory was developed to examine earthquake-related beliefs. Consistent with expectations of a high level of hazard awareness, respondents indicated a high level of agreement with the potential for major earthquake damage in the area, and also expressed a high appreciation for the benefits of

preparing for an earthquake. However, some confusion reigns regarding appropriate actions to take during an earthquake. Respondents readily agreed with the now outdated recommendation to seek shelter in a doorway during an earthquake and very few respondents correctly responded that, if in bed at the time of a quake, they should remain there until the shaking stopped.

Erroneous statements regarding earthquakes generally received lower levels of endorsement than accurate statements, but respondents failed to reject many erroneous statements related to the predictability of earthquake occurrence—either through use of weather patterns, strange animal behavior, planetary alignments, or science. These results replicate previous findings by Turner, et al. (1986). Respondents had no better than chance agreement as to whether God or some higher power would provide them personal assistance if an earthquake did occur. Overall, respondents disagreed with the idea of being personally invulnerable to earthquake victimization, but the level of disagreement is far from strong. The mean level of endorsement of items representing personal invulnerability was between scale points indicating disagreement and neutrality. Lesser agreement was accorded to erroneous beliefs regarding the provision of some sort of warning prior to the occurrence of a major earthquake.

Contrary to Hypothesis 1, little evidence was found for the expectation that earthquake beliefs are related to adoption of seismic hazard adjustments. There are three possible reasons for this finding. First, the participants in this study were college students and so few of them owned their homes—a variable that significantly predicts the adoption of hazard adjustments (Lindell & Prater, 2000). These more transient individuals would be expected to have less motivation and

ability to adopt the hazard adjustments recommended in the *Earthquake Preparedness Recommendations* pamphlet. Indeed, since nearly half of participants reported living with their parents, one would expect that few considered it their responsibility to prepare their homes for earthquake hazard (Mulilis & Duval, 1995).

Second, although each theory of self-protective action recognizes the importance of beliefs in promoting behavior change, each of them also indicates that the influence of belief on behavior is indirect. Additional variables such as perceived barriers to action, subjective norms, perceived responsibility, and perceived characteristics of hazard adjustments were not assessed in the present study, so future examination of the impact of erroneous beliefs on adoption of seismic hazard adjustments should assess these other important variables.

The third explanation for the low correlations of the earthquake beliefs is a somewhat more extreme version of the second explanation. This is that the beliefs that were measured are not just indirectly related to the adoption of hazard adjustments. Rather, they are completely irrelevant to the adoption of hazard adjustments, even though they are relevant to the hazard itself. In this connection, it is important to note that the Earthquake Belief Scale was developed using the same free-response procedure that Fishbein and Ajzen (1975) proposed for eliciting salient beliefs, but examination of the item content indicates that the beliefs were mostly about earthquakes (the attitude object), not about hazard adjustments (actions relevant to that object). According to the *Theory of Reasoned Action*, it should be no surprise that beliefs about an earthquake would have low correlations with hazard adjustment. The EBS was developed by means of a

procedure—elicitation of salient beliefs from risk area residents and from authoritative web sites—that provides significant support for its content validity. Consequently, the fact that its items do not predict hazard adjustments suggests that conventional procedures for communicating about earthquake hazard—which emphasize educating risk area residents about earthquakes (the attitude object), not about hazard adjustments (actions relevant to that object)—are unlikely to achieve their intended goals.

The data supported Hypothesis 2 because they showed that participants benefitted significantly from their exposure to the information, as evidenced by significant improvements on six of the eight earthquake belief dimensions. Thus, reading the material aloud exposed participants to accurate information, directed their attention to the message content, stimulated comprehension, and promoted retention. This is an important finding because it suggests that inadequate levels of hazard adjustment might be due in part to the absence of these cognitive activities. That is, inadequate levels of seismic hazard adjustment might be due selective exposure, deliberate inattentiveness, lack of comprehension, or poor retention of the information.

Nonetheless, these results are somewhat puzzling because the participants also increased their level of earthquake hazard adjustment over time even though the EBS items continued to have nonsignificant correlations with hazard adjustment. This suggests that the increase in hazard adjustment was due to factors other than the changes in the earthquake beliefs measured in the EBS. One possible explanation is that the common element in the two experimental conditions—reading the material aloud—increased hazard intrusiveness. According to this

explanation, it would be an increased frequency of thought and discussion about the hazard that caused the increase in hazard adjustment. To test this explanation, future studies should measure the level of hazard intrusiveness that respondents experience between the pretest and post-test.

The superiority of the “Myth vs. fact” condition, proposed in Hypothesis 3, is consistent with an information processing perspective in which the explicit conflict between myth and fact attracts participants’ attention and promotes comprehension of any incompatibility between existing beliefs and new information. This format also can increase retention over time because more thorough cognitive processing can increase the number and strength of the semantic connections and, thus, provide retrieval cues at a later time. Of course, the evidence for this mediating mechanism is indirect, so further research is needed to validate the explanation by measuring the intermediate steps directly. Because the support for Hypothesis 3 was found in only two (25%) of the eight earthquake belief dimensions, further research also must determine if there is something distinctive about these belief dimensions.

Consistent with Hypothesis 4, NFC was related to three of the eight earthquake belief dimensions, indicating that those who are high in this trait are less likely to believe that earthquakes are predictable, more likely to believe that building codes are useful for protecting persons and property, and more likely to believe that aftershocks can cause serious damage. As was the case with Hypothesis 3, finding this effect for three of the eight scales (38%) exceeds the experimentwise error rate (12.5%), but there is no obvious theoretical explanation why the effect

of NFC would be limited to these three dimensions. Further research is needed to determine if these findings can be replicated.

Also consistent with Hypothesis 4, those who are high in NFC were more likely to have adopted earthquake hazard adjustments prior to the pretest. This finding can be explained by recalling that those who are high in NFC tend to organize, elaborate, and evaluate information. Thus, they are likely to be chronically high in hazard intrusiveness because one would expect them to think and talk about this topic just as they do with other aspects of their lives.

The test of Hypothesis 5 indicates that individuals low in NFC can sometimes benefit more from the “Myth vs. fact” condition than from the “Fact only” condition. However, this combination of conditions was effective only in dispelling beliefs regarding the provision of a warning prior to earthquake occurrence. Support for the hypothesis can only be considered tentative because the predicted effect was not found for any of the other earthquake belief scales or for the adoption of earthquake hazard adjustments.

These findings lead to a number of recommendations for risk communicators. First, this study provides ample evidence that risk communication can produce more accurate beliefs about a hazard and also increase adoption of protective actions, but these two outcomes need not necessarily be causally related. Indeed, the use of novel message formats that stimulate more intense processing might be just as effective as repeated messages in creating hazard intrusiveness. One such approach—dispelling erroneous beliefs that may interfere with the adoption of hazard adjustments—was examined in this study. Consistent with the findings of

Turner et al. (1986), the results of the present study indicate that erroneous beliefs about earthquakes are prevalent and can co-exist with accurate beliefs about this hazard. Although there was no evidence of a direct adverse effect of such erroneous beliefs on adoption of seismic hazard adjustments, there remains the possibility that they have an indirect effect. For example, risk area residents might choose not to prepare far in advance if they can convince themselves that they will receive a warning of some sort before an earthquake strikes. Further, if they can convince themselves that they are not personally vulnerable to the hazard, then no preparatory actions are needed at all. Given that no such warning is possible, such beliefs could be quite dangerous. Risk communication campaigns targeting prevalent erroneous beliefs, therefore, could help eliminate an important barrier to the adoption of hazard adjustments.

The limitations of this study suggest a number of useful lines for further investigation. One limitation is that the absence of significant correlations between erroneous earthquake beliefs and hazard adjustment adoption may be due in part to the sample. In comparison to a random sample of risk area residents, college students are necessarily better educated, so they might be less likely to believe in the earthquake myths. In addition, they tend to be younger, earn less income, and are less likely to be either homeowners or the head of household. Such factors make them less likely to adopt earthquake hazard adjustments, particularly those involving greater time and effort. It is noteworthy that the mean number of adjustments reported in the pretest was nearly half of the total possible number—a level comparable to that of more representative samples



(Lindell & Prater, 2000). Nonetheless, additional studies should be conducted using a more representative sample of risk area residents.

It is especially important to conduct research that examines the role of other variables such as norms and behavioral intentions. Investigation of such variables could better test whether the erroneous beliefs are indirectly linked to the adoption of protective actions or whether they are altogether irrelevant.

The present study found that a brief, three-page pamphlet presenting a common myth followed by factual information refuting the myth was able to effect a significant amount of belief change. It is unknown whether this technique would be equally effective using other media—such as radio, television, or newspapers—where message recipients have greater opportunities for selective exposure and selective attention. However, the popularity of messages combining the joint presentation of myth and facts seems to be growing, as evidenced by their use in several television ads as well as on websites (e.g., Apple Computer, Inc., 2002). Further examination of this information format could provide a better understanding the cognitive processing of information about environmental hazards.

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Table 1. Means, Standard Deviations, Reliabilities and Variable Intercorrelations

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
<i>Phase 1</i>											
1. Need for Cognition	3.51	.48	<u>.82</u>								
<i>Earthquake Beliefs</i>											
2. Warning	2.04	.71	-.12	<u>.81</u>							
3. Prediction	2.53	.69	-.25	.53	<u>.75</u>						
4. EQ Damage Potential	4.14	.79	.03	-.08	-.03	<u>.85</u>					
5. Planning Efficacy	4.21	.77	.04	.10	.14	.13	<u>.64</u>				
6. EQ Likelihood	3.46	.57	-.03	-.08	-.09	.10	.10	<u>.62</u>			
7. Building Code Efficacy	4.04	.64	.18	-.18	-.13	.04	.10	.02	<u>.74</u>		
8. Personal Invulnerability	2.33	.69	-.04	.14	.10	-.13	-.04	-.07	.03	<u>.51</u>	
9. Aftershock Damage	3.84	.71	.16	-.13	-.08	.31	.09	.08	.09	-.23	<u>.54</u>
10. EQ Preparedness	13.60	5.84	.17	.16	-.07	-.11	.09	.05	.11	.13	.09
<i>Phase 2</i>											
11. Experimental Group <sup>a</sup>	.51	.50	-.05	-.02	-.02	-.05	-.07	.03	-.16	.00	.03
<i>Earthquake Beliefs</i>											
12. Warning	1.75	.68	-.16	.54	.27	-.02	.03	-.11	-.16	.09	-.07
13. Prediction	2.10	.79	-.18	.31	.49	-.03	.15	-.14	-.10	.04	-.12
14. EQ Damage Potential	4.16	.82	.04	-.12	-.05	.16	-.02	.06	.00	-.16	.35
15. Planning Efficacy	4.60	.58	.19	-.11	.04	.06	.20	.08	.09	-.22	.15
16. EQ Likelihood	3.66	.72	.12	-.02	-.08	.07	.28	.36	.11	-.24	.28
17. Building Code Efficacy	4.04	.80	.05	-.19	-.13	.07	.30	.15	.23	-.12	.11
18. Personal Invulnerability	2.04	.73	-.01	.18	.07	-.23	.04	-.07	-.01	.33	.00
19. Aftershock Damage	4.10	.73	.01	-.27	-.19	.09	.25	.26	.21	-.12	.53
20. EQ Preparedness	16.63	5.85	.20	.03	-.19	.02	.18	.10	.04	-.02	.22

Table 1 (continued)

Variable	10	11	12	13	14	15	16	17	18	19
10. EQ Preparedness	<u>1.0</u>									
<i>Phase 2</i>										
11. Experimental Group <sup>a</sup>	-.11	<u>1.0</u>								
<i>Earthquake Beliefs</i>										
12. Warning	.13	-.26	<u>.84</u>							
13. Prediction	-.04	-.36	.57	<u>.81</u>						
14. EQ Damage Potential	.13	-.13	.02	.02	<u>.85</u>					
15. Planning Efficacy	.04	-.09	-.21	-.15	.14	<u>.62</u>				
16. EQ Likelihood	.25	-.01	-.08	.05	.31	.31	<u>.80</u>			
17. Building Code Efficacy	.09	-.18	-.05	.04	.02	.16	.20	<u>.80</u>		
18. Personal Invulnerability	.09	-.09	.34	.20	-.06	-.25	-.06	.07	<u>.65</u>	
19. Aftershock Damage	.28	-.01	-.24	-.13	.33	.24	.43	.28	-.17	<u>.57</u>
20. EQ Preparedness	.68	-.03	.07	-.02	.04	.14	.18	.07	.10	.23

<sup>a</sup> coded 0 = "EQ Facts", 1 = "EQ Myth vs Fact"

*N* = 234 for correlations involving Phase 1 variables only

For variables involving only Phase 1 variables, all  $r \geq .13$  are significant at  $p < .05$

For variables involving only Phase 1 variables, all  $r \geq .17$  are significant at  $p < .01$

*N* = 126 for correlations involving Phase 2 variables

For variables involving Phase 2 variables, all  $r \geq .18$  are significant at  $p < .05$

For variables involving Phase 2 variables, all  $r \geq .23$  are significant at  $p < .01$

Table 2. Earthquake Beliefs Across Time.

Earthquake Belief	Phase 1		Phase 2		<i>t</i> -value
	M	SD	M	SD	
EQ Warning	2.00	.69	1.75	.68	$t(125) = 4.21, p < .01$
EQ Predictability	2.55	.68	2.10	.79	$t(125) = 6.64, p < .01$
EQ Damage Potential	4.13	.82	4.16	.82	$t(125) = -.30, ns$
Planning Efficacy	4.26	.73	4.60	.58	$t(125) = -4.56, p < .01$
EQ Likelihood	3.45	.56	3.66	.72	$t(125) = -3.23, p < .01$
Building Code Efficacy	4.02	.64	4.04	.80	$t(125) = -.25, ns$
Personal Invulnerability	2.34	.66	2.04	.73	$t(125) = 4.20, p < .01$
Aftershock Damage	3.91	.66	4.10	.73	$t(125) = -3.10, p < .01$
Earthquake Preparedness	14.55	5.81	16.63	5.85	$t(126) = -5.02, p < .01$



Figure 1. Interaction of Experimental Group by EQ Warning Beliefs Across Time

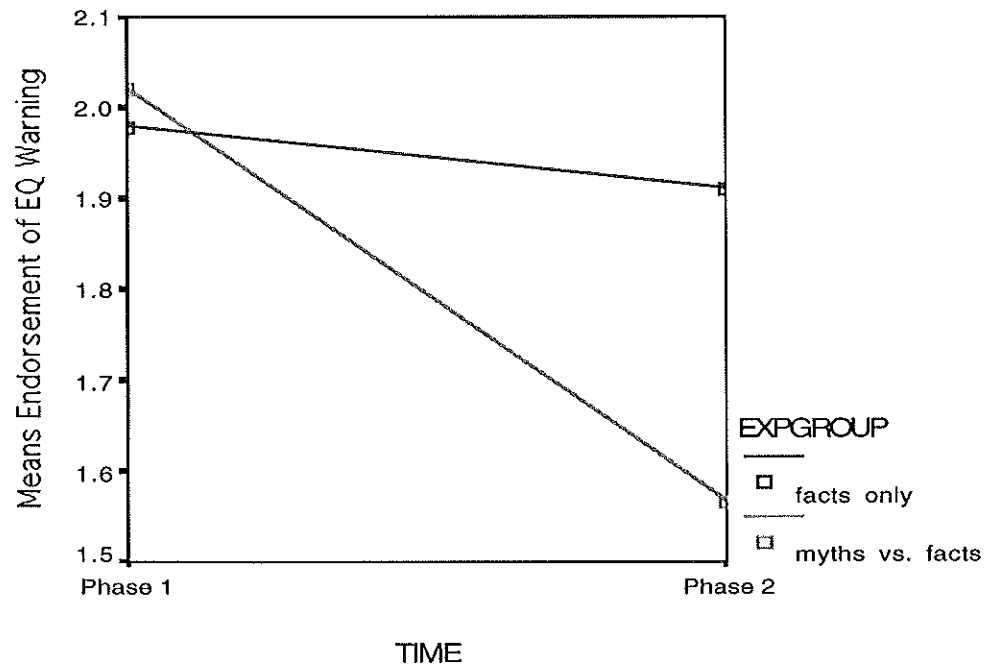


Figure 2. Interaction of Experimental Group by EQ Predictability Beliefs Across Time

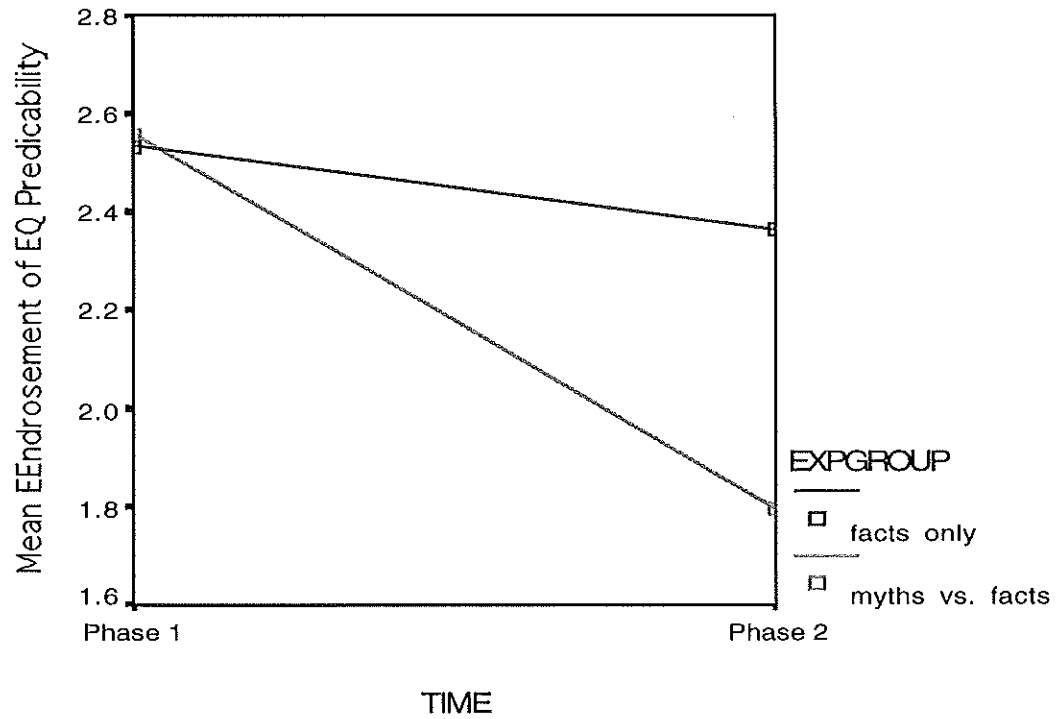
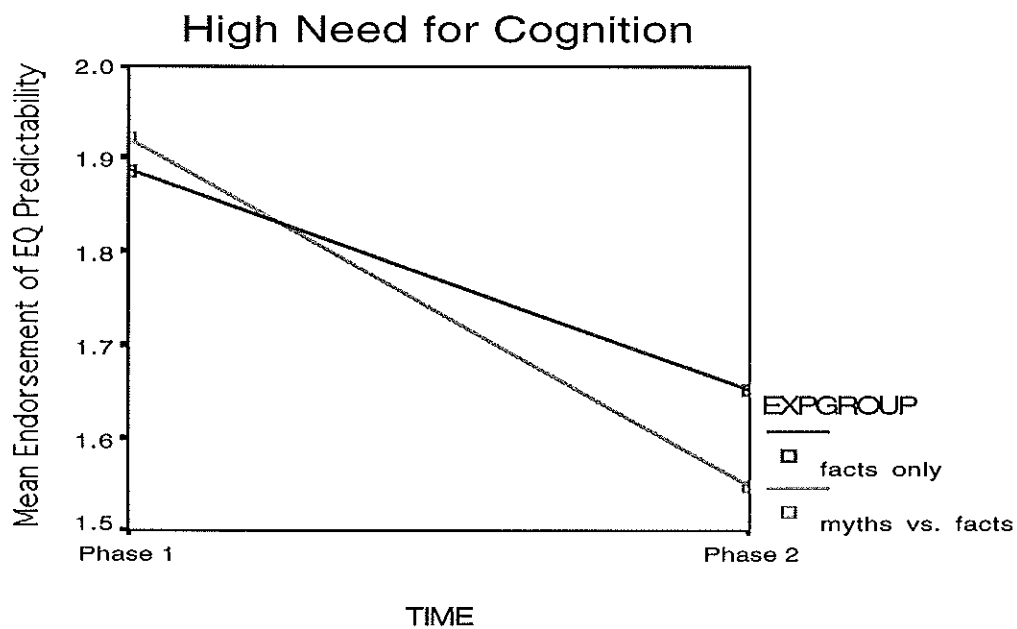
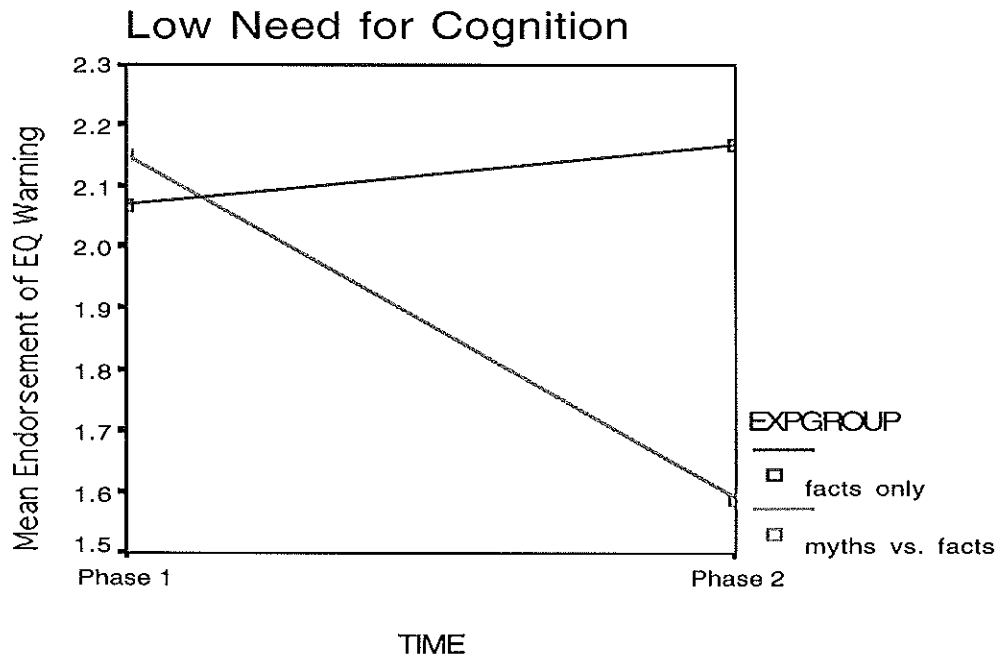


Figure 3. Need for Cognition by Experimental Group by EQ Warning Across Time



## Appendix A

## *Earthquake Actions Checklist*

This survey is intended to assess your earthquake preparedness.

**Please check (✓) all that apply.**

### 1. Which of the following do you have at home?

- ☐ operating flashlight
- ☐ working transistor radio
- ☐ extra batteries for flashlight and transistor radio
- ☐ complete first aid kit
- ☐ first aid manual
- ☐ camp stove or charcoal barbecue
- ☐ at least 4 gallons of water in plastic containers
- ☐ at least 4 days supply of dehydrated or canned food
- ☐ at least 1 week supply of required medications
- ☐ operating fire extinguisher
- ☐ wrench permanently available near gas utility turn-off
- ☐ a portable earthquake supply kit
- ☐ supply of dry or canned foods for all pets in the household
- ☐ loud whistle
- ☐ claw tool crow bar
- ☐ dust mask
- ☐ work gloves

### 2. Which of the following have already been done at your home?

- ☐ Securely attached water heater to wall.
- ☐ Installed child-proof safety latches on high kitchen cabinets and cupboards.
- ☐ Securely anchored tall furniture (such as bookcases, entertainment centers) to wall.
- ☐ Attached bungee cording across each shelf on bookcases.
- ☐ Securely fastened mirrors and framed paintings/prints to wall using closed (or, earthquake) hooks.
- ☐ Securely fastened television to wall to avoid falling from stand.
- ☐ Securely fastened computer equipment using Velcro or other fastener to avoid sliding from desk.
- ☐ Securely fastened stereo or VCR equipment using Velcro or other fastener to avoid sliding from shelf.
- ☐ Securely fastened valuable tabletop objects using Velcro or putty at the base.
- ☐ Developed a household earthquake plan.
- ☐ Designated an out of state contact for all members of family to call in the event of an earthquake.
- ☐ Ensured that the house is bolted to its foundation.
- ☐ Installed safety glass or covered glass windows with strong Mylar film to prevent shattering.

3. Do you...

- ☐ read materials on earthquake preparedness
- ☐ attentively listen to or watch radio or television messages about earthquake preparedness
- ☐ have earthquake insurance for the home in which you live
- ☐ know where and how to turn off water valve at your home
- ☐ know where and how to turn off gas valve at your home
- ☐ know where and how to turn off electric power switch at your home

## Appendix B

## Appendix B

<i>Item</i>	Phase 1			Phase 2		
	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>
Storing food and water will make a major difference if a major earthquake hits somewhere near my home. <sup>d</sup>	4.44	.72	.05	4.71	.66	.02
Property damage amounting to billions of dollars may occur if a major earthquake hit Southern California. <sup>e</sup>	4.22	.89	-.12	4.23	.90	.08
Thousands of people may be injured or killed by a major earthquake in Southern California. <sup>e</sup>	4.17	.85	-.12	4.21	.92	-.05
The movement of plate tectonics causes earthquakes.	4.15	.76	.09	4.33	.88	.02
If I were at home during an earthquake, I would try to brace myself in a doorway.	4.15	1.00	.06	3.40	1.39	-.08
Improving building codes helps reduce the loss of life and injuries following a major earthquake. <sup>f</sup>	4.10	.67	.12	4.09	.89	.09
An earthquake may potentially cause catastrophic damage to Southern California. <sup>e</sup>	4.02	.96	-.05	4.04	.98	.06
The degree to which an individual has prepared for an earthquake can mean the difference between life and death during an earthquake. <sup>d</sup>	3.97	1.04	.09	4.48	.71	.21*
Improving building codes helps reduce the amount of property damage following a major earthquake. <sup>f</sup>	3.97	.77	.08	4.00	.86	.03
Aftershocks from earthquakes may cause major damage to property or life. <sup>h</sup>	3.96	.75	-.02	4.16	.73	.20*
A major earthquake will likely occur in Southern California within the next 30 years. <sup>e</sup>	3.95	.91	.01	4.24	.81	.10
Earthquakes occur every day somewhere in the world.	3.76	.95	.19*	4.13	.98	.14
Aftershocks from earthquakes may occur years after the initial quake. <sup>h</sup>	3.72	.96	.15*	4.03	.99	.17
Animals often become restless before a major earthquake.	3.68	1.00	.10	2.95	1.33	-.03
A major earthquake will likely occur in Southern California within the next 5 years. <sup>e</sup>	3.50	.74	.09	3.62	.89	.17
Probably the safest "room" in my house during an earthquake is a hallway.	3.42	1.07	.04	3.50	1.16	-.08
We live in an area along "the Ring of Fire".	3.31	.98	.07	3.57	1.01	.15
If you were in a building during an earthquake, it would be safer to be next to an interior wall than an exterior wall.	3.18	.89	.12	3.24	.82	-.02
Homes built on bedrock will generally suffer less earthquake damage following a major earthquake than homes built on sand.	3.17	.89	.02	3.13	.99	.07
The rate of occurrence of earthquakes is increasing in Southern California.	3.12	.78	-.01	3.08	.83	.21*
God, or some Higher Power, is likely to provide some assistance to me during an earthquake.	3.07	1.31	.07	2.83	1.35	.03



<i>Item</i>	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>
Earthquake occurrence can be related to certain, identifiable weather patterns. <sup>b</sup>	3.06	1.03	-.07	2.55	1.22	-.02
Square shaped buildings are generally more resistant to earthquake damage than uniquely shaped buildings.	3.00	.73	.04	2.90	.76	.00
A major earthquake will likely occur in Southern California within the next year. <sup>c</sup>	2.92	.58	.03	3.12	.85	.18
Major earthquakes occur most frequently in the very early morning hours.	2.88	1.03	.04	2.34	1.15	-.05
Scientific predictions will likely immediately precede the occurrence of a major earthquake.	2.80	1.06	.04	2.30	1.10	-.07
Earthquakes will someday make Los Angeles a suburb of San Francisco.	2.77	.91	.04	3.32	1.00	-.02
St. Louis, Missouri is very susceptible to earthquakes.	2.75	.75	.02	2.79	.74	-.12
Underground nuclear explosions have been known to cause earthquakes.	2.69	.91	.05	2.81	1.00	.18*
A person is unlikely to be seriously injured or killed by a major earthquake if they have prepared appropriately.	2.65	1.13	.03	2.87	1.06	.08
My experience with past earthquakes leads me to believe I have little to fear during any future earthquakes. <sup>g</sup>	2.63	1.18	.10	2.31	1.06	.10
Earthquake occurrence can be predicted by certain planetary and lunar alignments. <sup>b</sup>	2.59	.99	-.12	2.05	1.02	-.03
A building that has been seismically retrofitted is immune to collapse.	2.55	.94	-.01	2.30	.99	-.17
Physical or mental illness can become more symptomatic just prior to an earthquake occurrence. <sup>b</sup>	2.48	.89	-.06	2.02	.92	.05
A home that has withstood past earthquakes is likely safer than a newly built home.	2.45	.88	.12	2.28	.85	-.09
Earthquakes follow a predictable pattern of occurrence. <sup>b</sup>	2.33	1.01	-.01	2.00	1.06	-.08
Concern with earthquakes is over-hyped.	2.26	.88	.01	2.15	.82	.01
I am less likely to be an earthquake "victim" than other Southern Californians. <sup>g</sup>	2.26	1.04	.20*	1.98	1.02	.04
Earthquakes are unlikely to ever have a major impact upon my life. <sup>g</sup>	2.24	.96	.03	1.89	.94	-.04
Before the Big One hits, I am likely to have some sort of intuition that it is about to occur. <sup>a</sup>	2.20	1.07	.12	1.69	.85	.07
An earthquake is unlikely to cause a major disruption to daily life in Southern California. <sup>g</sup>	2.19	1.15	.02	1.98	1.14	.14
Scientists can accurately predict the occurrence of major earthquakes within 2 to 3 days of occurrence. <sup>b</sup>	2.18	.92	-.01	1.90	.96	-.01
I believe I will have adequate scientific warning prior to a major earthquake. <sup>a</sup>	2.17	.92	.10	1.91	.92	.06
I believe I will have adequate personal or intuitive warning prior to a major earthquake. <sup>a</sup>	2.08	.90	.17*	1.94	.93	.10
If I were in bed during an earthquake, it would be best to stay there until the shaking stopped.	2.05	1.20	.05	3.74	1.22	-.04

<i>Item</i>	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>
An earthquake 5 times larger than Northridge could NOT possibly occur in Southern California.	2.03	.86	-.11	1.97	.93	-.15
It is unlikely a major earthquake will occur in Southern California in my lifetime.	1.97	1.19	-.03	2.05	1.27	-.11
If I was driving and a major earthquake hit, the best thing to do is to keep driving and ride it out.	1.95	.96	-.05	1.87	.97	.10
Looking back on past earthquakes I've experienced, I realize that I had some sort of premonition just before the earthquake occurred. <sup>a</sup>	1.92	1.01	.18*	1.64	.85	.07
I believe I will have adequate astrological or mystical warning prior to a major earthquake. <sup>a</sup>	1.82	.77	.04	1.58	.75	-.01
Earthquakes sometimes occur as punishment for sin.	1.51	.83	.00	1.56	.98	.08

$N = 234$

Note:

<sup>a</sup> indicates used in construction of the "EQ Warning" sub-scale

<sup>b</sup> indicates used in construction of the "EQ Prediction" sub-scale

<sup>c</sup> indicates used in construction of the "EQ Damage Potential" sub-scale

<sup>d</sup> indicates used in construction of the "Planning Efficacy" sub-scale

<sup>e</sup> indicates used in construction of the "EQ Likelihood" sub-scale

<sup>f</sup> indicates used in construction of the "Building Code Efficacy" sub-scale

<sup>g</sup> indicates used in construction of the "Personal Invulnerability" sub-scale

<sup>h</sup> indicates used in construction of the "Aftershock Damage" sub-scale

*r* represents correlation of item with total score on the Earthquake Actions Checklist

\* indicates the correlation is significant,  $p < .05$

## Appendix C

# Earthquake Myth vs. Fact

Did you know that people once thought the movement of a giant catfish caused earthquakes? Even today many myths and folklore about earthquakes persist. Below are listed some common myths, along with the truth.

**Myth** Scientists can accurately predict when an earthquake is going to occur.

**Fact** Although seismologists sometimes issue probabilities of earthquake occurrence such as “there is a 90% probability of a major earthquake in an urban area of California in the next 30 years”, scientists cannot predict when an earthquake is actually going to happen. No one has ever accurately forecasted the occurrence of an earthquake within a time period of several days.

**Myth** Animal behavior or personal intuition can predict the occurrence of an earthquake.

**Fact** Some people swear that their pet acts strangely just before a major earthquake. Others claim to have personal intuition regarding when an earthquake will occur. All such claims are false. Neither animals nor people can predict when an earthquake is about to happen. Humans seek order and predictability in events – unfortunately when it comes to earthquakes, we have no accurate predictors of earthquake occurrence.

**Myth** Major earthquakes always occur in the early morning.

**Fact** Earthquakes can occur at any time of the day or night. People remember the events they have experienced, and try to fit their experience into a predictable pattern. Unfortunately, there is no time of the day at which an earthquake is more or less likely to occur.

**Myth**

It's hot and humid during the day, and cool at night:  
earthquake weather!

**Fact**

There is no correlation between weather patterns and occurrence of earthquakes. Earthquakes begin deep within the earth's crust, below the region affected by surface weather. Once again, this is an example of people trying to fit a pattern to a random event. We simply cannot accept the unpredictability of earthquakes.

**Myth**

The Earth's alignment in relation to the moon and nearby planets causes earthquakes.

**Fact**

This proposition seems both logical and scientific given the influence of gravity, but scientific research suggests no relationship between quakes on Earth and the alignment or position of other planets or moons.

**Myth**

We have good building codes, so we must have safe buildings.

**Fact**

With each passing earthquake, scientists and engineers learn more about what makes buildings safer. In Southern California, many cities have instituted building codes to ensure that new buildings are constructed in the safest manner possible. Despite these efforts, however, no building is immune to earthquake damage. Further, many houses, apartment complexes, and buildings were built prior to stringent earthquake building codes. These buildings are not likely to have been retrofitted to make them safer for earthquakes.

**Myth**

My home survived the last major earthquake, so it must be earthquake safe.

**Fact**

Many factors influence whether a particular building will be damaged during a particular earthquake. Generally, the older the structure, the less likely its construction employs current earthquake standards.

**Myth**

If you are in a building at the time of an earthquake, run out as soon as possible!

**Myth**

If you are in a building at the time of an earthquake, stand in a doorway and hold on tight.

## **Fact**

In many earthquakes, the majority of fatalities result when people run out of the building and are hit by debris (such as bricks, wrought iron, or balconies) falling off the building. It is much better to stay within the building until after the shaking has stopped. The outdated idea that standing in a doorway is the best protection from an earthquake is true only for the oldest adobe homes. In all other buildings, the doorway is no stronger than the walls, and the door (which may swing back and forth) is likely to break your fingers.

If you are in a building at the time of an earthquake, duck under a sturdy table or desk, and hold on tight until the shaking is over. If you are in bed at the time of an earthquake, it's probably best to stay in bed until the shaking stops.

## **Myth**

Earthquakes are punishment for those who have sinned.

## **Fact**

This myth was endorsed by the British Royal Society in 1752. Ironically, just three years later a major earthquake hit Lisbon, Portugal on a religious holiday. Although nearly all of the population was in church at the time, sixty thousand people died from collapsing structures, fires, and an earthquake-related tsunami.

Many people have a very strong faith or sense of spirituality, and yet are still at risk for hazards. Proper preparation is the key to reducing risk.

## **Myth**

There is nothing you can do to prepare for an earthquake.

## **Fact**

While no one can be immune from injury or property loss caused by an earthquake, there are many things that you can do to protect yourself, your family, and your property. Each person is responsible for his or her own earthquake preparedness. For more information, call the Long Beach chapter of the Red Cross at (562) 595-6341 or find out information from the Southern California Earthquake Center's web site at [www.scecdc.scec.org](http://www.scecdc.scec.org)

# Earthquake Facts

Southern Californians are knowledgeable about a lot of issues. But how much do we know about earthquakes? Below are listed some important earthquake facts.

#1

*Worldwide , scientists detect about 35 earthquakes each day.*

Obviously, not all earthquakes are devastating. However, on average there are 18 major earthquakes each year with a magnitude of 7.0 or greater. Each year there is on average one earthquake with a magnitude of 8.0 or greater.

#2

Scientists measure earthquake magnitude on a variety of scales, including Richter and Moment-Magnitude scales.

For each increase of 1 in magnitude along a Richter scale, the ground motion displacement increases 10 times, and the amount of energy produced increases 32 times! For example, a Richter magnitude 7.2 earthquake produces 10 times more ground motion, and 32 times more energy than a Richter magnitude 6.2 earthquake.

Today scientists use a method of measuring earthquakes called the Moment Magnitude ( $M_w$ ). This scale provides a more accurate assessment of earthquake size by assessing the total energy released by the quake.

#3

The largest earthquake to hit the United States since 1900 was magnitude 9.2  $M_w$ .

This great earthquake centered near Prince William Sound in Alaska damaged nearly 30 blocks of homes and commercial buildings in the city of Anchorage, nearly 75 miles away from the epicenter!

The costliest earthquake in the United States was the 1994 Northridge earthquake, which had a magnitude of 6.7  $M_w$ . Due to its location in an urban area, the costs associated with this earthquake were estimated to be near \$20 billion.

## Movement along the Earth's tectonic plates causes earthquakes.

Southern California straddles the boundary between the Pacific Plate and North American Plate. These large sections of the earth's crust are sliding past each other. As the rocks in the two plates move past each other, stress builds up and the rocks slip suddenly. This event releases energy in waves that travel through rock to cause the shaking which we call an earthquake.

## The primary boundary between the Pacific Plate and the North American Plate is the San Andreas Fault.

A fault is a thin zone of crushed rock between two blocks of rock. When the rock on one side of a fault slips with respect to the other side, we experience an earthquake. We are all familiar with the San Andreas Fault system, which extends the length of California. The mountains surrounding LA are due to the clash of tectonic plates on either side of the San Andreas fault system.

The Pacific Plate grinds northwestward past the North American plate at a rate of about 2 inches per year. Over a period of many years, this will eventually result in making Los Angeles a suburb of San Francisco!

## *Everywhere in Southern California is within 30 miles of a fault capable of producing a strong earthquake.*

Although we've heard of the San Andreas, did you know that Southern California has over 200 faults that could cause a serious earthquake? Long Beach is located on top of a fault called the Newport-Inglewood fault. This fault is capable of producing an earthquake of greater magnitude than the Northridge quake.

## There's no way of knowing when or where the next big earthquake might occur.



Despite many scientific investigations, there is currently no way to accurately predict exactly when or where an earthquake is going to occur. Therefore, it's important to plan as if an earthquake could occur at any moment.

#3

According to the U.S. Geological Survey, there is a 90% probability that at least one major earthquake will strike an urban area in California within the next 30 years!

Despite the inability to predict earthquakes, researchers do estimate the probability of their occurrence in certain locations. All geo-scientists agree that Southern Californians are potentially at risk from earthquake hazard.

#9

If you are in a building during an earthquake, remain calm, duck under a desk or table, and hold on tight.

A sturdy table or desk is a great place to protect you from any falling objects. Because the shaking will cause the table to move, it's important to hold on tight. If you are in bed at the time of an earthquake, it's probably best to stay in bed until the shaking stops.

#10

Federal, state, and local building codes make newer buildings safer than ever.

With each passing earthquake, scientists and engineers learn more about what makes buildings safer. In Southern California, many cities have instituted building codes to ensure that new buildings are constructed in the safest manner possible. Despite these efforts, however, no building is immune to earthquake damage. Further, many houses, apartment complexes, and buildings were built prior to stringent earthquake building codes. These buildings are not likely to have been retrofitted to make them safer for earthquakes.

#11

Earthquake preparedness is the responsibility of every person!

You need to learn about things you can do to protect yourself from earthquake hazards. For more information, call the Long Beach chapter of the Red Cross at (562)

595-6341 or find out information from the Southern California Earthquake Center's web site at [www.scecdc.scec.org](http://www.scecdc.scec.org)

## Appendix D

# Earthquake Preparedness Recommendations

If a major earthquake occurs near your home, or where you're visiting, there's a good chance that you're not going to be able to shop, communicate or move about normally. If you and your family want to be as safe as possible, here's what you'll need to do before anything happens...

## Before the Earthquake

This fact sheet will present some general strategies for preparing for earthquakes. Keep in mind that not all earthquakes are serious: a little ground shaking is a part of life in many regions, and nothing to worry about. The experience of a more serious earthquake, however, can be frightening and disorienting. For that reason it's important to be very familiar with safety procedures. That way, when the earthquake happens, you'll simply follow the procedures instead of panicking. Some prior planning and practice will help you stay calm: this factor more than any other will likely improve your situation.

## Step 1: Collect emergency supplies

Emergency kits are one of those items that nobody pays much attention to until there's an emergency. Make sure that everyone knows where the kit is located. Put it in an easily accessible area (the garage is good), rather than buried in a bedroom closet. Also, consider preparing a smaller version to store in your car trunk. Your kit should contain as many of the following as possible:

- **A battery-operated radio and flashlight, with spare batteries.** Most telephones will be out of order or limited to emergency use. The radio will be your best source of information, instruction, and news to help you cooperate fully with public safety officials.
- **Avoid candles and matches** - Matches or candles should NOT be used after an earthquake unless you are CERTAIN no gas leak exists.
- **A fire extinguisher** - This should be suitable for all types of fires and should be accessible. Teach everyone in your family how to use it.
- **One gallon of bottled water, per person per day, for 5 days.** Store in air-tight containers, away from gasoline or other petroleum products. Change water every six months (when you change the clocks for daylight savings).
- **Non-perishable food** that does not need cooking or additional water. Store a one-week supply of food for each person. The same applies for your pets too!
- **A multiple tool knife with can opener.**

- **Extra blankets and heavy clothing**, including rubber-soled shoes and work gloves. Heat may not be on for some time so you may need these to keep warm. Shoes and gloves will be useful in protecting you from broken glass and other debris.
- **A first aid kit**, kept in a central location. Keep it well stocked with one-week supply of special medications and sunscreen. Consider taking a basic first aid/CPR course and keeping a first aid manual handy.
- **A claw tool crowbar and dust mask** to be able to remove debris to help others, and protect yourself from fumes and dust.
- **Pipe and crescent wrenches** to turn off gas and water mains. Keep a wrench permanently available near gas utility turn off so you can turn off as quickly as possible in the event of life-threatening leak.
- **A shovel and toilet paper**-- Sewer lines may have been disrupted during the earthquake. Avoid flushing the toilet and risking further contamination of the groundwater. Consider gathering other sanitation supplies such as plastic trash bags for waste, trash, and water protection; soap and detergent; shampoo, toothpaste, and toothbrushes; feminine and infant supplies; and household bleach.
- **Alternate cooking source**, such as a camp stove or charcoal barbecue. Have starter fluid and matches in case utilities are out of service. Consider keeping plastic knives, forks, spoons; paper plates and cups; paper towels; and heavy-duty aluminum foil handy as well.
- **Money**: \$30-\$100 in cash, depending on the size of household.

## **Step 2: Make your home or office earthquake-ready**

During an earthquake, certain objects in your home seem to have minds of their own:

- **Your water heater**, for instance, may topple over and sever its gas and water connections. To prevent that from happening, secure your unit to the wall. Use galvanized steel straps, with holes punched through the length of them, and screw them to the wall.
- **Any object on shelves may jump off, and the cabinetry itself may topple over.** Keep them against the wall with screws or brackets near the top of the unit. Don't put flammable materials anywhere but on the bottom shelf. Install childproof safety latches on high kitchen cabinets and cupboards to prevent hazardous objects from falling. Attach bungie cording across each shelf on bookcases.
- **Your mirrors, pictures, and other valuables could fall and break causing a loss for you and creating a hazard as well.** Use closed (or earthquake) hooks to securely fasten wall hangings. Fasten television, computer equipment, stereo, VCR equipment, and other valuable tabletop objects using Velcro, putty at the base, or other fastener to prevent sliding and falling.

- **Check chimneys, roof, walls, and foundation for stability.** Make sure your house is bolted to its foundation. Consider installing safety glass or covered glass windows with strong Mylar film to prevent shattering.
- **Learn how to shut off your own gas, water and electricity.** If any connections break inside the house, or even where they enter the house, you have a problem. Your local utility office will help you find the valves for gas and water, and they'll also warn you not to try to turn them off unless you're certain that a break has occurred.
- **Purchase earthquake insurance for your house or apartment.** Earthquakes can cause very costly damage to your house and the contents of your home. This damage is not covered by house or apartment insurance unless you have earthquake insurance. Your insurance agent can tell you how to obtain earthquake insurance through the California Earthquake Authority.

### **Step 3: Learn emergency procedures**

**Question:** if a major earthquake happened tonight, would your family know what to do? Perhaps one person is out of the house, how would they let the rest of you know that they're all right? Where would all of you meet? Emergency plans don't have to scare anyone, and they're pretty simple to write down and put on the refrigerator.

Some important points would be to:

- **Select an out-of-town relative or friend to be your contact person.** When separated, family members can call this person to report their safety, or to leave messages, since local phone lines will likely be down for awhile.
- **Conduct practice drills with all family members to ensure everyone knows which areas of your house and property are "safer" than others.**
- **Choose a place to meet following the earthquake.**

**And picture this:** could there be a worse feeling than seeing someone you know injured, and not knowing what to do? Consider learning CPR and basic first aid.

Red Cross offices or your local city hall will point you towards training programs. YMCAs and YWCAs are also good places to find information. The courses don't take long and are often scheduled in the evenings or on weekends.

**Remember...** you can never be too prepared for a disaster, so keep up on new materials on earthquake preparedness. Always listen to radio and television messages about earthquake preparedness and there's a wealth of information available on the Internet.

## **Step 4: In Your Car...**

You never know where you're going to be during a major earthquake, so learn to be prepared no matter where you are. If you are driving when an earthquake occurs, pull over to the side of the road, unless you are on a bridge or under an overpass. Below are listed some supplies to keep in your car in case you are driving when an earthquake occurs.

- **Drinking water and snack food**
- **Small first aid kit** - so you can assist yourself or others in need of care
- **Working flashlight** -electricity could be out at night and you'll have no way to navigate or find your supplies without this.
- **Comfortable walking shoes**- you may need to walk a distance to get to a phone and call your emergency contact or get to a safe place.
- **Local area maps**- this is important since usual roads may not be accessible and you may need to walk and locate area safe spots or navigate alternate routes.
- **Other supplies...**blankets, toilet tissues, work gloves, and pocketknife.

**Always...**keep at least a half a tank of gas in your car since most gas stations won't be operating for awhile after a major earthquake.