WAITING FOR DISASTER: CHANGING REACTIONS TO EARTHQUAKE FORECASTS IN SOUTHERN CALIFORNIA*

Ralph H. Turner
University of California
Los Angeles, California 90024, USA

Several earthquake near predictions in 1976 initiated a period of waiting in Los Angeles County for a great and destructive earthquake. Hypothesized negative effects of an extended period of waiting under an open-ended threat of disaster include (1) declining sense of urgency and vigilance, (2) disillusionment and disbelief, (3) accumulating anxiety and defensive denial of danger, and (4) resentment and scapegoating. Hypothesized positive effects include (5) familiarization, appreciation, and sensitization, and (6) symbolic and active rehearsal of responses. Interviews with five waves of adult County residents over a period of nearly two years, followed by a sixth wave immediately after a moderate but nondestructive earthquake, provided measures of change and stability of response to earthquake threat. Measures of fear, imminent expectation for a damaging earthquake, household preparedness, confidence in scientific earthquake prediction capability, suspicion that information was being withheld, attitude toward releasing uncertain predictions, focus on scientific as compared with unscientific forecasts, and preferred media source of information on forecasts tend to disconfirm the disillusionment, denial, and scapegoating hypotheses, to support reduced urgency and familiarization hypotheses, and to provide weak support for the rehearsal hypothesis.

Introduction

Residents of Los Angeles County were assailed with a dramatic series of earthquake near predictions throughout the year 1976, beginning with public announcement by the prestigious United States Geological Survey that a vast stretch of the earth's surface along the

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critical San Andreas Fault in California was measurably uplifted. The initial announcement in February and subsequent warnings from both scientific and nonscientific sources continued intermittently through December, initiating a period of waiting for a great and destructive earthquake. The opportunity to conduct five sample surveys of the county's adult population at intervals from February 1977 to December 1978 enabled us to examine trends with respect to a variety of earthquake attitudes and perceptions during this extended period of waiting. As a matter of interest, the community is still waiting and authorities are still making plans, more than six years later, for the disastrous quake that scientists still say is due in the region.

Theories of waiting

Six different but not always mutually exclusive theoretical assumptions have guided our investigation of the effects of waiting. (1) The most obvious hypothesis is that lengthening experience in an open-ended time window should lead to a declining sense of urgency and correspondingly reduced vigilance and preparedness. (2) The second hypothesis carries the same principle a step further, positing a false-alarm or cry-wolf effect. The first hypothesis envisions no loss of conviction that disaster will strike eventually. But under the second hypothesis people conclude that the entire alarm was unjustified in the first place, and that scientists or other forecasters really do not know what they are doing.

(3) The third hypothesized effect is accumulating anxiety and fear with their many attendant effects. People should resist and resent new information, and should practice defensive denial of danger. Earthquake salience could increase while expressions of fear were moderated. (4) The fourth hypothesized effect is the translation of accumulating personal tension into more active and aggressive responses. Anger, resentment, and scapegoating should be directed

1. The initial survey consisted of interviews in the field. But for the sake of economy, the four follow-up interview waves and the New Year's Day earthquake interview (mentioned only in the conclusions) were conducted by telephone, with sampling by random digit dialing within regions of the county paralleling those used in the sampling design for the field survey. The possibility must therefore be considered that differences between the February 1977, basic field survey and subsequent waves might be consequences of the changed interview or sampling mode. After a comprehensive review of all the timeseries findings, we conclude that they cannot be explained in this way. Most telling is the frequent observation that a trend found between the basic field survey and the first follow-up wave is continued during the next time interval. Another relevant observation is that the New Year's Day earthquake restores certain key variables to the basic field survey level. For these and other reasons we are satisfied that the time-series can be accepted at face value.
against scientists for disturbing the peace by issuing unsettling pronouncements, and against public officials for their implied collaboration. Scientists should be viewed with increasing distrust, and appeals for preparedness should be met by active and hostile noncompliance.

While these four possible negative effects of living through a lengthening disaster time window have been widely advertised, a plausible case can also be made for some effects of a more positive kind. We shall describe two.

If the extended time window creates occasions for discussion and exposure to media examination of the earthquake threat, the earthquake prospect could become increasingly real and vital. As a new idea, earthquake prediction is poorly grasped and understood by most people. (5) Extended exposure to the idea in an alert mode can lead to familiarization, appreciation, and sensitization to the signs and implications of earthquake hazard. (6) Carrying this reasoning one step further, the sixth hypothesis is that responses to early and repeated warning announcements become rehearsals and drills in preparation for the eventual emergency. Through trial and effort people discard inappropriate responses and replace them with more suitable ones.

We shall not explore these hypotheses one by one, but will refer to them as we attempt to understand the significance of the trends in our data. But first it should be helpful to present a fuller account of the portentous events of 1976.

Earthquake harbingers

On February 4, the tragic Guatemalan earthquake which killed more than 20,000 people and left more than 200,000 homeless heightened local awareness of earthquake preparation and survival in Los Angeles area newspapers. But on February 13, before the Guatemala disaster ceased to be news, a front-page story in the Los Angeles Times announced the discovery that the earth's surface was uplifted over a vast area centered near Palmdale. The precise meaning of the uplift remained a puzzle to seismologists, and scientists admitted that alternating uplift and subsidence can occur without accompanying earthquakes. However, four circumstances could not be ignored, namely: (1) an uplift of this nature is one important hypothetical precursor to an earthquake; (2) if the uplift were a precursor, its extent--covering approximately 100 miles along the fault--could indicate an earthquake in the magnitude 8 range on the Richter scale; (3) a National Oceanic and Atmospheric Administration (NOAA) study published in 1973 had estimated that a quake of similar magnitude centered in approximately the same location could cost as many as 12,000 lives in the greater Los Angeles area, with astronomical injuries and property loss; (4) seismologists had long warned that a serious earthquake was overdue in the southern portion of the San Andreas fault. While acknowledging the uncertain
meaning of the uplift, the California Seismic Safety Commission on April 8 officially declared that "the uplift should be considered a threat to public safety and welfare in the Los Angeles metropolitan area."

Although nothing approaching a true prediction had yet been issued, the southern California uplift might well serve as a prototype for the first stage leading toward eventual prediction of a highly destructive earthquake affecting a major metropolitan area. The U.S. Geological Survey rapidly increased instrumentation and observation in the uplifted area. A succession of further developments might well occur, culminating either in a positive prediction, a reinterpretation of the uplift as benign, or an actual earthquake that struck while scientists and responsible community leaders were still debating the significance of the anomaly. Accordingly it was decided to launch a study into public interpretation and response to announcement of the uplift and whatever subsequent developments might occur (Turner et al., 1980, 1981).

Subsequent events have justified the assumption of a developing scenario, though not yet the anticipation of a true earthquake prediction. On April 21, 1976, another front-page story in the Los Angeles Times reported that Professor James Whitcomb of the California Institute of Technology's Seismology Laboratory had "predicted" a quake between the magnitudes of 5.5 and 6.5 to occur any time from that date until April, 1977. The quake might occur on any of several faults in the area, and anywhere within an irregularly shaped circle some eighty-seven miles in diameter. It could not be determined at once whether this qualified prediction referred to the same phenomenon as the southern California uplift, or whether Los Angeles now faced the prospect of two earthquakes. In subsequent discussion, Professor Whitcomb made it clear that he was merely engaged in testing a controversial hypothesis rather than issuing a confident prediction.

On May 28 the Los Angeles Times again carried a front-page story with the headline "Palmdale 'Bulge' Higher, Wider Than First Thought." This latest story suggested that the uplift might relate to a fault on the Los Angeles side of the San Gabriel Mountains, rather than the San Andreas fault, and reported a growing conviction at the U.S. Geological Survey that the uplift indeed presaged an earthquake.

The year following the first announcement of the uplift was marked by an abundance of earthquake-related news. There were more destructive earthquakes around the world than usual, with the July 28 Tangshan quake in the People's Republic of China and the May 6 quake in northern Italy receiving most attention. Issues such as what to do about old and unsafe buildings, existing and projected dams, and the safety of nuclear reactors kept earthquakes in the public attention. Just about the time that Professor Whitcomb was cancelling his near prediction, a forecast from outside of the established scientific community attracted nationwide attention.
Henry Minturn, a self-styled geophysicist generally unknown to the scientific community, was given a hearing by the local NBC radio affiliate on November 22, 1976. He claimed to have predicted many earthquakes successfully in the past, including a small one that occurred while he was in the studio. On the air he forecast an earthquake for the Solomon Islands on December 7, to be followed by a quake in Los Angeles on December 20. Although professionally recognized earthquake scientists consistently disparaged Minturn’s methods and his predictions, interest in the forecast mushroomed. Media coverage was extensive, though it ranged from positive to inquiring to devastatingly critical. After December 20 had passed without an earthquake, most of the media simply dropped further mention of Minturn, without so much as a recapitulation and assessment.

In the following pages we shall review the trends from early 1977 to late 1978 in a wide range of public attitudes, conceptions, and responses. We begin with awareness of the earthquake hazard and the sources of information people used. We then examine belief in the predictability of earthquakes, the extent of expressed fear and concern over the anticipated earthquake, whether people expect a damaging earthquake soon, and personal preparedness and attitudes toward collaborative preparedness and government action.

**Earthquake Hazard Awareness**

Announcements remembered

A standard question on "predictions, statements, or warnings about earthquakes" was repeated in each of the surveys, and the results are graphed in Figure 1. Remembrance of announcements fell dramatically from February 1977 to January 1978, levelling off thereafter. The proportion of respondents who could not remember any recent announcement tripled from February to August, and quadrupled from February to January. An exponential curve fits the trend in mean number of announcements remembered quite well (F-2 114.56; 1, 3 d.f.; p<.001). The trend of awareness confirms the impression that

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2. On the first three occasions interviewers were instructed to record up to five separate answers and space was provided on the interview schedule for five corresponding sets of follow-up questions. To prevent an overly long interview and because respondents seldom offered more than three answers, only three announcements were recorded in the two final interview waves. In order to establish comparability, we have included only the first three announcements from each of the interview waves in the analysis of change and stability. For that reason there will be slight differences in the findings from the initial survey as reported earlier.
1976 had been a busy year for earthquake intimations, and that 1977 and 1978 were quieter.

Yet there were new announcements during the latter years. Seers continued to proclaim their forecasts, there were periodic reports on the status of the uplift, and general reminders were still being issued. Why did they no longer make the same impression as before? Perhaps the new developments were less newsworthy because they were repetitions and revisions of prior announcements, or because they lacked the urgency or specificity of some earlier forecasts like Henry Minturn's. Perhaps many people had experienced "saturation" on the basis of the 1976 announcements, or the threshold for significant experience had been raised. But the fact that people continued to ask for more media attention to earthquake hazard (Turner et al., 1979:58) weakens the plausibility of this explanation.

A more tenable explanation may be that experiences are significant when they either create new convictions or undermine old ones. Early announcements caused many people to think seriously about the prospect of an earthquake and conclude that a quake was coming. Once that view was established, and while the conviction remained, new announcements made little distinctive impression. They were more like the familiar sights that remind an automobile driver that he is still on the right road, without requiring active attention, than like the signs that command attention while one is trying to find the way along an unfamiliar route.

But does this marked exponential decline apply equally to all kinds of earthquake forecasts and cautions? All types of announcements were more salient in February 1977, than later, but the rates and patterns of decline differ. Pseudoscientific announcements declined

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**Figure 1:** Changing Earthquake Awareness
most dramatically between February and August 1977, closely approximating an exponential curve. A slight decline in prophetic announcements approximated an exponential curve, but more loosely. General or vague announcements also dropped substantially, but mostly between August 1977 and January 1978. The trend of scientific announcements (Figure 1) is a somewhat flattened version of the trend for all announcements.3

Because pseudoscientific announcements show the most dramatic exponential decline, we must be wary of the possibility that the fading memory of Henry Minturn's forecast alone accounts fully for the overall trend of awareness. Disconfirmation of Minturn's forecast for December 20, 1976, was less than a month past when our interviewers commenced the basic field survey. To resolve this question we computed the mean number of earthquake announcements mentioned when references to Minturn are eliminated. Although the decline is now more linear and less concentrated in the first period, there is still substantial decline with single interruption of the downward trend between January and July, 1978. The overall relationship is highly significant. The main conclusion is clear. Although the Minturn announcement contributes greatly to the overall trend of awareness, its effect is chiefly to intensify a trend that also characterizes other notices and to exaggerate the loss of awareness between February and August 1977.

While the mention of scientific announcements declined, scientific notices may have increased in prominence relative to other kinds of announcements, especially from February 1977 to January 1978. The James Whitcomb announcement--more often identified as coming from Cal Tech than by Whitcomb's name--was mentioned by only 4.8 percent of our respondents at the beginning of 1977 and had dropped to a mere 0.4 percent by the end of 1978. The trend was significant and linear. The uplift, on the other hand, increased in salience from August 1977 to July, 1978, with the major increase occurring between August, 1977 and January, 1978. The upward trend appears to be reversed by a substantial drop in the final period. We shall come back to the uplift later. But for the present, while Minturn is being forgotten most rapidly and Whitcomb less rapidly, while general warning announcements are being mentioned less often, and while other pseudoscientific and prophetic announcements remain fairly constant after an initial drop, the uplift is the one easily identified topic whose salience increases during a substantial portion of the study period. While the increased salience of the uplift contributed to a slight shift toward greater salience of scientific than non-scientific

3. For pseudoscientific announcements: F=56.52; 1,3 d.f.; p<.01; exponential curve. For prophetic announcements: F=14.29; 1,3 d.f.; p<.05; exponential curve. For general announcements: F=18.53; 1,3 d.f.; p<.05; linear trend.
announcements, it also signaled a growing tendency for most scientific announcements to be tied to the uplift.

Respondents' own source attributions for earthquake notices do not correspond exactly with our classification of sources. Differences are chiefly of two kinds. The vague statements that we classified as general announcements are mostly attributed, on further questioning, to either scientific or prophetic sources. And many forecasts that we called pseudoscientific—especially Minturn's forecast, the declaration that much of California will break off and fall into the ocean, and the less often mentioned Jupiter effect—were attributed to scientists.

Trends for source attributions are not substantially different from the trends for types of announcement as we classify them. Attributions to seers and psychics and to religious leaders show no consistent trends. Attribution to scientific increased more decisively than announcements that we could identify as having scientific origins. The reference to amateur scientist, applying mostly to Henry Minturn, declines over the entire period according to an exponential pattern. It is interesting to note that while less than half the people who mentioned Minturn in the first survey when his forecast was still very salient correctly identified him as an amateur, larger proportions of those who continued to remember Minturn's forecast correctly identified its author as an amateur.

If we look at the objective classification and subjective source attributions together, we can summarize trends in the following terms. A general decline in remembrance of earthquake predictions, forecasts and cautions is partly but not entirely explained by the unusual attention focussed on Henry Minturn's forecast that was disconfirmed one to two months before our initial survey. If attention that might have been claimed by another Minturn-type announcement shifted rather than disappeared, it contributed immediately to a relative increase in remembrance of vague general warning statements. The relative salience of secular and religious prophetic forecasts, whether identified as such by our coders or by the respondents' own attributions, seems to be a fairly stable component of all notices remembered. Contradicting the general trend, the proportion of all respondents who mentioned the southern California uplift actually increased throughout the period of study. This change contributed to a slight relative increase in the prominence of announcements that were identifiably from scientific sources, and a clearer increase in the extent to which respondents think of science as the source of whatever predictions, forecasts, and cautions they have heard.

Increases in both relative and absolute salience of the uplift during most of the waiting period might indicate that progressively more people became aware of the uplift and of its significance. Alternatively they might indicate merely that the uplift has become salient to a larger proportion of the people who heard of it, without any increase in general awareness. In Figure 1 we report the four levels
of awareness for the five surveys. Respondents are divided into four groups, namely those who have not heard of the uplift, those who have heard of the uplift but do not realize that it may signify a coming earthquake, those who have heard and understood but do not expect damage where they live in case of such an earthquake, and those who have heard and understood and expect damage where they live.

None of the types increases or decreases significantly except at an awareness peak in July, 1978. Increased salience of the uplift did not signify a spreading awareness and appreciation of the uplift in the population at large. Nevertheless, with declining awareness of other than prophetic announcements, the persisting awareness of the uplift is striking and contradicts any hypothesis of generalized loss of interest and declining awareness during an extended period of waiting for a vaguely but scientifically forecasted disaster.

Sources of information

We have found that what people remember changed as well as how much they remember during the second and third years of waiting. In parallel fashion, where they hear about earthquakes has changed along with how much they hear. In the left hand portion of Figure 2 are graphed the answers to our standard question on "your chief source of information," asked about each of the earthquake announcements people remember. Television was named as the chief source of information more often than any other source combined in February 1977. But the steady decline in reliance on television

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**Figure 2:** Chief Sources of Information on Earthquake Predictions, and Cautions.
thereafter is remarkable. The drop from 52.7 percent to 33.6 percent at the end of 1978 is highly significant and approximates a linear trend line quite closely (F = 72.03; 1,3 d.f.; p < .01). In sharp contrast, principal reliance on newspapers almost doubles (18.7 to 36.7 percent) during the same period. This relationship is also highly significant and the increase is loosely described by a linear trend line (F = 29.48; 1,3 d.f.; p < .05). Although television was cited more than two and a half times as often as newspapers at the beginning of the study period, newspapers were cited slightly more often than television by the end of the period.

Although the changes are more erratic and are not statistically significant, the general trend for radio is similar to the trend for television, and the general trend for books and magazines (not graphed separately) is similar to that for newspapers. Hence the observed changes might be described as a shift away from the airways to the printed word as prime sources of information about future earthquakes changes.

One explanation for the shift could be that the credibility of newspapers was increased and the credibility of the airways decreased because of the generally skeptical attitude toward the Minturn prediction taken by newspapers. To be credible, however, this explanation would require an acutely exponential rather than linear change.

Another explanation could be found in elaborating the idea of affinities between particular media and types of content. Perhaps the effect of repeated attention to the same topic leads people to seek more detailed and profound information. Having heard repeatedly that we are overdue for a severe earthquake, people are only attentive to new and elaborated information about the earthquake threat. The printed word can more easily convey such elaborations than television and radio with their brief announcements incorporated in daily news broadcasts.

We also noted earlier that scientific announcements are relatively more often ascribed to newspapers while general announcements are more often ascribed to television. Some of the change in media prominence might have been the consequence of changing types of announcements. Accordingly we have graphed separately, for comparison, the sources given for information about the uplift (Figure 2), when the uplift is mentioned as one of the "predictions, statements, or warnings about earthquakes" people have heard. The downward trend for television, while less linear, is magnified (from 46.6 to 22.2 percent). Starting from a higher level, the use of newspapers increases by the same proportion as before, from 26.0 percent to 51.9 percent.

Comparing the sources for information about the uplift and about all earthquake announcements suggests two observations. First, the shift from television to newspapers cannot be explained primarily by the greater salience of the uplift, since people who remembered the
uplift exhibited the same shift to an even greater degree. Second, a disproportionate amount of the shift is by people who are sufficiently tuned in to the scientific basis for concern about earthquakes to think spontaneously of the uplift when asked about recent earthquake warnings. Thus the increased relative salience of the uplift and the increased reliance on the print media combine to suggest a pattern of awareness and communication which, while less intense than before, is less frivolous and better harnessed to reality.

The Predictability of Earthquakes

As months go by without the anticipated earthquakes and an unpredicted quake strikes a nearby community destructively, flagging faith in current and future earthquake prediction capability would not be a surprising side effect. And if anxiety accumulates, there would be another reason to expect weakening confidence in prediction capability. On the other hand, earthquake prediction was a new idea and the period of waiting could foster progressive familiarization and education, leading to increased confidence in scientific prediction. The same contrasting lines of reasoning could lead us to expect public support for releasing earthquake predictions to be either undermined or reinforced, and suspicion that scientists and officials are censoring the bad news about a coming earthquake to be magnified or lessened.

Faith in the accuracy with which scientists can predict earthquakes

![Figure 3: Belief in Scientific Earthquake Prediction](image)
at the present time exhibits a generally upward trend (Figure 3). Belief that scientists can predict quite accurately increases dramatically and steadily, but not until after August, 1977. Belief that scientists can predict somewhat accurately or better increases substantially between February and August, 1977, from 41.9 to 52.5 percent, with no consistent pattern of change thereafter. The evidence seems to rule out lines of reasoning that posit accumulating doubts as people wait for the long delayed earthquake. Hypotheses of enhanced familiarity and reinforced conviction from repeated media support for the idea of earthquake prediction are more congenial with these data.

So large a percentage of respondents (from 83 to 87 percent) believe that scientist will eventually predict earthquakes at least "somewhat accurately" that there is very little variability during the study period (Figure 3). The apparent rise in the number of "quite accurately" responses should be treated as spurious, since it is fully explained by inclusion of people who think earthquakes can be predicted quite accurately now.

If the cumulative familiarization hypothesis has merit, it applies only to the belief that scientists can predict earthquakes quite accurately at the present time. But this belief is unrealistic. Most earthquake scientists would not even have agreed that earthquakes could be predicted "somewhat" accurately at the time of this investigation. We must assume, therefore, that superficial familiarization rather than deepened understanding characterizes this small segment of our respondents. Hearing repeatedly about scientists' efforts to predict earthquakes, without fully comprehending the message or grasping the qualifications contained in most newspaper accounts, these respondents have simply taken a perfected capability for granted.

We reported earlier that nearly everyone favors the public release of predictions when scientists are highly confident of their accuracy (Turner et al., 1979:61). But there are differences of opinion about the release of less confident predictions. A small but significant increase (from 30.4 to 36.5 percent) in the proportion of respondents who insist that authorities should be "definitely sure the earthquake will occur" before releasing the prediction took place between February and August 1977. The proportion remained fairly stable thereafter. Thus doubts and anxieties that are not intense enough to undermine faith in media-validated scientific prediction may have added a small increment of caution to public thinking about prediction.

The suspicion that scientists and public officials are withholding information from the public did not change significantly over the period of extended waiting. Neither anxieties nor disillusionment were strong enough to augment the prevailing level of suspicion.

Nonscientific forecasting must not be overlooked as part of the relevant public experience. We do not see significant changes in the
beliefs that other people besides scientists can predict earthquakes, that psychics and mystics can predict earthquakes, or that earthquake weather is a valid premonitory sign. But confidence in unusual animal behavior as an earthquake sign increased from 67.5 to 75.7 percent and in premonitions and instinct from 38.5 to 45.2 percent between February and August of 1977. Both remained fairly stable at the higher level for the rest of the period. Increased faith in animal behavior could have resulted from continuing media attention and some scientific attention to its possible use in earthquake prediction. But the parallel enhancement of faith in premonitions seems to call for a different explanation for both.

This interval of time is the same one during which faith in current scientific earthquake prediction capability increased the most. With faith in three contrasting modes of earthquake forecasting increasing simultaneously, we should look for a common explanation rather than viewing the three separately. Since the majority of our respondents are classified as believers, who accept both scientific and nonscientific methods of earthquake forecasting (Turner et al., 1979:147), we should not be surprised to see these three popular modes changing together. Whatever cause may have augmented confidence in the predictability of earthquakes by both science and personal intuition simultaneously was only at work during the first half of 1977. We shall return to this problem with a tentative explanation later.

Earthquake Fear and Concern

We have learned that the awareness of earthquake forecasts and warnings changed both quantitatively and qualitatively over the 22-month study period. But are these changes matched by corresponding changes in concern and expectation? Apart from the memory of any specific earthquake warning, does the earthquake problem weigh heavily on people's minds? Do people fear the prospect of an earthquake? Are the forecasts taken seriously? Do people expect a severe earthquake soon?

Salience

All interviews with new respondents commenced without reference to earthquakes as the topic for investigation. Interviews opened with three leading questions designed to elicit references to earthquakes if they were very much on the respondents' minds. Only after these questions were completed was the respondent told that the balance of the survey would deal with earthquakes. If people mentioned earthquakes once or more in answer to any of the three questions, the topic was said to be salient for them. The level of salience was very low. Only 6.6 percent of respondents in our basic survey mentioned earthquakes without prompting.

Low as it was, the initial figure was higher than in any later
survey. Salience dropped by August 1977, and again by January 1978, to 50 percent of the initial rate. Subsequently in July 1978 and again in November-December 1978, salience rebounded, but less than half way to its original level. The overall relationship, however, is only marginally significant, and none of the trend curves fits within acceptable confidence limits. Salience certainly did not increase during the two years. It is possible--but not demonstrated--that 1977 was a quiet year in which the initial low level of salience dropped even lower, and that attention to earthquake news brought a partial recovery of salience in 1978.

Fear and Concern

Fear of earthquakes could be viewed as a more general attitude than salience, less affected by warnings of moderate-to-low credibility and specificity. Three questions were used, and weighted equally in establishing an index of fear and concern over earthquakes. The index registers a significant drop between February and August 1977, but remains strikingly stable thereafter. The proportion of respondents expressing high and high medium fear is loosely described by an exponential curve (F(1=21.03; 2,2 d.f.; p.<.05).

In order to guage people's own assessment of the effect of recent events on their concern about earthquakes, we asked whether their concern had increased, decreased, or remained the same during the preceding year. The majority of respondents in each survey felt that their concern had neither increased nor decreased. However, the number who said their concern had increased dropped significantly by half between February and August 1977. An apparent slight rebound to January 1978, was not statistically significant. Otherwise the proportion who said their concern had increased did not change appreciably after the drop--during the first half of 1977. The overall relationship is highly significant. But because of the irregularity of the trend, none of the curves fits the data within acceptable confidence limits.

Our respondents' own perceptions of change and stability in their concern over the earthquake danger seem to correspond approximately, though not perfectly, with the observed changes in the concern expressed by successive waves of interview respondents. Thus we can be confident that concern had been raised by events in 1976 but dropped back to a stable level by late summer of 1977.

The three items that make up the fear index cohere satisfactorily in the basic survey according to the usual standards for index construction. However, their literal meanings are not identical and it is conceivable that they might respond differently to changing circumstances. Accordingly we have summarized responses to the three items separately in Figure 4. The three items do indeed exhibit different responses. For all three items the substantial change occurs between February and August 1977. Each of these changes is significant at the .001 level when we consider only the two adjacent
sets of responses. Respondents in August expressed considerably less fright and less worry over the possibility of a damaging earthquake striking southern California. These two changes are consistent with the change we reported based on the three items together. But the third item reveals an substantial change in the opposite direction. This item was worded as follows:

If you were certain that a damaging earthquake was going to occur at a specific time in a place where you live or work would you: try to be where the earthquake would occur, try to get as far away as possible, try to find a safe place near the earthquake, or go on as usual and be wherever you are at the time?

The second response was interpreted as indicative of the greatest fear. The proportion of respondents endorsing this response jumped from 29 to 37 percent, and remained higher than at first at least until after July, 1978.

Apparently the third item incorporates a critical element other than simple fear and concern. Perhaps it is the disposition to accept a severe earthquake as a "normal" event to be dealt with as if nothing out of the ordinary were happening. The observed change would then signify that a growing number of people were no longer viewing a

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**Figure 4:** Expressions of Fear and Concern
severe earthquake in this normalized fashion. While this changed perspective did not cause an increase in fear and concern, it might be reflected in a greater disposition to act in case the treat were made concrete and imminent by a credible short-term earthquake warning.

Announcements taken seriously

If people remembered fewer earthquake announcements as time passed, did they take them as seriously as before? The answer should depend in part on whether they attached higher or lower intensities to the forecasted quakes. The number of people who could remember one or more announcements referring to earthquakes that were supposed to destroy buildings and take lives did decline, especially from February 1977 to January 1978. By August 1977, and for the remainder of the study period, fewer than half could recall any recent announcement that referred clearly to a damaging earthquake. However, this trend is fully explained by the declining number of all announcements remembered, plus an increasing proportion of respondents who are unable to associate intensities with the announcements they have heard. While people became increasingly unclear about the severity of the anticipated earthquake, there was no trend toward remembering more or less severe earthquake forecasts during the period under investigation.

Similarly, the number of people who remembered one or more announcements that they took seriously declined slightly but steadily (Figure 5). But if we pay attention only to respondents who remembered one or more announcements, the proportion who took one or more seriously showed a steady increase from February 1977 to January 1978. The trend is highly significant for the entire study period, and is loosely described by a convex parabolic curve (F=23.89; 2,2 d.f.; p<.05). More dramatically (not graphed), the percent of all announcements remembered that was taken seriously rose from 32 to 50 percent by January 1978, remaining stable to July, then dropped part way back to 42 percent.

Fairly similar curves apply to taking forecasts of destructive earthquakes seriously and to taking scientific earthquake forecasts seriously (Figure 5). The trend toward taking scientific announcements seriously is the more dramatic, reaching a peak in January 1978, and declining less steeply until the end of 1978. There have clearly been changes in what we call the quality of awareness. As fewer announcements are remembered, scientifically based notices become more salient, and more of these are taken seriously. The composite picture would be simple and encouraging, except for the parabolic curves that describe the latter trend. Before attempting to deal with this complexity, we must look for changes in expectation for an early damaging earthquake.

Earthquake expectation

Respondents in each survey were asked how likely they thought it
was that a damaging earthquake would strike southern California within the next year. The data in Figure 6 reveal two different kinds of change. The proportion saying they "don't know" how likely it is that an earthquake will strike increases between February and August 1977, and again between January and July 1978. Uncertainty is more than three times as frequent in late 1978 (19.5 percent) as in early 1977 (5.5 percent). The overall relationship is highly significant and the trend is loosely described by an ascending linear trend line (F=29.48; 1,3 d.f.; p.<.05). Increasing uncertainty seems an appropriate response during a period of repeated reminders of an undated impending disaster.

The other change is a significant increase in negative replies matched by a decrease in positive answers between February and August 1977. After this early drop in earthquake expectation there are only nonsignificant oscillations thereafter.

Fear of earthquakes, perceived recent change in concern, and expectation for a damaging earthquake within a year all exhibit the same clear drop between February and August 1977, followed by relative stability for the remainder of the study period. This

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**Figure 5:** Announcements Taken Seriously
consistency among the three variables makes the changes more obviously interpretable. A substantial segment of the populace are no longer convinced that disaster is imminent in spite of an earlier conviction to that effect brought on by events in 1976. With disaster less imminent they are now less fearful than before.

One year is an unrealistic period within which to expect a damaging earthquake in southern California in the absence of more definite credible predictions than had been issued. But we specified one year in the question in order to assess to the sense of imminence about the earthquake threat. In the last two survey waves we added an identically worded question referring to a five year period. There is no apparent change between August and November-December 1978, and we do not know how the questions would have been answered earlier (Figure 6). The graph serves chiefly to emphasize that most southern California residents expect a damaging quake within a few years, if not within a single year.

If fear and the sense of imminence, but not the conviction that southern California is due for a destructive earthquake, declined substantially during the first half of 1977, and then stabilized, this must have been a period of relaxing tension. If we assume that sustained anxiety undermines confidence and inhibits realistic assessments of the dangerous situation, relaxing tension could explain some of our other findings. Growing confidence in the predictability of earthquakes by science and by folk signs could have resulted from lessened anxiety and urgency. Abandonment of the normalization

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**Figure 6:** Probability of a Damaging Earthquake
approach to impending danger by admitting the urge to get as far away as possible from an earthquake could illustrate the ability to face reality as the threat became less imminent. All of these developments were most marked during the first half of 1977 immediately after the crisis year of 1976 had passed. With anxiety and urgency diminished, people might then be ready to attend to earthquake notices in a more discriminating fashion, accounting for the rise in the "taking seriously" curve during the next interval of time. Once the lagged effect had worn off, a false-alarm effect concerning new notices might emerge, accounting for the parabolic shape of the relevant curves. These are, of course, post hoc speculations made in an effort to discern a plausible comprehensive pattern in the data, and not demonstrated conclusions from the research.

Action and Action Orientations

We have seen a lessening of media attention and informal discussion and a corresponding reduction in awareness and sense of urgency about the earthquake threat. In spite of these changes, we have also seen what may be a less frivolous and more discriminating and realistic pattern of awareness. But are these tendencies translated into action, and into those attitudes most closely linked to action? Support for enforcing building codes and improving the prompt communication of earthquake predictions remained unchanged at a high level. But enthusiasm for state of California government expenditure for loans to reinforce unsafe structures and for prediction studies waned somewhat. Because of this differentiated response, whatever effect the Proposition 13 (property tax reduction initiative) debates and the extended waiting may have had must have been filtered through special circumstances, such as the well publicized and seemingly futile effort to overcome political opposition to dealing with old buildings.

There appears to be a continuous but very slight increase in fatalistic attitudes, loosely described by a convex exponential curve. But the overall change is not statistically significant. So we must limit our conclusion to saying that the increased faith in the predictability of earthquakes is not matched by an increased confidence that the disastrous effects of earthquakes can be controlled.

Individual and collective solutions

Research into natural disasters has convincingly documented the importance of a spontaneous, community-wide surge of altruism in facilitating emergency response in natural disaster situations (Barton, 1970; Miletci, Drabek and Haas, 1975). A comparable response might be essential for the community to mobilize effectively to deal with a serious earthquake warning. We asked whether the 1976 warnings had been met with a response pattern conducive to altruism. The
appropriate response pattern would be one in which people recognized that some groups were at greater risk than others, could identify some of these groups, thought something could be done to ameliorate their risk, and accepted some collective responsibility for doing so. The relevant set of questions was asked only on the first and last surveys, so we can observe the 22-month change but not the intervening trends.

The social awareness we are measuring could be simply an aspect of general awareness, or it might be an emotional matter. In the former case, it might have declined during extended waiting. In the latter case, the anxiety aroused in 1976 could have inhibited altruism, leading to increasing social awareness as the sense of imminence abated.

Recognition that some groups are in greater danger increased significantly from 62.9 to 69.7 percent. But this finding is counterbalanced by the observation that fewer groups were mentioned as being especially at risk. Most groups were mentioned less often, but residents in old buildings with a 24 percent drop and the elderly and disabled, both with 10 percent drops, headed the list. People living near a fault and in high density areas were mentioned significantly more often. The one dramatic increase was that 17 percent more of all the socially aware mentioned poor people as being disproportionately at risk. Changes were roughly paralleled by changes in proportions of people who included themselves in the various high risk categories.

The increase in abstract awareness that the danger is not the same for everyone without accompanying concern for specific groups is not encouraging as a sign of growing altruism. And increased concern for the poor at the expense of the elderly and disabled suggests that issues of national politics may be displacing a specifically earthquake-focused compassion. With lessened urgency and less communication about the earthquake threat, sensitivity to the plight of those who most need to be the beneficiaries of altruistic concern in preparing for an earthquake has also declined.

The optimistic view expressed by most respondents in early 1977 that something could be done to mitigate the risk was not dampened by the end of 1978, and even increased for some groups. And fewer people were disposed to place the full responsibility for ameliorating their conditions on the potential victims. These two shifts should be favorable for an altruistic response.

Thus our conclusions must be mixed, though it may parallel the findings for some other variables. The plight of those least able to prepare for and deal with an earthquake became less salient as the period of waiting for the disaster that many had thought was imminent was extended indefinitely. As stagflation in the American economy intruded dramatically into public awareness, economic distress may have displaced attention from earthquake vulnerability, and may have contaminated the sentiment of compassion for the
vulnerable. At the same time a modest qualitative change was taking place within the reduced compass of social awareness. By noticeable increases in the sense that something could be done for the vulnerable and that the responsibility to do so ought to be shared, our socially aware respondents have taken a small step in the direction of altruism.

Personal and household preparedness

An index based on sixteen preparedness measures frequently recommended to the public (Turner et al., 1979:97-103) was computed for all surveys (Figure 7). A slight increase in preparedness scores from the beginning to the close of the study period may be significant (p<.05 when only the first and last surveys are compared). But the striking changes are between February and August 1977, and between August 1977 and January 1978. The proportion of respondents with high and high-medium scores increased by sixteen percentage points during the first interval. During the remainder of the first year, scores declined significantly but not all the way to the original level. Subsequent fluctuation is not statistically significant.

The pattern suggests that some short-lived stimulus triggered a spurt of preparedness, with the inevitable decline as the effect wore off. We have already ruled out fear as the trigger, since the spurt coincided with declining fear and sense of imminence. Increased preparedness could be a manifestation of increasing realism, but so
rapid a decline is difficult to explain. Later we shall explore further what the trigger might have been.

To measure the effect of earthquake concern on preparedness more sensitively, we report a companion index including only measures people said they took because of the earthquake prospect. When the two indexes change in parallel fashion, we can safely infer that changing concern about earthquakes accounts for changes in preparedness. But when changes in the second index are not accompanied by changes in the first, we must assume that people are simply attributing actions they took for other reasons to the earthquake threat.

Index scores do change according to a similar main pattern, but with a different outcome. The spurt of preparation between February and August 1977, is replicated significantly in the second index. The subsequent deterioration of preparedness to January 1978, is also repeated, but with preparedness dropping more nearly back to the starting level. Thereafter, however, preparedness rebounds with an even stronger spurt between January and July 1978, and remains at the new high level. Accordingly, the dramatic preparedness spurt and subsequent deterioration during 1977 do seem to be true changes in the state of preparedness caused by changing attention to the earthquake prospect as an extraordinary event. But the subsequent rise and persistence in preparedness levels attributed to concern over a future earthquake are not fully paralleled by changes in actual preparedness levels. Hence during the second half of the study period we see an augmented tendency to explain preparedness actions on the basis of the earthquake threat, rather than a true increase in levels of preparedness.

Like many of our findings, these may be interpreted as encouraging or discouraging. The early peak of preparedness (which was not high in absolute terms) was not sustained, though the overall trend was slightly upward. The discrepancy between the trends of actual preparedness in the second year and preparedness attributed to the earthquake prospect suggests that people are fooling themselves about their levels of preparedness, or responding to a felt social pressure to be earthquake-prepared by redefining their own motivations rather than by actually taking protective actions. While these interpretations seem fairly compelling, their acceptance does not preclude a more optimistic assessment of public readiness to act in case of a true emergency, such as a credible warning of imminent earthquake danger. The earlier spurt of preparedness should have familiarized people with some of the steps they might take, making it easier for them to retake them in a more credible emergency. And the greater tendency to attribute measures actually taken to the earthquake concern may enhance the availability of that motivation as a basis for stimulating further action. Calls to prepare for a damaging earthquake could then be more effective in the event of a credible future emergency.
Extent and Nature of Stability and Change

Stability

In general, stability is more characteristic of the responses we have measured than change. Several crucial types of response have remained without significant change throughout the nearly two years covered by our surveys. For responses that have changed, the change has often not been dramatic. When the evidence of change is unambiguous, the change most often occurred between early and mid-1977, with chiefly random fluctuations thereafter. (On the other hand, some of the responses that exhibited greatest stability for twenty-two months suddenly changed in the unsettling aftermath of the moderate and unpredicted earthquake of New Year's Day, 1979.)

The relative credibility given scientific and nonscientific forecasts and warnings and, after adjustment for the one-time Minturn forecast, the relative awareness of scientific and nonscientific forecasts and near predictions were fairly constant throughout the study period. The level of fatalism about earthquake damage was quite stable. High levels of confidence in the eventual achievement of accurate scientific earthquake prediction and endorsement of government spending to mitigate earthquake hazard changed little during the study period, though both declined under the unsettling impact of the New Year's Day earthquake. The suspicion that scientists and public officials were withholding information concerning predictions from the public likewise remained at a steady level over the twenty-two months, but shifted surprisingly toward lessened suspicion after the New Year's Day tremor. Although our information is less complete for these variables, desire for news about earthquake topics remained at a high level and the tendency to interpret smaller earthquakes and other events as clues to the imminence of the anticipated destructive earthquake was recurrent. Salience of earthquake concern was always low, and after an initial drop, general fear and concern over future earthquakes was relatively unchanged, even after the New Year's Day quake.

There are several plausible reasons for such relative stability of response. First, some of the variables such earthquake fatalism, scientific versus nonscientific orientation, support for government spending, and the suspicion that important information was being withheld from the public may be surface expressions of underlying attitudes of greater generality. This highly plausible interpretation is weakened, however, by the observation that such stable responses as

4. A nondestructive earthquake of magnitude 5.0 struck on January 1, 1979. We launched another survey in its aftermath which is not reported in this paper. We shall refer occasionally to the findings from that survey in order to enrich the interpretation of the trends already described.
support for government spending, confidence in the eventual achievement of accurate scientific earthquake prediction, and suspicion that information is being withheld changed significantly after the New Year's Day quake. Either the events during the twenty two months were too mild by comparison with the New Year's tremor to have an effect on these responses, or they were the wrong kinds of stimuli. But in any case, it is difficult to believe that attitudes changed by so mild a stimulus as the New Year's quake are primarily expressions of relatively impervious fundamental attitudes.5

A second reason for the observed stability might be that significant changes took place during the interval before our first survey, and our monitoring of individual response began after most responses were already restabilized. This interpretation gains in plausibility from the observation that most of the observed changes took place between our first and second surveys. These changes may have been just the final stages of a much more dramatic and comprehensive set of changes during the initial year of the uplift. The fact that some apparently stable responses were significantly modified by the objectively rather inconsequential earthquake of New Year's Day 1979, lends further plausibility to the speculation that a great deal of change might have taken place before our first survey.

On the other hand, examination of the absolute levels for many of the variables impels us to think twice about placing too much weight on this kind of speculation. Support for government spending, faith in the ultimate achievement of scientific earthquake prediction, the desire to hear more about earthquakes, and belief in anomalous animal behavior as an earthquake sign could hardly have been higher. Perhaps salience of earthquake concern could have been higher. Variables that changed during the first interval such as imminent expectation of an earthquake and expressed fear of earthquakes were at fairly high levels at the time of the first survey. How plausible it is that even more than 43 percent at one time expected a damaging earthquake within a year, or that even more people admitted being frightened at the prospect of an earthquake?

Most likely awareness and response developed gradually during the months after announcement of the uplift, but little turnabout in general awareness and response had occurred by the time of our first survey.

If we accept the evidence of stability at face value, two further explanations can be offered. The fact that most people took a moderate, qualified, or tentative stance on most questions may have reduced dissonance when the anticipated earthquake failed to materialize. The Chinese have repeatedly insisted that false alarms did not undermine public cooperation in their earthquake prediction program.

5. Unfortunately, time limitations made it impracticable for us to include earthquake fatalism in the New Years Day tremor study.
because the people were taught to understand prediction as a science that was still being perfected (Haicheng Earthquake Study Delegation, 1977:236-272).

Nevertheless the level of faith in current earthquake prediction capability in our sample is unrealistically high. Hence the realistic appreciation of the tentative nature of earthquake prediction may not be sufficiently widespread to insulate public attitudes from the effects of events like the unpredicted Santa Barbara and Los Angeles New Year's Day earthquakes.

Finally, stability of response may come from the normal anticipation of earthquakes in southern California. If announcement of the uplift, Whitcomb's near prediction, and Minturn's forecast merely added a sense of imminence to the standing anticipation of an earthquake, only moderate attitude changes should follow disconfirmation. Since the scientific announcements have been vague and qualified and the Minturn forecast was enveloped in controversy, this may be the most generally applicable explanation for response stability.

Change

In spite of the relative stability of response, several significant changes did occur during the study period. People remembered fewer announcements and engaged in less discussion and the sense of imminence declined. The admission of uncertainty about the likelihood of an early earthquake grew steadily. More people doubted the wisdom of releasing uncertain predictions and many reconsidered the attitude of treating a severe earthquake as a normal event. The unrealistic assessment of present earthquake prediction capability became more general, and people looked more strongly to government to deal with the problems of especially endangered groups. The earthquake threat may have been assimilated to political issues of more widespread concern such as the plight of the poor. And the New Year's Day earthquake induced a distinctive pattern of changes that were in some instances the extrapolation of earlier changes and in other instances a reversal.

Waiting as the Cause of Change

We can describe the near prediction conveyed by announcements of the uplift as having zero lead time and an open-ended time window. We hypothesized that people would attempt to give closure to the window, and would often translate time window into lead time. The high percentage initially expecting a damaging earthquake within a year suggests that the closure tendency was at work, and the subsequent reduction suggests a reopening of the time window in the popular view.
Six alternative but not mutually exclusive hypotheses concerning the effect of waiting for disaster were outlined. First, there should be an initial sense of urgency, perhaps translated into action, followed by a period of lessened urgency as people live through the ever-extending time window. If there is a strong sense of closure, the sense of urgency should be restored as the assumed end of the time window approaches. If the former pattern applies, such variables as imminent expectation of an earthquake and recently intensified concern should decline, either linearly or following a declining exponential curve and approaching a horizontal asymptote. If the latter applies, the trend might be described by a concave parabola. Although five moments are too few for fitting a curve confidently, the exponential curve provides the nearest fit to the largest number of variables, and the parabola fits the fewest. In one instance, individual and household preparedness, the spurt of preparedness comes at the second rather than the first moment, which seemed best explained as a response to a disaster survival test program on national television. But the subsequent decline fits the model of lessened urgency, though we cannot specify a curve to fit the foreshortened data.

The second hypotheses is that waiting translates the earthquake warning into a slowly developing false alarm, inclining people toward skepticism and disillusionment about scientific prediction. Since the changes are actually in the opposite direction, we must reject the false alarm or "cry wolf" hypothesis.

The third hypothesis is that waiting is a period of accumulating anxiety, leading to defensive denial of danger and other pathological responses. Our data provide no evidence to support this hypothesis.

The fourth hypothesis is that accumulating personal tension is translated into active and aggressive responses, expressed as suspicion, resentment, and scapegoating. Again, there is no increased suspicion that information is being withheld, there is continued support for government spending, and more people have confidence in government preparedness than in their own or the general public's preparedness. We do not find evidence to support this hypothesis.

The fifth hypothesis assumes that the period of waiting is not one of passivity, but one of repeated reminder, clarification, informal discussion and information seeking. As a result the period of waiting increases familiarity with the threatening situation and its many aspects and increases sensitization to the cues that may be relevant at the time of crisis. The most striking evidence bearing on this hypothesis is the increased confidence in current earthquake prediction capability, with the trend beginning and ending at levels that are unrealistic in relation to actual scientific capability. There is no cumulative growth in awareness of predictive announcements or of the uplift, but there is some change in the quality of announcements remembered, with more focus on the uplift and scientific announcements. Thus, there is suggestive support for this hypothesis.
The final hypothesis assumes an even stronger positive effect, with waiting and periodic reminders leading to rehearsals and the selection of more effective responses through trial and error. Many people assumed that the crisis event will be preceded by a short-term warning. A relaxed sense of urgency may save people from destructive anxiety, and if coupled with learning for more effective response during the waiting interval, may mean a population that could be transformed from apparent apathy rather quickly. We have no real test for this hypothesis, though we observe that survival lessons as standing under an inside door frame during an earthquake and not immediately rushing outdoors have been widely learned. And without expressing greater fear, fewer people say they would go on with life as usual if they knew that an earthquake was imminent.

While there has been a declining sense of urgency, there has been no general disillusionment or scapegoating during the waiting period. There has, on the other hand, been increased acceptance of scientific earthquake prediction, and some indication that the prospect of a damaging quake is being faced more realistically, as the normalcy bias is eroded.

The analytic separation between the effects of waiting and the effects of passing is artificial. It is undoubtedly important that the period of waiting has been punctuated by a series of unfolding developments, and that the media have managed to keep a three-year-old announcement newsworthy. The validity of each of our six hypotheses probably depends in large part upon the nature of the events and the media treatment. The unsettling effect of the New Year's Day earthquake underlines the contingent effects of events on the longer term waiting effects. No doubt a more combative press and television could have stirred up some of the effects described in hypotheses two, three and four. On the other hand, active political leadership to develop a comprehensive community-based program for earthquake preparedness and prediction awareness could undoubtedly have strengthened the effects anticipated under hypotheses five and six.

Concluding Observations

After three years of waiting for an earthquake that many thought would come within a few months, the people of Los Angeles County showed few of the perversive effects that are often given as reasons for withholding soundly based but uncertain earthquake forecasts. Neither the disillusionment associated with "crying wolf," the defensive denial associated with accumulating anxiety, nor scapegoating of scientists and public officials occurred on a widespread basis. The sense of imminence and urgency did decline, but coupled with evidence of increased appreciation and selectiveness of attention to earthquake news this change must be interpreted positively as
increasing realism. In light of the small gains and the absence of negative effects, I conclude that such periods of waiting can and should be deliberately used by responsible officials to foster understanding and to perfect responses that will help to mitigate the worst possible effects of an earthquake or an imminent earthquake prediction.

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