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INITIAL BEHAVIORAL RESPONSE TO A RAPID ONSET DISASTER: A CASE STUDY OF THE OCTOBER 1, 1987 WHITTIER NARROWS EARTHQUAKE*

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This paper examines the immediate response behavior of Los Angeles County residents to the October 1, 1987 Whittier Narrows earthquake. Drawing on both social science disaster research literature and occupant behavior studies, the authors consider various situational, demographic and socioeconomic variables as potential correlates of actions taken by individuals and families in response to the earthquake which measured 5.9 in magnitude. Survey data were obtained from 690 residents of the county, 191 in a pre-designated high impact area which included the City of Whittier and the immediate area and 499 persons selected at random from the remainder of the county. It was discovered that taking cover in a doorway, hall or under furniture was the modal response for people who were at home or work as was pulling to the side of the road and stopping for those driving on a road or highway. Among those who were at home at 7:42 a.m. when the earthquake struck, fear, the presence and

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identity of other people and gender were found to be associated with response actions. At work, response behavior was related to fear, ethnicity and the presence of others. The impact of fear on the propensity to take cover both at work and at home appeared to be amplified by several variables some of which had no significant bivariate relationship with taking cover. The authors conclude that the findings of this study are consistent with the generalization from the literature that behavior in a rapid onset disaster is controlled, rational and adaptive.

At 7:42 a.m. on October 1, 1987, the Los Angeles metropolitan region experienced its third worst earthquake this century. Only the Long Beach earthquake of 1933 and the Sylmar event of 1971 surpassed this most recent disaster in magnitude, casualties and damage. The "Whittier Narrows" earthquake, as it became known, was centered in an area of low hills approximately 15 km northeast of downtown Los Angeles. The mainshock, which measured 5.9 in magnitude, ruptured along a previously unrecognized thrust fault and was followed by several significant aftershocks, including a magnitude 5.3 on October 4th which caused additional damage (Jones and Hauksson 1988). The earthquake and its main aftershock caused eight deaths, over two hundred injuries and $358 million dollars in property damage.

The Whittier Narrows earthquake was experienced as a series of sharp jolts of several seconds duration and was felt as far away as Bakersfield, Palm Springs and San Diego. Strong ground motion records and intensity estimates indicate that the City of Whittier, located approximately 10 km from the earthquake's epicenter, had the heaviest shaking. The earthquake was widely felt by Los Angeles County residents although it was not immediately identified as an earthquake by many. While most people who were at home, work or at school recognized that an earthquake was occurring, those who were driving or on buses frequently mistook the earthquake's motion for mechanical problems.

Occurring without warning or any detectable precursory phenomena, the October 1st earthquake set into motion response actions at every level of the community from the individual citizen, to the largest organization and at every level of government. We will examine how residents of southern California communities responded to the October 1st earthquake. This objective is basic and event-centered; it involves an assessment of what people did during the shaking and within the first few minutes after the earthquake. Given the highly situational nature of response actions, where people were when the earthquake struck will be as important as what they did. We will also examine a variety of demographic and socioeconomic factors which may have an impact on response behavior.

Response Behavior: The Research Literature

Disaster response behavior has received considerable attention from social scientists dating back to the early part of this century (Prince 1920). A great majority of these studies have focused on the immediate post-impact period of rapid onset disasters, generally a time frame ranging from a few hours to a few days after impact. In the various summaries of this rather extensive literature (see especially Drabek 1986; Nilson et al. 1981), there emerges a central theme, that individual and collective behavior is controlled, rational and adaptive in contrast to popular stereotypes which suggest breakdown and personal disorganization. Upon close examination of this research literature, one discovers that remarkably few reports contain findings on human response **during** the actual disaster, particularly the few seconds of strong ground shaking which characterize a locally damaging earthquake. It is to this literature that we will first turn our attention.

A consistent finding in investigations of earthquakes as well as other natural disasters is that individuals and families respond actively rather than passively. Several studies of response behavior during earthquakes in Japan suggest that going outside and turning off fuel outlets are common responses (Takuma 1972, 1978; Ohta and Ohashi 1985; Archea and Kobayashi 1984). Attempting to brace large household furnishings was a prevalent behavior as noted in the Archea and Kobayashi study. Takuma and Ohta and Ohashi showed that self and family protective behaviors were more common when dependent children were present and that roles of responsibility for others continued to be performed in spite of high levels of fear. In addition, previous experience with earthquakes and the intensity of ground motion were positively related to taking protective measures, both for self and others.

Some of the most focused studies of immediate response behavior have been conducted by engineers and architects rather than social scientists. These investigators have examined human behavior in the context of structural and nonstructural building components with the objective of improving occupant safety. Most of these studies are based on small non-random samples making generalization precarious. Nevertheless, the investigations offer insights and suggest hypotheses which can be examined in a more systematic and methodologically sound manner.

Alexander's (1990) study of response behavior to the 1980 Circum-Vesuvian area earthquake (magnitude 6.8) found flight to be the most prevalent response among members of a small convenience sample. This investigator argues that panic flight was widespread during impact and that the tendency to flee was not mitigated by the constraining influence of

primary groups or extensive local experience with volcanic and seismic events. A major conclusion of the study was that in some cultural contexts, earthquake-induced panic may occur, and indeed, be quite widespread (Alexander 1990).

Studies conducted after the Loma Prieta earthquake of October 17, 1989 (magnitude 7.1) and the October 15, 1979 event in Imperial County California (magnitude 6.6) present data on response behavior in dwellings and an office building respectively. Using a study design previously employed to examine earthquake response in Japan, Archea (1990) found that during the recent Loma Prieta earthquake people took refuge in the doorway of the room they were already in, "rode it out," helped other persons or went outside. After the earthquake, 51% were judged to be in a point of refuge and 42% were still totally vulnerable. The investigator concluded that those considered vulnerable had exposed themselves to considerable danger in moving from one location to another.

In an assessment of occupant behavior among county office workers during the 1979 Imperial Valley earthquake, Arnold and colleagues (1982) found that remaining in place or getting under a desk were most frequently reported, followed by standing in a doorway, avoiding falling objects and getting to the main corridor or out of the building. In explaining the reason for the actions taken, 45% of the county employees stated that they had acted in conformity with previous instructions and drills. An additional 25% based their action on experience with other earthquakes which have been frequent in the Imperial Valley area.

Based on studies of immediate impact response to rapid onset disasters other than earthquakes, we also know that people tend to assume familiar roles. Research on fires suggests that behavior in accordance with traditional male/female roles is common: females tend to warn others and seek direction and assistance from others, males are more likely to fight the fire (Paulsen 1981). A generalization based on the study of many disasters is that disaster victims and non-victims attempt to structure and define the disaster situation, to "integrate the novelty of the disaster into conceptual schemes used in everyday life" (Anderson 1968).

The question of how people respond to the sudden disruption and potentially dangerous motion of a large earthquake is of considerable importance both to social scientists and seismic safety planners. For social scientists, behavior during impact is not well documented and systematic studies are needed to fill this gap in knowledge. The review of this section has raised many questions about response: are there cross-cultural variations in response? How does response vary based on where people are

located at onset? What sociodemographic factors influence behavioral response? Seismic safety planners are equally interested in response at onset and seek answers to their own questions: have people followed the advice of disaster response agencies to seek cover during the shaking, to avoid running outside and other behaviors which would enhance the dangers posed by the earthquakes shaking? We shall attempt to address these questions in this paper.

Methods

Between October, 1988 and May of 1989, 30 minute telephone interviews were conducted by the Institute for Social Science Research at the University of California, Los Angeles with 690 residents of Los Angeles County. Interviews were conducted in both English and Spanish with 191 persons in a pre-designated high impact area and 499 persons proportionally distributed throughout the remainder of Los Angeles County. Random digit dialing procedures were employed to obtain a representative sample, and Kish (1965) tables were used to select a resident over 18 who had lived in the household on October 1, 1987. Telephone numbers were not pre-screened.

Intentional oversampling was conducted in communities which experienced the strongest shaking from the October 1 earthquake. This "high impact zone" was defined in terms of incorporated communities where the Modified Mercalli shaking intensities (MMI) were equal to or greater than 7. This zone included the cities of Monterey Park, Rosemead, El Monte and South El Monte where the MMI was 7, and Whittier, with an MMI rating of 8. Within the high impact area, interviews were conducted with 191 of the 254 eligible households identified. In the remainder of the county, interviews were conducted with 499 of the 1,190 numbers assumed to be eligible for the survey. Assuming alternately that all or none of the uncontacted numbers contained eligible respondents, we obtained a response rate of 75% to 80% within the high impact area and 42% to 57% in the remainder of the county.

The sample is quite diverse demographically though there were few differences between the high and low impact zones. Consistent with other Los Angeles County samples, the mean age is 44 years and 54% of the sample is female. The average number of years of schooling completed is 13, although more people have completed college in the low-impact area. Household income is comparable in the two areas with 38% of households having incomes over $40,000 and 28% having incomes of less than $20,000 in 1987. A significantly greater number of respondents own their own

homes in the high impact area. Ethnically, the two sample strata are somewhat different : the high impact area is twice as likely to be of Mexican origin and the remainder of the county more likely to identify themselves as Black or White. These distributions are consistent with those reported elsewhere with the exception of Asian residents who may be under-represented in the high impact area.

The analysis will be descriptive and exploratory, using the Statistical Package for the Social Sciences (personal computer application V.3.1) to produce simple two and three-way crosstabulations. We have chosen to use the nonparametric measure Chi-Square for testing hypotheses about earthquake response behavior and the Chi-Square based Phi coefficient as a measure of association between variables. We will observe the customary threshold of .05 in reporting significance levels (Yates correction for continuity will not be applied) although non-significant results will be reported if there are trends in the data which seem worthy of further investigation. The sample will include only those respondents who felt the earthquake, were at home, work or travelling on a road or freeway when the earthquake struck and reported some physical response (as distinct from cognitive or verbal) at the onset of the shaking (N = 520). The analyses reflect appropriate sample weighting to account for oversampling in the high impact area; respondents living in the high impact area were assigned a weight of .44 and those in the low impact area a weight of 1.00.

The questionnaire used for data collection was adapted from one developed by Turner, Nigg and Heller-Paz (1986) for use in the event that a damaging earthquake occurred during the period of their study of community response to the earthquake threat in southern California (1977-1979). Our survey questionnaire presented the question of individual response as an open-ended item: "when you felt the earthquake, what was the very **first** thing you did?" For those who reported multiple response actions, we attempted to identify the one most salient (i.e. what seemed to be the principal objective of a sequence of actions) and relevant to the research literature.

Because response differed significantly based on location, that is, on whether respondents were at home, at work or driving, we chose to analyze behavior in these contexts separately. The major dependent variables, taking cover, going outside, and remaining in place were each dichotomized (into their respective behavioral responses vs. all other behavioral response options). There were several other responses which are treated briefly and more qualitatively due to being mentioned less frequently or to being of less interest from a planning and social science perspective.

Results

Response by Location

Different physical settings present different response options (See Table 1). Although most of our survey respondents reported being at home at the time of the earthquake, there were significant numbers who were either at work or on the road (N = 166, 24.1 % of the overall survey sample). In our sample as a whole, 94% of our respondents were at home, at work or traveling on a road or freeway when the earthquake struck. Based on our examination of the open-ended survey items on response and statistical analysis of our coded response items, we chose to analyze behavior at onset in the context of where one was located when the shaking commenced. Eliminated from the overall sample of 690 were 67 respondents who did not feel the earthquake, 37 who were not at home, at work or on the road and 66 who did not identify a physical response to the earthquake.

Table 1. Response During the Whittier Narrows Earthquake

Behavioral Responses	At Home (%) (N = 373)	At Work (%) (N = 114)	On Road (%) (N = 33)
Took Cover	42.6	39.5	—
Remained in Place	19.3	20.2	—
To Outside	9.1	17.5	—
Out of Bed/Dressed	8.6	—	—
To Other People	8.3	—	—
Away from Hazards	3.5	6.7	—
To Phone	—	3.5	—
Caught Objects	1.9	—	—
Pulled to Curb/Stopped	—	—	46.0
Continued Driving	—	—	43.0
Passenger	—	—	11.0
Other*	6.7	13.2	—
	100.0	100.0	100.0

*The "other" category includes 15 persons who were at home and 11 persons who were at work during the earthquake who reported a physical response but no objective. Respondents who moved without objective are not separately analyzed in this paper.

The home or work environment presented the following set of response possibilities: whether to remain inside or leave the house or building, to stay put or seek cover, to avoid falling objects or attempt to brace or catch them and so on. In some cases, the home and work environment offered similar response options, in others these options differed markedly, particularly for those whose work sites included volatile materials, heavy equipment or other potential hazards. At work, one was likely to be in the presence of co-workers, at home there might be other adults but also dependent children whose well-being created additional response options.

Results will be examined in three major sections according to where the respondent was located. Within each section, we will separately examine the immediate actions taken by persons in response to the earthquake at home, at work, and on the road. These immediate actions will be examined for relationships with the intensity of the shaking as measured by location of the respondent's home (impact zone), the level of fear reported, the presence of others, past experience with earthquakes, occupational status and relevant sociodemographic factors.

In the analytical sections which follow, we will report findings involving levels of expressed fear and response to the earthquake which challenge the conventional wisdom and, to some extent, the disaster research literature. Thus, it may be instructive to first identify how fear was measured, and second, provide a brief social, demographic and situational profile of the more and less fearful. Our survey instrument contained a single item on fear: "thinking back to your feelings and experiences during and immediately after the October 1, 1987 earthquake, which of the following best describes your overall feelings? Would you say you were: very, somewhat, not very, not at all frightened and upset or did you enjoy the experience?"

Demographically, the highest levels of fear were expressed by women, Hispanics, those with lower incomes and levels of education, those who reported fewer years of residence in California and their local communities and respondents who had experienced fewer earthquakes. Higher levels of fear were also associated with the presence of children when the earthquake struck, residence in the high impact area and lower perceived levels of earthquake preparedness. The less fearful occupied the opposite extremes of these variables and, ethnically, were White or Asian.

Response at Home

Two thirds of our overall sample (N = 420) reported being at home at 7:42 a.m. on Thursday, October 1, 1987. A majority (61.1%) reported being with others, approximately half (47.3%) of these others were children under

age 18. Nearly all of those who were at home indicated that they were indoors when the earthquake struck. Table 1 summarizes the response of people who were at home at the time of the earthquake. Physical movement from one part of the dwelling to another made up 81% of all responses at home.

Taking Cover at Home. Taking cover in a doorway, hall or under furniture was the most frequently reported response among those who were at home. When we consider only those who reported physical movement (N = 301) from one location in the household to another (i.e. eliminate those who remained in place throughout the shaking), taking cover was the objective of 52.8% of our sample.

Fear appears to have been an important factor in the decision to take cover during the earthquake shaking. Those who admitted to being "very frightened and upset" by the earthquake were more inclined to seek self-protective refuge in a doorway, hall or under sturdy furniture (56.7%), than those who reported lesser levels of fear (35.0%) ($p < .001$, Phi = .201). Finding that fear and location in the high impact zone were weakly associated ($p < .05$, Phi = .089), we suspected that there was some interaction between fear and impact zone on the propensity to take cover. Controlling for residence in the impact zone, we found that the relationship between fear and taking cover held only for those outside the high impact area where those who were very frightened were inclined to take cover ($p < .001$, Phi = .202). While only 33.8% of those outside the high impact area who expressed less fear took cover, 55.8% of those who were quite fearful did so.

Women were somewhat more active in taking cover than men ($p < .05$, Phi = .118). Although women tended to express more fear than men ($p < .0001$, Phi = .212), men who acknowledged being very frightened were twice as likely to have taken cover (57.2%) than men who were less frightened (28.3%) ($p < .01$, Phi = .241). Women who expressed high levels of fear were somewhat more likely to seek protective cover (56.5%) than those who were less frightened (40.0%). The relationship between fear and this response was statistically significant for both men ($p < .01$, Phi = .241) and women ($p < .05$, Phi = .159).

The presence of others in the household when the earthquake struck appeared to be an important factor in the propensity to take cover. More important than the presence of others, however, was the identity of those present. Interestingly, the presence of other adults in the household was associated with a significantly diminished probability that one would seek cover; whereas 56.6% of those not in the presence of adults took cover, only

34.4% of those with adults sought protective refuge ($p < .005$, Phi = .213). The presence of dependent children, however, was positively related to taking cover. Only 33.3% of those not in the presence of children took cover, and 50.3% of those with children did so ($p < .05$, Phi = .172).

We found that the relationship between fear and taking cover was strongest when other adults were not present ($p < .005$, Phi = .374). While over three-fourths of those who reported higher levels of fear took cover, only 40.5% of those who reported lower levels of fear took cover. When adults were present, the relationship between fear and taking cover was weaker ($p < .05$, Phi = .204) with 50.3% of those recalling higher levels of fear taking cover and 28.5% of those recalling lower levels of fear taking cover. We also noted that those who were very fearful and reported having children at home during the earthquake were twice as likely to take cover (73.9%) as those who were less frightened and had children at home (36.0%) ($p < .001$, Phi = .367). Fear was not significantly related to taking cover, however, when no children were present (See Table 2).

Table 2*. Taking Cover at Home by Fear Controlling for the Presence of Dependent Children

Children Present	**Level of Fear (%)**	
Took Cover	High	Low
Yes	73.9	36.0
No	26.1	64.0
Total	37	61

Chi Square = 13.228, $p < .001$, Phi = .367

No Children Present	**Level of Fear (%)**	
Took Cover	High	Low
Yes	46.8	28.4
No	53.2	71.6
Total	26	70

Chi Square = N.S.

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

The impact of fear on the propensity to take cover at home appeared to be amplified by several variables, none of which had a direct statistical association with taking cover. The better educated (13 or more years of school) who were very frightened (65.6%) were significantly more active in seeking protective cover during the shaking than their academic peers

who were less frightened (35.8%) ($p < .005$, Phi = .247). Those with a high school education or less and were very fearful (52.2%) were similarly more likely to have taken cover than the less frightened (34.0%), but the statistical association ($p < .05$, Phi = .178) was not as strong as that observed for the best educated group. Respondents reporting a family income of $40,000 or more and high levels of fear (66.1%) took cover with greater frequency than high income persons who were less frightened (28.2%) ($p < .01$, Phi = .299). There was no similar pattern between fear and taking cover among the lower income group (See Table 3).

Table 3*. Taking Cover at Home by Fear Controlling for Education and Income

Education (Years of School)

	Years of school > 13		**Years of school < 13**	
	Level of Fear (%)		**Level of Fear (%)**	
Took Cover	High	Low	High	Low
Yes	65.6	35.8	52.2	34.0
No	34.4	64.2	47.8	66.0
Total	31	115	62	108
	Chi Square = 8.923, $p < .005$ Phi = .247		Chi Square = 5.411, $p < .05$ Phi = .178	

Income (Total Family in $ per year)

	$ per year > 40,000		**$ per year < 40,000**	
	Level of Fear (%)		**Level of Fear (%)**	
Took Cover	High	Low	High	Low
Yes	66.1	28.2	51.7	40.5
No	33.9	71.8	48.3	59.5
Total	15	72	50	108
	Chi Square = 7.767, $p < .01$ Phi = .299		Chi Square = N.S.	

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

Among ethnic groups, Whites and Mexican-Americans who were very frightened were significantly more disposed to take cover at home during the earthquake than less fearful members of these groups. Among Mexican-Americans, nearly seventy percent who expressed high levels of fear took cover; only 37.3% of the less frightened did so ($p < .05$, Phi = .308). For Whites, high fear was similarly associated with taking cover where 56.9%

of those who were very frightened took cover and 33.8% of those who were less frightened took cover ($p < .01$, Phi = .197). Blacks, Asians and other Hispanics who reported being very fearful during the earthquake also tended to take cover, but the analysis was rendered difficult by the small numbers of cases in these groups. When Blacks, Asians and other Hispanics were grouped into a single category, the relationship between fear and response for this aggregate ethnic category was not significant (See Table 4).

Table 4*. Taking Cover at Home by Fear Controlling for Ethnicity

Mexican-Americans	**Level of Fear (%)**	
Took Cover	High	Low
Yes	69.3	37.3
No	30.7	62.7
Total	23	41

Chi Square = 6.128, $p < .05$, Phi = .308

Whites	**Level of Fear (%)**	
Took Cover	High	Low
Yes	56.9	33.8
No	43.1	66.2
Total	39	138

Chi Square = 6.894, $p < .01$, Phi = .197

Other Ethnic	**Level of Fear (%)**	
Took Cover	High	Low
Yes	50.0	34.3
No	50.0	65.7
Total	27	41

Chi Square = N.S.

*To correct for oversampling in the high impact area, respondents living in the high impact area were each

Individual self-assessments of preparedness at the time of the earthquake were examined, and no direct association between level of preparedness and taking cover was found. For the better prepared, however, being very fearful translated into a strong inclination to take cover at home ($p < .01$, Phi = .259). Nearly two-thirds of those who considered themselves "earthquake prepared" and very frightened by the October 1st earthquake took cover, whereas only 32.5% of those who were less frightened took cover. While high levels of fear were sufficient to spur slightly over half of

the ill-prepared to seek protective cover, the difference in taking cover between high and low fear groups was not statistically significant for those who were poorly prepared (See Table 5).

Table 5*. Taking Cover at Home by Fear Controlling for Level of Perceived Earthquake Preparedness

Well-Prepared for Earthquake	**Level of Fear (%)**	
Took Cover	High	Low
Yes	64.2	32.5
No	35.8	67.5
Total	29	118

Chi Square = 9.835, $p < .005$, Phi = .259

Not Well-Prepared for Earthquake	**Level of Fear (%)**	
Took Cover	High	Low
Yes	53.3	38.1
No	46.7	61.9
Total	104	169

Chi Square = N.S.

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

We chose to examine whether those with earthquake experience were more likely to take cover than those who had experienced no, or few, earthquakes. When we examined the bivariate analysis, we found no relationship between experience and self-protective actions at home. We noted, however, that the level of fear reported was inversely related to the number of earthquakes experienced ($p < .05$, Cramer's V = .126), so we examined the interaction between experience and fear as they affect response. The relationship between fear and taking cover at home varied with previous earthquake experience. As earthquake experience increased, the association between fear and taking cover increased. The greatest contrast was within the most experienced group where those who had experienced five or more earthquakes and who reported high levels of fear (64.5%), were twice as likely to have taken cover as those who expressed lower levels of fear (32.7%) ($p < .01$, Phi = .268) (See Table 6).

Something of an anomaly was our finding that residence in California for 21-30 years moderated the relationship between fear and taking cover

Table 6*. Taking Cover at Home by Fear Controlling for Earthquake Experience

Earthquakes Experienced = 0	Level of Fear (%)	
Took Cover	High	Low
Yes	52.6	44.1
No	47.4	55.9
Total	17	18

Chi Square = N.S.

Earthquakes Experienced = 1 to 4	Level of Fear (%)	
Took Cover	High	Low
Yes	57.6	35.6
No	42.4	64.4
Total	50	115

Chi Square = 6.915, $p < .01$, Phi = .205

Earthquakes Experienced > 4	Level of Fear (%)	
Took Cover	High	Low
Yes	64.5	32.7
No	35.5	67.3
Total	22	78

Chi Square = 7.223, $p < .01$, Phi = .268

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

at home. There was no statistically significant relationship between fear and response for those who had resided in the state for 20 years or less or over 30 years. Among the 21 to 30 year residents who acknowledged high levels of fear, 69.3% took cover while just 34.0% of those who were less fearful did so ($p < .01$, Phi = .315).

We examined other variables which might have influenced self-protective behavior in the form of taking cover at home. Residence in the local community as well as residence in the high impact zone of Whittier and the surrounding area were not related to taking cover. Age was assessed both individually and in combination with other variables and appeared to be unrelated to taking refuge during the Whittier Narrows earthquake.

Remaining in Place at Home. The most frequently reported response to the Whittier Narrows earthquake other than taking cover was to remain in place. This response was reported by one-fifth of those who indicated some form of response to the earthquake. Those categorized as "remaining in place" during the Whittier Narrows earthquake had in common the fact that they did not move to another location in the dwelling. Approximately two-thirds of those placed in the category of "remained in place" reported that they simply chose not to move to another location or as many stated, they decided to "stay put" where they were. The second most numerous type of response (16.1 %) labeled "remained in place" were those who indicated that they were in bed and "sat up" when the earthquake occurred. The remainder of this category is made up of responses which included "did nothing", "stopped an activity", "couldn't move", "froze in place" and various combinations of these responses.

Those who remained in place for the duration of the Whittier Narrows earthquake tended to be those who were less frightened. Those who were less fearful were twice as likely (23.7%) to remain in place as those who were more fearful (12.7%) ($p < .05$, Phi = .125). In addition to the bivariate relationship between fear and remaining in place, we found that three variables, ethnicity, education, and the presence of dependent children interacted with fear in their relationships with earthquake response. This "amplifying" effect of other variables on fear was also noted in our analysis of taking cover at home.

We found that Whites who were less fearful were over twice as likely to have remained in place (26.2%) as the more fearful (11.3%) ($p < .05$, Phi = .147). For Mexican-Americans, the effect of lower levels of fear on the propensity to remain in place was even more pronounced. While just over twenty percent of Mexican-Americans who reported being less fearful remained in place, only two percent of the very frightened did so ($p < .05$, Phi = .257).

Having a high school education or less was also related to fear and remaining in place at home. Within this educational category, the less fearful were three times as likely to have remained stationary (31.1%) during the earthquake as the more frightened (10.3%) ($p < .005$, Phi = .236). Among the better educated group, those with thirteen or more years of schooling, there was no relationship between fear and remaining in place at home.

The presence of dependent children affected the association between fear and remaining in place at home by greatly enhancing the probability of movement for the very frightened ($p < .05$, Phi = .256). Those who were not very frightened by the earthquake and reported that dependent children

were present were far more likely to have remained in place (21.1%) than the more frightened who were with children (2.7%). The relationship between fear and remaining in place was not statistically significant when children were not present.

There was a curvilinear relationship between the number of years lived in California and staying in place at home during the earthquake with those having resided in the state for less than 21 years or over 30 years being more likely to remain in place ($p < .005$, Phi = .228). We also examined age, gender, ethnicity, prior earthquake experience, the presence of others, perceived level of earthquake preparedness, level of education and income, residence in the high and low impact zones and home damage and found no significant relationships between these variables and remaining in place at home.

Going Outside at Home. Going outside was an activity reported by 11.3% (N = 34) of those who engaged in physical movement during the earthquake. Nearly half (47.1%, N = 16) of those who left their homes during the shaking, reported running. The remainder used less specific terms to describe their movement outside, mainly "went" or "got." A total of 16 (4.3%) of our respondents who were at home (N = 373) during the Whittier Narrows earthquake reported both "outside" as an objective and "running" as the means of getting there. It should be recalled that our survey prompted respondents to indicate their "first" response, however, we cannot specify the exact timing of flight from dwellings; that is, we cannot rule out the possibility that some ran outside after the earthquake shaking had stopped.

Our findings indicate that the level of expressed fear was unrelated to the propensity to go outside during the shaking. For analytical purposes, we separated those who ran outside from those whose descriptions of their exit from dwellings did not include running to determine whether fear was associated with the means of exit rather than its destination. We found a rather weak statistical association between fear and running outside ($p < .05$, Phi = .094). Recall that fear was a significant factor in taking cover which, in combination with its apparently weak influence on leaving the dwelling, suggests that fear may be a contributing factor to individual and collective self-protection rather than exposure to additional danger.

There was no association between ethnicity, the presence of others or gender and going outside. Experience with earthquakes was statistically unrelated to the tendency to run or otherwise leave one's home during the earthquake. We also considered length of residence in California and in the local community which, like experience, may indicate the operation of a disaster subculture. Neither of these variables was related to going outside;

nor were location in the high impact zone, level of education or income, or level of perceived earthquake preparedness contributing factors to leaving one's dwelling while the earthquake was occurring. Finally, we considered the possibility that the type of dwelling might be a factor; however, respondents reported leaving a house, apartment or duplex and a condominium in about equal proportions.

Catching Objects at Home. Respondents who attempted to catch or brace objects which were falling due to the earthquake's shaking constituted only 1 percent of our overall sample (seven persons in a total sample of 690). Despite the small number of cases, this type of response merits our attention for two reasons. First, the attempt by persons to catch objects or brace unstable furniture is perhaps the most dangerous action that can be taken during an earthquake. A second reason for examining this activity is the observation by other researchers that this response action was quite prevalent.

None of these respondents reported being injured during the earthquake and we did not determine whether they were successful in preventing damage to their property. We determined that most of the object catchers were women, white, had above average family incomes, were not frightened by the shaking, had previous experience with earthquakes and lived in single family homes. Items on which there was no clustering included years of schooling completed, length of residence in California and the local community and residence in the high or low impact groups.

Other Responses Involving Physical Movement at Home. Nine percent (N = 32) of those who were at home reported getting out of bed and attempting to get dressed during the earthquake. Eight percent (N = 31) reported going towards others, and three percent (N = 13) recalled moving away from hazards. Very small numbers of respondents reported using the phone to check on others, checking their utilities, or turning on the television or radio during the shaking.

Response at Work

Our sample contained 114 people (16.5% of the overall survey sample) who reported being at work at 7:42 a.m. on Thursday, October 1, 1987. A great majority (86.8 %) were inside when the earthquake struck; and a nearly equal number were with others, nearly all of whom were co-workers. We also learned that over 70% of those on the job remained there rather than try to go home to check on family members or property in the two hours following the earthquake. Nearly one-third of those at work reported being "very frightened and upset" by the earthquake. This level of fear was

somewhat higher than that expressed in the sample as a whole, but the difference was not statistically significant.

With over 100 persons at work when the earthquake struck, we understandably obtained a range of respondent occupations and industry affiliations. In the sample as a whole, professional services and manufacturing were the modal categories for industry, and clerical/administrative support was the modal occupation. We anticipated, however that respondents who were on the job at 7:42 a.m. might represent a somewhat different set of industries and occupations than would have been the case had the earthquake occurred at mid-morning. Indeed this proved to be the case. When compared to the distribution of industrial affiliations in the sample as a whole, manufacturing is over-represented and personal and professional services are somewhat under-represented. We also found that operators, laborers, craftsmen and repairman were more prevalent in the sample at work than in the sample as a whole.

Demographically, the "at work" sample was predictably younger with those over 60 substantially under-represented. The early morning work force also tended to be male, non-white and had somewhat lower incomes than the sample as a whole. There was little difference in experience with earthquakes or length of residence in California between those who were at work and the remainder of our sample population. We were unable to ascertain what effect being in the high impact zone had on response behavior at work since impact zones were based on the location of respondents' residences.

Taking Cover at Work. A total of 39.5% (N = 45) of those at work took cover. When we consider only those who moved from where they were at the onset of shaking to another location (N = 77), the percentage of those who took cover is 49.5%.

We found a significant relationship between fear and taking cover at work, just as we did for those at home. The bivariate analysis revealed that those who were more fearful at work were over twice as likely to take cover (62.2%) as those who were less fearful (28.3%) ($p < .005$, Phi = .322). When earthquake experience was held constant, we found that the relationship between fear and taking cover held only for those who had experienced between one and four earthquakes ($p < .001$, Phi = .552). Those with higher levels of fear were almost three times as likely (92.1%) to take cover as those with lower levels of fear (32.0%) (See Table 7).

The relationship between fear and taking cover at work was also influenced by the presence of others (most likely co-workers), gender, ethnicity, and level of education. When others were present, those with

Table 7*. Taking Cover at Work by Fear Controlling for Earthquake Experience

Earthquakes Experienced = 0	**Level of Fear (%)**	
Took Cover	High	Low
Yes	38.5	12.0
No	61.5	88.0
Total	5	8

Fisher's Exact = N.S.

Earthquakes Experienced = 1 to 4	**Level of Fear (%)**	
Took Cover	High	Low
Yes	92.1	32.0
No	7.9	68.0
Total	11	26

Chi Square = 11.302, $p < .001$, Phi = .552

Earthquakes Experienced > 4	**Level of Fear (%)**	
Took Cover	High	Low
Yes	45.7	30.9
No	54.3	69.1
Total	13	27

Chi Square = N.S.

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

higher levels of fear tended to take cover with over twice the frequency (66.7%) as those with lower levels of fear (28.3%) ($p < .005$, Phi = .358). The relationship between taking cover and fear was not statistically significant when the respondent was alone. While levels of fear and taking cover at work were unrelated for men, they were significantly related for women. Women who experienced high levels of fear were over twice as likely to take cover at work (64.6%) as those who were less fearful (27.9%) ($p < .05$, Phi = .367).

Ethnicity also appeared to influence the relationship between taking cover at work and fear. For Whites, those with high levels of fear took cover twice as often (67.8%) as those with lower levels of fear (31.3%) ($p < .05$,

Phi = .307). Because of the small numbers of Asians, Blacks, Hispanics (not of Mexican origin) and other ethnic minority respondents at work, these individuals were placed in a single category for purposes of this analysis. These individuals also tended to take cover more often under conditions of higher fear (53.6%) than conditions of lower fear (15.4%) ($p < .05$, Phi = .401). Taking cover and level of fear were statistically unrelated for Mexican-Americans.

Level of fear and taking cover at work were related only among those who reported having more than 12 years of schooling. Among the better educated respondents with higher levels of fear, taking cover was reported over twice as often (71.8%) as it was among those who reported lower levels of fear (29.9%) ($p < .01$, Phi = .380).

We speculated that there may be differences in self-protective measures at work based on occupation. We reduced the eight category occupation variable into a simple dichotomy between blue and white collar workers to assure adequate numbers of cases for analysis. White collar workers were defined as managers, administrators, professional/technical workers, sales-people and clerical workers. Blue collar workers were made up of service workers, craft/repair people, equipment operators, mechanics and laborers. There was no apparent relationship between taking cover at work and occupation, as expressed in a simple blue collar/white collar distinction.

In our analysis of taking cover at home, we found that the presence of others appeared to influence the propensity toward self-protective action. At work, however, a great majority were with others, and these others were overwhelmingly co-workers. We examined taking cover among those who were with co-workers and the small number of people who were alone at work. Although the number of cases prevents generalization, there was no difference between the percentage who were alone and took cover and for those who were with others.

We considered the effect of gender and ethnicity both individually and in combination with occupation on the propensity to take cover at work and found that there were no significant relationships. Unfortunately, there were too few respondents in our sample of those at work who reported no experience with earthquakes to adequately test the relationship between earthquake experience and taking cover. We were, however, able to examine the relationships between the number of earthquakes experienced, the number of years lived in California and taking cover and found no tendency for more extensive earthquake experience or longer residence to result in a greater inclination to take cover at work.

Remaining in Place at Work. Those who remained in place and did not move from one location to another throughout the several seconds of ground motion constituted approximately one fifth of the sample at work. This proportion is nearly identical to that observed among those who were at home on October 1st and was also the second most frequently reported response at work. There was variation in response within this category, though all respondents so classified had in common the fact that they remained stationary throughout the period of shaking. Most simply reported that they "stayed put" (64%); also mentioned were "did nothing" (12%), "stopped an activity" (8%), "checked for hazards" while remaining in place (8%), "froze" (4%) and "sat up" (4%).

A great majority of those who were on the job during the earthquake were in the presence of others, overwhelmingly co-workers. The few respondents who were alone were significantly more likely to have remained stationary throughout the earthquake (44.0%) than those who were with others (17.0%) ($p < .05$, Phi = .216). We also found that those who were less frightened were three times more likely to remain in place (25.6%) than those who were more frightened (8.3%) ($p < .05$, Phi = .198). There was no statistical relationship between fear and the presence of others at work. The relationship between fear and remaining in place at work held only for those with greater than 12 years of schooling. None of those individuals remained in place when levels of fear were high, and 23.5% remained in place when levels of fear were low ($p < .05$, Phi = .280).

Other variables which were potentially related to remaining in place—gender, the number of years of residence in California, earthquake experience, occupation, years of schooling, income and ethnicity did not appear to be related to the propensity to remain stationary during the earthquake. For the sample at work, age was not testable since many people over the age of 60 were out of the work force.

Going Outside at Work. We found that seventeen percent of those at work reported going outside during the earthquake and nearly half of these ran outside. The proportion of those who left structures at work was nearly twice that observed among those who were at home during the earthquake. It will be recalled that there were no significant relationships between our situational or demographic variables and going outside at home.

We observed ethnic differences in the propensity to go outside at work in the Whittier Narrows earthquake. Because of the small numbers of Blacks, Asians and non-Mexican-American Hispanics in the sample of respondents at work, we were forced to collapse categories into Whites, Mexican-Americans and others. Table 8 reveals that Whites were the least

likely (7.9%) to go outside and that other ethnic groups (excluding Mexican-Americans) were the most inclined (33.2%) to leave structures during the earthquake ($p < .05$, Phi = .288) (See Table 8). We suspected that there may be interaction between ethnicity and occupation in their effect on going outside, but our sample size prevented us from testing this.

Table 8*. Going Outside at Work by Ethnicity

	Ethnic Group (%)		
Went Outside	Whites	Mexican-Americans	Others
Yes	7.9	18.3	33.2
No	92.1	81.7	66.8
Total	44	18	28

Chi Square = 7.471, $p < .05$, Cramer's V = .288

*To correct for oversampling in the high impact area, respondents living in the high impact area were each given a weight of 0.44. The remainder of the respondents were given a weight of 1.00.

We considered the possibility that occupational factors might be associated with the tendency for more people to go outside at work than did so at home. The relationship between occupation and going outside at work was not statistically significant. However, we found that those who worked in close proximity to heavy, potentially unstable equipment or other dangerous conditions (e.g. mechanics, construction workers and machine operators) were somewhat disposed to go outside during the earthquake.

Other Responses Involving Physical Movement at Work. Responses involving physical movement at work other than taking cover or going outside comprised 22.8 percent of the total. Twenty-seven percent of these actions (N = 7) were measures to avoid hazards, typically to avoid falling or unstable objects and breaking glass. Movement for the purpose of stabilizing ones stance was also mentioned. A total of four people mentioned use of the telephone, an action which is discouraged by public and private organizations which advise the community on appropriate earthquake response.

Response While Driving

A total of 52 persons or 7.5% of the overall survey sample reported that they were "traveling on a road or freeway" when the Whittier Narrows earthquake struck. Of those traveling, 46% pulled to the curb and stopped,

43% continued driving and 11% were passengers. Everyone who was driving felt the earthquake. Many reported sensing a disturbance and some believed at first that they were experiencing mechanical difficulties. Others noted that they witnessed traffic lights swaying, utility poles moving or other disturbances.

Gender and the presence of others, which were associated with the propensity to take cover at home, were not related to actions taken in response to the earthquake among those driving. The number of respondents was inadequate to assess the relationships between age, ethnicity, fear, years of schooling, occupation, length of residence in California and the local community and earthquake experience and earthquake response behavior among those driving.

Discussion and Conclusions

The social science disaster research literature, including studies of occupant behavior, suggested that response to a rapid onset disaster agent like a major earthquake would be active rather than passive and adaptive rather than maladaptive. Our data support both of these generalizations. Regardless of where people were located at the time of the earthquake, some form of physical movement from one location to another was highly salient. We also found that self-protective measures—taking cover or avoiding hazards at home and work and pulling to the side of the road, if driving, were the modal responses in each of the three contexts we examined. But self-protection during the earthquake was not universal and there were a number of behaviors recorded which should be of concern to disaster response planners, behaviors which could result in injury or death in a major earthquake.

Self-protective actions in response to the earthquake included taking refuge in a doorway, hall or under sturdy furniture. For those driving, self protection involved pulling the car to a curb and stopping for the duration of the shaking. Those who chose a doorway or hall outnumbered those who took cover under furniture by a factor of five to one. This finding may be of interest to response planners and educators, some of whom have argued that the protection afforded by sturdy furniture is superior to that provided by doorways or halls. In some cases, it has been pointed out that doorways present dangers during an earthquake and should be avoided, if possible. Nevertheless, it appears that large sectors of the public continue to regard doorways and halls as places of safe refuge in earthquakes and that efforts to change perceptions will require time and the commitment of resources.

Perhaps the most interesting finding of our study with regard to self-protective behavior was the role played by fear, both as an independent correlate with taking cover and in its interaction with several other variables. The disaster research literature led us to assume that fear would be associated with ill-considered flight or that self-protective actions might be taken despite considerable fear. On the contrary, we discovered that as expressed fear increased, so did the propensity to take cover during the earthquake. Fear, as a response to a sudden onset disaster appears to contribute to a definition of the situation as threatening to self and others and triggers certain learned responses which are survival-oriented. The propensity toward self-protection appears to intensify when high levels of fear interact with other environmental and demographic factors—being in the presence of others (dependent children at home, other adults at work), being better educated, having experienced previous earthquakes and being White or Mexican-American. In addition, those who were at home and regarded themselves as well-prepared for an earthquake seemed better able to translate their intense fear into self-protective actions than the ill-prepared. These findings can only be regarded as preliminary and should be examined in other disaster contexts and with various other measurement techniques.

We also recorded response actions which have been discouraged by public and private disaster response organizations—running outside, attempting to catch falling objects, immediate use of the telephone and remaining frozen in place during the shaking. The number of respondents who reported attempts to catch or brace falling objects or make phone calls during the earthquake was quite small. Leaving structures or remaining in place were reported by a substantial minority of respondents. We found that those who were at work when the earthquake occurred were twice as likely as those at home to leave structures during the shaking. It seems that there may be work environment safety concerns operating in which those in less threatening workplaces are less likely to go outside during an earthquake; whereas those who work near heavy, potentially unstable objects, equipment or structures may be prone to flee these hazards. Going outside was not, as some studies have suggested, a product of intense fear. In fact, those who exited buildings during the earthquake were generally less frightened than those who took cover. These findings indicate that greater advocacy is needed in response planning and nonstructural hazard mitigation in the workplace, particularly in the manufacturing and mechanical services sector.

Remaining in place presents an interesting dilemma to disaster response planners. Those who "stayed put" during the shaking did not engage in activities which are vigorously discouraged like bracing or catching falling

objects or running outside. Nor did they actively seek the self-protective shelter afforded by sturdy furniture, an interior hallway or a door frame. Response planning and advice has been strongly weighted in favor of movement toward cover in an earthquake and thus, remaining stationary is regarded as less than appropriate. Our data indicate that remaining in place was a response primarily of those who were alone, less fearful and relatively long-term residents of the state. It should be recalled that the period of intense shaking lasted less than ten seconds and left a great majority of communities undamaged. Given the duration of the event and less intense shaking in many areas, it appears that many persons may have considered the risk of movement greater than remaining stationary. It is also possible that those who were alone at home or isolated at work found the situation more difficult to define as an earthquake or lacked the cues from others which defined the situation as threatening.

Earthquake response studies conducted after major earthquakes in other nations clearly suggest cross-cultural variations in behavior during the event. Our study indicated that response behavior during the Whittier Narrows earthquake was quite different from that displayed by Japanese residents of Urakawa or southern Italian villagers during major earthquakes in those countries. More specifically, flight reactions were far more prevalent in response reported by Takuma (1972, 1978) in Japan and by Alexander (1990) in Italy than was the case in our study of response in southern California or that of Archea (1990) in northern California. Even more dramatic was the difference between Japanese and American studies in terms of the reported propensity to catch or brace falling objects in the home. While Archea and Kobayashi (1984) found that over one-third of those interviewed after the off-Urakawa earthquake had attempted to catch falling objects or brace furniture, these responses were extremely rare in the Whittier Narrows earthquake.

We were curious to determine whether there were ethnic variations in response within the "melting pot" of southern California. Unfortunately, the number of Blacks, Asians and non-Mexican-American Hispanics was too small for rigorous statistical analysis or confident generalization. The survey contained a sufficient number of Mexican-Americans for analysis and this group displayed a tendency to respond in a self-protective manner across all three situational contexts examined—at home, at work and while driving. This pattern of response by Mexican-Americans invites further investigation. Indeed, the social science disaster research literature suggests that there may be good cultural and sociological reasons to expect adaptive behavior among Mexican-Americans. Their strong interpersonal networks centered around the family play important roles in discussion of earthquake

topics and interpreting disaster messages from the media (Perry et al. 1983; Turner et al. 1986). Turner found that Mexican Americans are more future-oriented than either Whites or Blacks, they have a strong belief in personal efficacy and, contrary to popular stereotypes, are least likely to express attitudes of fatalism.

Lengthy residence in the state of California and the local community and experience with previous earthquakes, factors which might arguably affect earthquake response, did not prove to be salient in immediate response to the Whittier Narrows event. It was only in association with high levels of fear that previous earthquake experience resulted in taking cover. There was a somewhat anomalous finding in which those who had resided in California for 21-30 years appeared far more likely to have responded actively than those with either shorter or longer periods of residence. Aside from these weak indicators of a nascent disaster subculture (See Wenger and Weller 1973), we were unable to provide evidence of subcultural influences on immediate response behavior.

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