

## **How UC Berkeley Undergraduate Students Perceive the Risk of Earthquakes in Berkeley, CA**

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**Abstract** Risky events are those that have potential to cause extreme damage and adversely affect people and their possessions. Previous studies have found that people perceive risks differently based on a combination of different variables, including past experiences, familiarity with natural hazards, knowledge about the hazards, and ethnicity of the person. One of these events is earthquakes, unpredictable natural hazards that could potentially cause fatalities, and catastrophic damage to both structures and communities. Because UC Berkeley lies directly over an active fault that has a 27% chance of causing a catastrophic earthquake within the next 3 years, students at UC Berkeley are at risk of harm from an earthquake. This study analyzed the students' earthquake risk perceptions to determine whether or not risk perceptions are dependent on earthquake experience, knowledge about earthquakes, and ethnicity. The hypothesis states that students with positive experiences, those who knew more about earthquakes, and those who were in white ethnic groups would perceive earthquakes as less risky than those with negative experience, those who don't know much about earthquakes, and those in non-white ethnic groups. The results indicate that risk perception of earthquakes is independent of experience and knowledge, and a large sample size is needed to compare risk perceptions of people in different ethnic groups. This study has determined that in future earthquake risk perception studies, a larger sample size should be used and other sources of variation should be explored.

**Introduction**

A risk can be defined as a hazard, a potential threat, the consequence of an event (Slovic 2002), or a probability that typically estimates the occurrence of a negative event (Brun 1994). Some widely known events that pose risks are natural disasters (Smith 2004). Smith (2004) states that even though a hazardous event can occur in regions that are uninhabited, it is only considered a hazard when it adversely affects people and their possessions; it becomes a disaster because of the widespread damage it causes and the resulting great losses faced by the community and its functions (Smith 2004). One such disaster is earthquakes. As uncontrolled, unpredictable, and possibly life-threatening natural occurrences, earthquakes pose a huge risk to those living in earthquake-prone areas (Bolt 2006), but they do not pose the same amount of risk to every person. The way people view the possible occurrence of an earthquake can differ greatly depending on a variety of different factors, including by both gender and ethnicity (Finucane *et al.* 2000). Consequently, studies are performed to assess how risky natural hazards are in the eyes of the public, and why people perceive risks the way they do.

The concept of risk means something different to everyone (Slovic 1987). Risk perception, also called subjective risk assessment, refers to the intuitive assessment or judgment by a person who is not an expert in the field of risk analysis (Bostrom *et al.* 2008). A perceived risk by a layperson involves the understanding and experience an individual has regarding the event (Oltedal *et al.* 2004). Studies of risk perception analyze people's thoughts and judgments when they are told to describe and assess different hazards (Slovic 1987). To help understand risk perception, the psychometric paradigm is commonly used to develop a quantitative depiction of people's risk perceptions (Fischhoff *et al.* 1978). Some of the properties used to help quantify risks include voluntariness, dread, knowledge, controllability, benefits, and catastrophic level of the event (Oltedal *et al.* 2004). This paradigm allows researchers to find similarities and differences of attitudes and perceptions of risks among different people (Slovic 2002).

There are several factors that influence people's perceptions of risks and their responses to hazards, including familiarity with, control over, and knowledge about the hazardous events (Fischhoff *et al.* 1978). To explain the factor of familiarity, Douglas

and Wildavsky (1982) note evidence that past experiences with environmental risks influence the person's subsequent assessment of the hazard. If people have had negative experiences, they are more likely to perceive the hazard as a greater risk than before; however, if they do not see or experience any harm, it is likely that the perception of risk would decrease (Vaughan *et al.* 1991). Vaughan (1991) also observes that those who feel they are more knowledgeable and have more control over a hazard perceive it as less risky. The damage potential and frequency of the occurrence of a hazard also plays a large part in risk perception—the risk of rare events that can cause great amounts of damage is usually overestimated, while the risk of events that occur quite frequently but do not result in such great damage is underestimated (Fischhoff *et al.* 1978). Another study demonstrates that people's emotional states at the time of the study influence risk perceptions (Hogarth *et al.* 2007). Results show that participants of the study measured risks as lower when they were in more positive moods (Hogarth *et al.* 2007). Finally, some other factors that have been found to contribute to people's perceptions of risk include gender as well as ethnicity and culture (Short 1984).

Many studies have assessed the differences in risk perception between males and females, but few have taken a closer look at ethnicity, or people who have shared cultural experiences and have had similar upbringings (Finucane *et al.* 2000). However, it is still important to determine if risk perceptions are dependent on ethnicity. It can be assumed that people of the same gender or ethnicity share similar upbringings, experiences, and values and are more likely to view some events in the same way. Therefore, they are more likely to have similar perceptions of risk than others from different backgrounds (Vaughan *et al.* 1991). Most researchers who have focused on gender differences in risk perception have come to the conclusion that females judge risk higher than males (Finucane *et al.* 2000). It has also been found that women view most risks as being more likely to occur than men do (Hogarth *et al.* 2007). The study carried out in the United States by Finucane *et al.* (2000) also focuses on perceptions among different ethnic groups, finding that risks are judged lower by white people than they are by people of color (specifically African-Americans, Asian-Americans, and Hispanic-Americans), and that most of the time, non-white females report the highest risk ratings. These results indicate that differences in worldviews, trust, control, and other factors contribute to the

differences of risk perceptions between different genders and different ethnicities in the United States (Finucane *et al.* 2000). Risks may be perceived as greater by women of all races and non-white men because they feel more exposed and susceptible to risky events, have less control over them, and benefit less than white men (Finucane *et al.* 2000). However, another survey conducted recently afterwards demonstrates that the differences in risk perception between white males, and females and non-white males is much more complex than first thought. Further investigation is required to determine differences in risk perceptions among different genders and ethnic groups.

In addition to the very few thorough studies have been carried out on the relationship between environmental risk perceptions and ethnicity, there have not been any studies on the risk perceptions of specific natural hazards, mainly earthquakes in the United States, which is why I have chosen this as the focus of my research. I have conducted a study that will help fill in this gap of knowledge and therefore contribute to the growing field of risk analysis. I carried out my project by surveying subjects who attend UC Berkeley in Berkeley, CA. The university has a populated campus with students from all different parts of the country (UCB Office of Planning and Analysis 2008), and is situated directly on top of the Hayward Fault (Fig. 1); this is an active fault that has a 27% chance of rupturing within the next 3 years and producing an earthquake with a 6.7 magnitude (Bolt 2006). Because of the fault, simply living in Berkeley and attending classes on campus poses a risk of being negatively affected by an earthquake.



Figure 1: The Hayward Fault (the red line) runs directly underneath UC Berkeley's Memorial Stadium as well as other parts of campus and surrounding areas (Association of Bay Area Governments and U.S. Geological Survey, 2005).

My objective is to answer one main question of how students of UC Berkeley perceive the risk of an earthquake in Berkeley. I will answer this question by specifically examining whether or not people who have experienced more than one earthquake view the risks of earthquakes differently than those who are not familiar with them. I will also focus on whether or not people's experiences with earthquakes were negative, and how that correlates to their perceptions of risk. In addition, I will link the data to the ethnicity

of the subjects to determine whether or not there is a correlation between ethnicity and risk perception. I hypothesize that people who have had negative experiences with earthquakes and those who have never experienced earthquakes at all will perceive them as a much greater risk than those who have had positive experiences with earthquakes. Because previous studies have found that those who are more knowledgeable regarding a certain risk feel they have more control over it, I hypothesize that people who know more about earthquakes will perceive them as less of a risk. I also hypothesize that there will be a difference between the risk perceptions of those in different ethnic groups, with white ethnic groups perceiving a lower risk and non-white ethnic groups perceiving a higher risk.

### **Methods**

To answer the question of how UC Berkeley undergraduate students perceive the risk of an earthquake, I conducted a survey to help me investigate possible relationships between people's risk perceptions and their ethnicities, hometowns, and experiences with earthquakes. I randomly recruited 100 undergraduates at UC Berkeley to take part in my study. To obtain a random, representative sample, I handed out my surveys at three different parts of campus: North Gate, Upper Sproul, and outside Crossroads dining facility. Surveying was done on Upper Sproul on weekday afternoons from 12-1pm the week of February and at North Gate from 12-1pm on weekdays in March because most students are coming and going from campus at that time for classes. I also stood outside Crossroads on weekday evenings in February from 6-7pm when most students come to eat dinner. I asked every second person who walked by to take my survey to ensure it was random.

My survey consisted of four parts. The first part tested general knowledge about earthquakes, faults, and potential damage in the Berkeley area. For each correct answer, one point was awarded. For each incorrect answer or question left blank, no points were awarded. The second part of the survey focused on earthquake risk perception. The subjects were indirectly asked to rank earthquakes among other risks, such as driving and commercial flying, as well as other natural hazards such as wildfires and landslides. This allowed students to understand the scale of risk by providing them other risk-posing events to compare earthquakes to. There were also questions about earthquake

preparedness. The third section of the survey asked about experiences that subjects have had with earthquakes. If they had never experienced one, they were told not to complete this section. If they had, they were asked the number of earthquakes they've experienced, the magnitudes of the earthquakes, and their feelings about them on a scale from 1 to 10 (negative to positive). The last section was demographic questions (gender, age, ethnicity, and hometown). Please see Appendix A for the survey.

To test the relationship between earthquake risk perception and experience, I did a regression analysis. I graphed the quality of experience people have had with earthquakes against the different risk levels they assigned earthquakes. To analyze whether or not risk perception is dependent upon knowledge, I also did a regression by graphing the number of questions participants got correct against the risk level they assigned earthquakes. The regression analyses were used to determine whether or not there was a significant correlation between the two variables in each section. I also used the statistical test, a one-way ANOVA to determine if there is a significant difference in earthquake risk perception among people of different ethnicities.

## **Results**

An accurate representation of the undergraduate student population was obtained. Of the 100 participants, 47% were Asian-American, 45% were Caucasian, 5% were Hispanic, and 3% were African-American, similar to the breakdown of the UC Berkeley undergraduate student population: 42% Asian, 31% Caucasian, 12% Hispanic, and 3% African-American. There were 3 Asian Americans and 3 Caucasians in my study who did not assign earthquakes a perceived risk level, and therefore were not included in the data set.

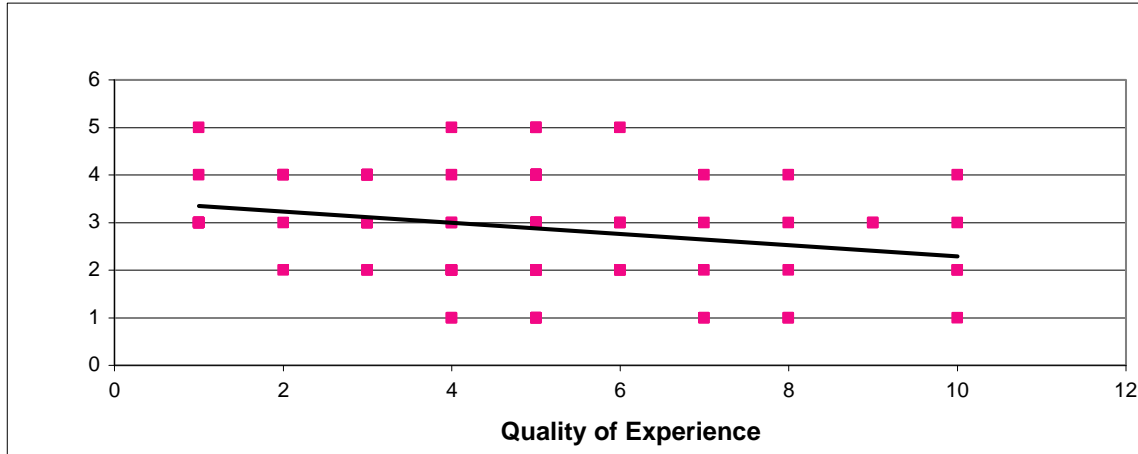


Figure 2: Relationship between quality of experience and risk perception (x-axis: 1=negative, 10=positive; y-axis: 1=not risky, 5=risky).

Only 5 of the 94 participants have never experienced an earthquake and viewed them as anywhere between not risky and risky. Of the 89 who have felt earthquakes, experiences varied from negative to positive. As participants ranked their experiences more positively, their perceived level of earthquake risk decreased slightly. However, this correlation was not significant ( $y=-0.1175x + 3.4694$ ,  $r^2=0.0569$ ,  $p=0.46$ ).

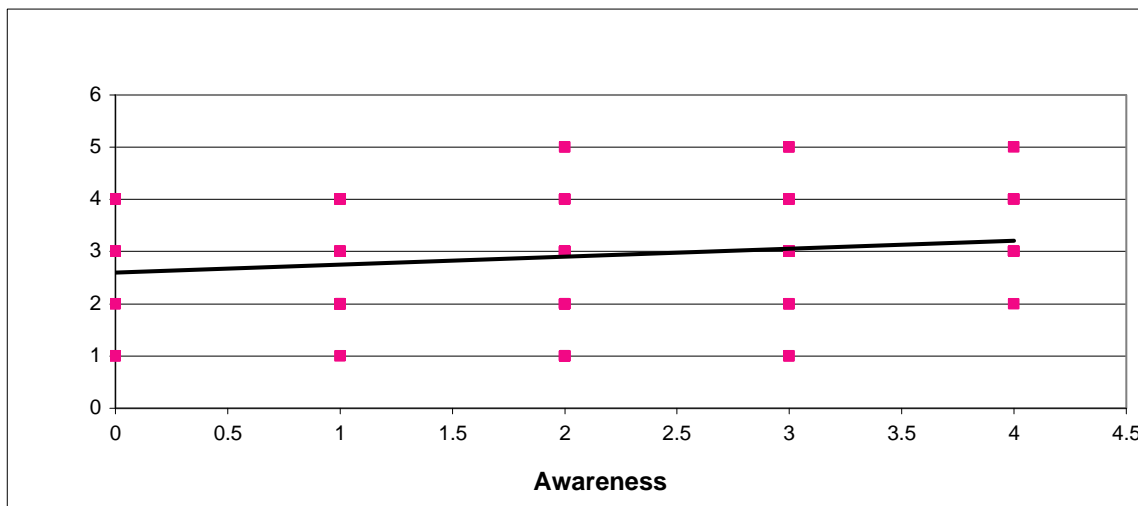


Figure 3: Relationship between knowledge about earthquakes and faults in Berkeley and risk perception of earthquakes (x-axis: number of correct answers to section 1 questions; y axis: 1=not risky, 5=risky).

As students answered more questions about earthquakes correctly, they tended to perceive earthquakes as slightly more risky. However, this correlation between



knowledge and risk perception of earthquakes was not significant ( $y=0.1516x + 2.598$ ,  $r^2=0.264$ ,  $p=0.48$ ).

Table 4: Variation among groups and correlation risk perception averages. The test statistic ( $F=1.353$ ) is much smaller than the F crit ( $F \text{ crit}=2.705$ ).

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4.82478	3	1.6082	1.353572	0.262072	2.705
Within Groups	108.122	91	1.18816			
Total	112.9473	94				

Risk perceptions of earthquakes varied greatly between not risky and risky within ethnic groups. The test statistic was much smaller than the F critical value; therefore, the results of the ANOVA determined that the null hypothesis is accepted. There is no statistically significant difference among the different ethnic groups and the way they perceive risks.

### Discussion

According to the data, UC Berkeley undergraduate students who had negative experiences with earthquakes were just as likely to perceive them as a low risk as those who had positive experiences. In addition, those with positive experiences were as likely to perceive them as great risks as were those who had negative experiences. Those who had more neutral experiences also ranked earthquakes anywhere between not risky and very risky.

These results of this study conflict with the findings of previous studies. Douglas and Wildavsky (1982) determine that in the case of environmental hazards, people perceive risks based on their level of familiarity (past experiences) with that risk. Another study indicates that when these experiences are negative, the perceived risk is greater than when the past experiences are positive (Vaughan *et al.* 1991). This does not agree with my results, as they showed no correlation between the two variables. It is possible that despite having positive experiences with earthquakes, people may still understand the dangers of earthquakes and therefore see them as a higher risk, indicating that perception is independent of experience. Another possibility is that people have negative experiences with earthquakes and still perceive them as low risks because their negative experiences

could have been the result of a simultaneously occurring negative event, and not because of the earthquake.

The results also indicate that there is no significant correlation between those who are knowledgeable about earthquakes and faults in Berkeley and risk perceptions of earthquakes. The study found that even though some people know about the Hayward Fault running below the stadium and the safest places in Berkeley during an earthquake, their knowledge has no affect on how risky they believe earthquakes are. In addition, those who did not know anything about the fault or where to go during an earthquake were just as likely to perceive an earthquake as not risky. Therefore, in my study, knowledge evidently did not play a role, unlike it did in the study performed by Fischhoff *et al.* (1978). According to this study, those who are more knowledgeable about an event would feel that the hazard is less risky than those who don't know much about it. Another study indicates that people who understand and know more about hazards feel as though they have more control over the natural hazards (Vaughan 1991). However, my results indicate the possibility that those who are more knowledgeable are consequently more understanding and aware of the great damage an earthquake can cause. Therefore, they perceive it as a higher risk. According to my study, being knowledge about a natural hazard possibly has a different effect on the way each person perceives the risk of that hazard.

The results of the ANOVA showed that people perceive risks of earthquakes independent of their ethnicities. Some studies determined that people perceive risks differently based on ethnicity because non-white groups tend to feel more vulnerable and less in control of a natural hazard than would white groups (Finucane *et al.* 2000, Vaughan *et al.* 1991). Vaughan *et al.* (1991) states that people perceive risks in the same way as those from their background, and differently from others. However, despite the fact that averages of risk perception by ethnicity were extremely close to one another in my study, it is difficult to draw any conclusions with respect to the possible relationship between ethnicity and earthquake risk perception because of the small number of Hispanic people and African-Americans who participated.

Several factors exist that could possibly have been limitations of my study. The greatest limiting factor is the small sample size of Hispanic people and African-American

respondents. This did not allow me to make an accurate conclusion about how people of their ethnicity perceive the risk of earthquakes. In addition, none of the UC Berkeley student participants have ever before experienced a severely catastrophic earthquake, greater than magnitude 5.2, that has caused more than a few fatalities or widespread physical damage to communities. An example of such an earthquake is the Great China Earthquake of magnitude 8.0 that occurred in Sichuan, China in August, 2008. Therefore, conclusions cannot be made about people who have had extremely negative experiences and how they perceive the risks of earthquakes. Another possibly limiting factor is that people may have guessed on some of the questions testing their knowledge. If they guessed answers correctly to questions they did not know, the results are not a true reflection of their actual knowledge, and the data may not be accurate. Outside influences that should also be taken into account are media sources. Someone who does not perceive earthquakes as risky may learn from the news about the tens of thousands of people negatively affected around Sichuan, China in August, 2008, and may consequently conclude that earthquakes are much riskier than previously thought.

There are also possible explanations as to why the results of this study were not identical to those of previous studies. These previously performed studies did not focus specifically on earthquakes, but instead focused on natural hazards in general. Earthquakes are different from most other natural hazards in that they are still unpredictable, and people do not have time to prepare for the first hit of an earthquake once it has occurred (Bolt 2006). Another explanation is that previous studies have determined that people tend to perceive events as lower risks when they are in positive moods (Hogarth *et al.* 2007). My survey did not include any questions to determine the mood the participants were in, which could have therefore possibly changed some of my data.

Overall, this study determined that risk perception of earthquakes is possibly independent of past experience and quality of experience, as well as knowledge of earthquakes and faults in and near Berkeley, CA. However, it has also had an unexpected purpose in revealing the great number of people living in Berkeley, a dangerously earthquake-prone area, who are not prepared for such a hazardous event to occur, nor who know of the great dangers a looming earthquake poses. General knowledge and

awareness regarding earthquakes should be spread among UC Berkeley undergraduates for their own safety. In addition, future research should focus specifically on whether or not there is a relationship between ethnicity and risk perception by improving upon my study and using a significantly larger sample size. Other studies should also focus on exploring other sources of variation of risk perception in regards to earthquakes.

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6. How well prepared are you for an earthquake (is your room earthquake-safe, do you have a first aid kit prepared, do you know what to do/where to go during and after an earthquake)?

Not at all          A little          Somewhat          Very          Totally prepared

### III. Experiences with Earthquakes

7. Have you ever experienced an earthquake?

Yes                          No

If no, please skip down to section IV. If yes, please continue...

8. How many earthquakes have you experienced?

1                  2                  3                  4                  5 or more

9. Put a checkmark next to the highest magnitude earthquake you have ever experienced.

- 1-2.9** (felt by few, delicately suspended objects may swing)  
 **3-4.9** (felt indoors by many, walls creak, doors move, motorcars sway)  
 **5-6.9** (felt by all, tall objects sway, plaster cracks, damage slight)  
 **7-8.9** (slight damage in well designed structures, partial collapse in ordinary substantial buildings, noticed by those driving cars, chimneys break, heavy furniture overturned)  
 **9-10.9** (buildings shifted off foundations, ground cracked, landslides considerable from river banks and steep slopes)  
 **11-12** (few structures remain standing, bridges destroyed, waves seen on ground surfaces, lines of sight and level distorted, objects thrown upward into the air)

During this earthquake, how scared were you on a scale of 1-10?

(1=not scared, 10=extremely scared)

1          2          3          4          5          6          7          8          9          10

10. Overall, your experience with earthquakes has been—

[1=Negative (hated it!), 10=Positive (fun!)]

1          2          3          4          5          6          7          8          9          10

**IV. Demographics:**

Male\_\_\_\_ Female\_\_\_\_

Age\_\_\_\_\_

Ethnicity:

\_\_\_\_Hispanic

\_\_\_\_Asian or Pacific Islander

\_\_\_\_African-American

\_\_\_\_Caucasian

\_\_\_\_Multiethnic (please specify):\_\_\_\_\_

\_\_\_\_Other (please specify):\_\_\_\_\_

In what city were you...

Born:

\_\_\_\_\_

Raised (if raised in more than one city, please list):

\_\_\_\_\_