

How the 2010 Canterbury (Darfield) earthquake affected earthquake risk perception: Comparing citizens inside and outside the earthquake region

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We thank Brenda Mackie for assistance in gathering the data. This research was funded by a Foundation of Research Science and Technology (FRST) subcontract from GNS Science: CO5X0402. Correspondence should be addressed to: John McClure, School of Psychology, Victoria University of Wellington, P. O. Box 600, Wellington, New Zealand. Email may be addressed to: john.mcclure@vuw.ac.nz

Abstract

This study examined changes in the judgments of the risk of earthquakes before and after the 2010 Darfield, Canterbury earthquake in three cities: Christchurch (Canterbury), Wellington and Palmerston North. Christchurch citizens were chosen because of their direct experience of the earthquake, whereas Wellington and Palmerston North were chosen because their citizens were likely to have different earthquake expectations. Whereas many citizens in Wellington have long expected an earthquake, this is less likely in Palmerston North. Palmerston North therefore provides a comparable sample to Christchurch before the Darfield earthquake. Participants judged the likelihood of an earthquake in different locations before and after the Darfield earthquake. Participants judged earthquake likelihoods for their own city, for the rest of New Zealand, and with participants in Wellington and Palmerston North, the likelihood of another major earthquake in

Canterbury. Christchurch participants also reported damage suffered in the earthquake. Expectations of an earthquake occurring in Canterbury were low before the Darfield earthquake in all three samples and rose significantly after that earthquake. Palmerston North expectancies of an earthquake in their own city also rose after the earthquake. In contrast, Wellingtonians' expectancies of an earthquake in Wellington were higher before the Darfield earthquake and did not rise after that earthquake. These findings clarify the effects of earthquakes and prior expectancies on risk judgments about earthquakes inside and outside the directly affected region.

Keywords: earthquakes, Canterbury earthquakes, risk perception, perceived earthquake likelihood

Introduction

For people to prepare for natural disasters such as earthquakes, they need to recognize the risk they are exposed to from the hazard. Thus it is important to understand what factors influence citizens' judgments of risk from these hazards. One factor is people's experience of those hazards, either directly or at a distance. When a natural disaster occurs, does it affect the risk judgments of those who live in the disaster region differently to people who live outside the region and are vulnerable to the same types of disaster?

Research has shown that judgments of the probability of negative events such as disasters are subject to a range of factors, including optimistic biases in people's judgments about different sorts of events, and people's personal experience of these events.

Optimistic bias

Research on risk perception has shown that people often make biased appraisals about their own risk relative to others. Specifically, many people display an optimistic bias where they view themselves as less likely to be harmed by future risks than other citizens (e.g., Weinstein, 1980). This unrealistic optimism can lead people to underestimate the likelihood that they will experience a negative event, such as an illness or a car accident.

Several studies have demonstrated this optimistic bias in relation to natural disasters. Jackson (1981) found that the majority of respondents in cities that were prone to earthquakes believed they would not experience an earthquake, or that if they did, they would not suffer personal harm. Mileti and Darlington (1995) found that whereas 80% of respondents in an earthquake risk zone believed an earthquake would occur where they lived in the next five years, most judged that they would not suffer injuries or loss to their property. A similar optimism has been found in relation to hurricanes (Sattler, Kaiser, & Hittner, 2000), and volcanic eruptions (Johnston, Bebbington, Lai, Houghton, & Paton, 1999). Spittal, McClure, Siegert and Walkey (2005) asked new Zealand citizens not only about their own prospects in an earthquake, but also about the prospects of an acquaintance and an 'average other' person. Participants judged the likelihood of both personal harm and property damage across the three target persons. Consistent with previous research, respondents judged themselves to be less likely to suffer harm than an acquaintance. Interestingly, on the damage to property measure, they rated themselves *more* likely to experience damage than either an acquaintance or an 'average other', which suggests that financial loss is less susceptible to optimistic bias. These findings show that people tend to underestimate the likelihood that they will be personally harmed by natural disasters.

Optimistic bias may be compounded by citizens' beliefs about the different levels of risk that particular hazards pose in different regions. For example, in New Zealand, prior to the recent Canterbury earthquakes, citizens' estimates of the probability of an earthquake in Canterbury were likely to have been lower than for Wellington (Becker, 2010), which is widely known to be vulnerable to earthquakes. However, the objective risk of an earthquake in Christchurch was still serious, as has been borne out by recent events in 2010 and 2011 - two large earthquakes occurring in the region that caused huge damage and loss. Similarly, before the Kobe earthquake, the estimated probability of an earthquake in the Kobe region was significantly lower than for Tokyo (Nakashima & Chusilp, 2003). Yet it was Kobe that experienced the earthquake and its damaging consequences.

A key problem in citizens' risk judgment is that people in regions that are objectively deemed a lower risk than other regions appear to think that they are not at risk at

all – they think that the hazard will strike the higher risk region first. This pattern may be analogous to people's tendency to edit low frequency events as having zero probability (Slovic, Fischhoff, & Lichtenstein, 1982; Stone, Yates, & Parker, 1994). This inferential leap has been shown to be an inaccurate extrapolation from the risk probabilities in both Kobe and Christchurch, as well as many other examples. This line of reasoning can have disastrous consequences, because people think they do not need to prepare.

The effect of experiencing a disaster

Personal experience of a natural disaster can reduce optimistic bias. Burger and Palmer (1992) showed that with students who experienced the 1989 Loma Prieta earthquake, optimistic bias about negative events was absent directly after the earthquake, but returned three months later. Following the 1994 Northridge earthquake, Helweg-Larsen (1999) similarly found a lack of optimistic bias in respondents; however, unlike Burger and Palmer's sample, optimistic bias in regard to earthquakes did not return five months later, when the respondents were surveyed again. This suggests that there was a longer reduction in optimistic bias as a result of the earthquake experience. This difference may reflect the fact that Burger and Palmer's items did not focus specifically on optimism about earthquakes.

Although experience of an earthquake does increase many citizens' judgments of risk, the outcome of a person's experience is also an important factor. Mileti and O'Brien (1992) found that in comparison with those who suffered loss, people who suffered no personal losses or injuries were more optimistic about possible consequences of a future earthquake and were less likely to take warnings of aftershocks seriously. Mileti and O'Brien claimed that these participants showed a 'normalization bias', in that when they experienced no negative impacts from the first event, they thought they would not be affected by subsequent impacts.

The present article

The aforementioned studies examined the effect of personal experience on risk perception following a major earthquake in a single geographical area – usually the area that is vulnerable to or hit by an earthquake. To our knowledge, no studies have systematically compared the judgments of earthquake probability for people who have experienced an earthquake with the judgments

of others outside the region. Thus there is a gap in the understanding of the effects of personal experience on risk judgments for those inside and outside the affected area. Yet these effects are likely. For example, the Chernobyl disaster affected American citizens' perceptions of risks of nuclear energy (Reve, 2011), and the recent Japanese nuclear disaster triggered by a tsunami had similar effects on German citizens (Spiegel online, 2011).

The present study directly addresses this issue. The research was carried out shortly after the 2010 earthquake in September 2010 that occurred in Darfield, Canterbury, near Christchurch (magnitude 7.1 on the Richter scale). The study compared the judgments of participants in the city of Christchurch, New Zealand, the largest urban area affected by the earthquake, with those located in two other cities in New Zealand: Wellington and Palmerston North. The location of the two latter cities was distant from the earthquake and citizens in these two cities did not experience the earthquake first hand. Whereas many citizens in Wellington have long expected an earthquake, due to civil defence warning and commentaries in the mass media that focus specifically on Wellington (e.g., Aftershock, 2008), this is less likely in Palmerston North. The Palmerston North sample may therefore be comparable to Christchurch before the Darfield earthquake, where many citizens had not strongly expected an earthquake before the Darfield earthquake (Becker, 2010). Seismologists knew that there was a serious possibility that a major earthquake could occur in or near to the Christchurch region, and newer buildings had been built to earthquake building code standards.

Using a questionnaire format, participants judged their recall of earthquake likelihoods prior to the 2010 Darfield Canterbury earthquake and following the same earthquake. They made these judgments for their own city, for the rest of New Zealand, and in the case of participants in Wellington and Palmerston North, for Canterbury. The study assessed whether judgments of earthquake likelihood following the Canterbury earthquake differed across the three regions. We predicted: first, that for all three participant groups, expectancies of another earthquake in Canterbury would be higher following the Darfield earthquake than before the event; second, that the expectancies of another earthquake in Canterbury would be higher for Christchurch citizens than the other two groups; and third, that expectancies of the probability of a local

earthquake would rise in Palmerston North but not in Wellington. We made no predictions about an increase in judged likelihood of an earthquake in another part of New Zealand.

The study also assessed whether Wellington and Palmerston North participants who knew people in Christchurch judged the future earthquake risk higher than those who did not- an issue where there is little previous research. We also assessed whether participants who suffered damage in the earthquake perceived the future risk as higher than those who did not, as found by Mileti and O'Brien (1992).

Method

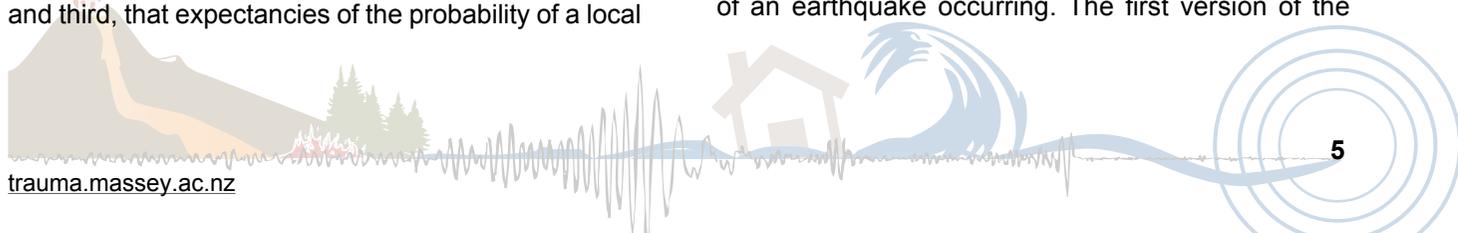
Participants

The participants completing the questionnaire were 380 residents from three cities in New Zealand: Christchurch, Wellington and Palmerston North. For the Christchurch sample, to gain a sample of the general population, participants were recruited at a popular market in Riccarton, central Christchurch on a Sunday, five weeks after the Darfield earthquake. This sample consisted of 200 participants (gender: male = 49, female = 139, not stated = 12), with a median age of 41-50 years, and a mean of 0.76 children per household.

The Wellington sample consisted of 100 participants (male = 33, female = 48, not stated = 19), whose median age was 21-30, with a mean of 0.57 children per household. Data was again collected at the food market in downtown Wellington, and at lunchtimes in a popular urban park over three days, twelve weeks after the Darfield earthquake. For the Palmerston North sample, 80 participants were recruited (male = 35, female = 36, not stated = 9), with a median age of 41-50, and a mean of 0.63 children per household. In Palmerston North, researchers were denied permission to survey participants in most public spaces, and the sample comprised some passers-by on a major street ($n = 20$), staff members from the Palmerston North City Library ($n = 21$), and staff members from the Palmerston North City Council ($n = 39$), thirteen weeks after the Darfield earthquake. In all three cities, participation was voluntary and anonymous, and a chocolate bar was offered in appreciation of their participation.

Materials/Procedure

The questionnaires measured the perceived likelihood of an earthquake occurring. The first version of the



questionnaire was constructed for Christchurch, and took account of the fact that this sample had recently experienced a major earthquake. The second version of the questionnaire, designed for Wellington and Palmerston North, was adapted from the Christchurch questionnaire. Questions that were not appropriate for those cities, such as 'Did you incur a lot of damage in the earthquake?' were excluded, and additional questions such as 'Has the risk of an earthquake become more real or plausible to you since the Canterbury earthquake?' were added. The questions in the Wellington and Palmerston North version of the questionnaire were identical, except that in questions that specifically referred to the city where the participants lived, the name of the city was changed to that of the resident.

The Christchurch questionnaire had three earthquake likelihood items, two of which asked how likely participants thought it was that a big earthquake would occur in or near Christchurch *before* the Darfield Earthquake and *after* the Darfield earthquake. The third item assessed the likelihood of an earthquake happening in another part of New Zealand. In the Wellington / Palmerston North questionnaire, three further likelihood items were added. Two items elicited the perceived likelihood of an earthquake occurring in the participants' city (i.e., Wellington or Palmerston North), *before* and *after* the earthquake. A further item assessed recall of the likelihood that a serious earthquake would occur in another part of New Zealand *before* the Darfield earthquake. Responses were given on a 5 point Likert Scale, with endpoints labelled 'Not at all likely' and 'Very likely'. Related questions asked: 'Did you expect an event such as the Canterbury [i.e., Darfield] earthquake to happen in your lifetime?' 'No/not sure/yes'; and 'If you previously thought an earthquake in or near Christchurch was unlikely, why was that?' with a blank line for comments.

In addition to these earthquake likelihood items, the Christchurch survey asked: 'Did you incur a lot of damage in the earthquake?' (Yes/no) Because of the sensitive nature of the questionnaire, a question asked if answering the questions made the participant feel uncomfortable (or upset), to be answered with yes/a little/ not at all, followed by a blank space for comments. These questions were only appropriate for the Christchurch sample.

The Wellington and Palmerston North questionnaires also asked: 'Has the risk of an earthquake become more real or plausible to you since the Canterbury

earthquake?' and 'Did you know anyone close to you who lives in Christchurch?'; with Yes and No response options.

All versions of the questionnaire asked 'Before the earthquake, were you aware of any information about how to prepare for a possible earthquake in [Participant's city]?' The response options were: Yes, not sure, no. 'If you were aware of this information, and did you regard it as relevant to you?' The response options were: Yes, some relevance, no. A question asked if there were any other comments participants would like to make, followed by optional questions about demographic information: gender, age, number of dependent children in the household, and for Wellington and Palmerston North, their suburb. Other questions dealing with preparation are reported elsewhere.

Results

Judged likelihood of an earthquake before and after the earthquake

Figure 1 shows the data for expectancy of an earthquake in occurring in or near Christchurch. These data were analysed with a 3 (Participant City: Christchurch, Wellington, Palmerston North) x 2 (Time: before, after the earthquake) mixed design analysis. This showed a main effect for Time, $F(1, 375) = 334.29, p < .001, \eta^2 = .47$, in that participants' expectancies of an earthquake near Christchurch were higher after the Darfield earthquake ($M = 3.61$) than before the earthquake ($M = 2.13$). There was also a significant interaction between City and Time, $F(2, 375) = 4.64, p < .01, \eta^2 = .02$, so separate analyses were preferred for each time. In recall of their expectancy of an earthquake around Christchurch before the Darfield earthquake, participants from the three cities did not differ, $F(2, 375) = 1.22, ns$, whereas after the earthquake, they did differ, $F(2, 375) = 4.88, p < .01, \eta^2 = .02$, with Christchurch participants ($M = 3.83, SD = 1.12$) rating the likelihood of a future earthquake near Christchurch higher than participants from Wellington ($M = 3.45, SD = 0.98$) and Palmerston North ($M = 3.67, SD = 0.99$).

Figure 2 shows the data for expectancy of an earthquake in the participant's own city. These data were analysed by a 3 (Participant City: Christchurch, Wellington, Palmerston North) x 2 (Time: before, after the earthquake) mixed design analysis. There were main effects for Time, $F(1, 375) = 122.88, p < .001, \eta^2 = .25$, and City, $F(2, 375) = 50.86, p < .001, \eta^2 = .25$. These

main effects were qualified by an interaction between City and Time, $F(2, 375) = 66.42, p < .01, \eta^2 = .26$. Both Palmerston North and Christchurch participants rated a future earthquake in their own region more likely after the earthquake, ($M = 3.46, SD = 0.99; M = 3.83, SD = 1.12$, respectively), than before the earthquake, ($M = 3.01, SD = 1.11; M = 2.05, SD = 1.36$), whereas Wellington participants rated a future earthquake in Wellington equally likely after ($M = 4.16, SD = 0.83$) and before the earthquake ($M = 4.03, SD = 1.01$).

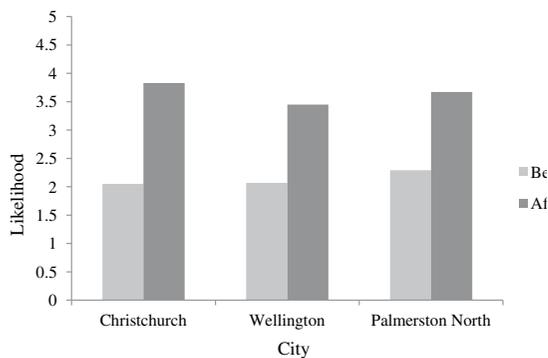


Figure 1. The perceived likelihood of an earthquake occurring in or near Christchurch before and after the Canterbury Earthquake. (1= not at all likely, 5 = very likely)

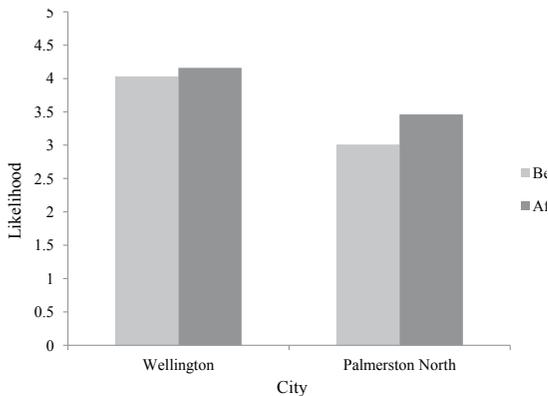


Figure 2. The perceived likelihood of an earthquake in participants' own city before and after the Canterbury Earthquake in Wellington and Palmerston North. (1= not at all likely, 5 = very likely)

Figure 3 shows the data for expectancy of an earthquake in another part of New Zealand. These data were analysed with a 2 (Participant City: Wellington, Palmerston North) x 2 (Time: before, after the earthquake) mixed design analysis. This showed a main effect for Time, $F(1, 178) = 5.47, p < .02, \eta^2 = .03$, in that this expectancy was higher after the Darfield earthquake ($M = 4.30$) than before the earthquake ($M = 3.76$). A marginal main effect for City, $F(1, 178) = 3.55, p < .06, \eta^2 = .02$, showed that Palmerston North participants judged

an earthquake in another part of New Zealand more likely ($M = 4.26$) than Wellington participants ($M = 3.79$). There was no interaction between City and Time. A 3 (Participant City: Christchurch, Wellington, Palmerston North) between subjects ANOVA on expectancy of an earthquake in another part of New Zealand after the Darfield earthquake showed no difference between Christchurch and the other two cities, $F(2, 376) = 2.53, ns$.

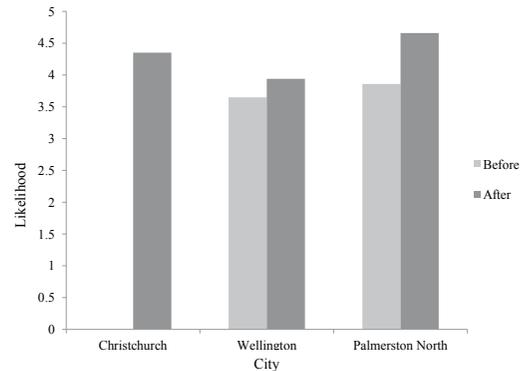


Figure 3. The perceived likelihood of an earthquake in another part of New Zealand before and after the Canterbury Earthquake. Note: The 'before' question was not given to Christchurch participants. (1= not at all likely, 5 = very likely)

Lifetime Expectancy and reality of risk

On the question of whether participants thought before the Darfield earthquake that an event such as the Darfield earthquake would occur in their lifetime, there was a significant association between participant city and expectancy, $\chi^2(4) = 59.34, p < .001$. Over half of people in Wellington (56%) and Palmerston North (59%) believed such an event would happen in their lifetime, whereas the percentage was much lower for Christchurch (22%) (See Table 1). This shows that the City variable has a moderate relationship ($V = .28$) with lifetime expectancy of a disaster. The proportion of participants who felt that the risk of an earthquake had become more real or plausible since the Darfield Earthquake did not differ significantly by city (Wellington and Palmerston North), $\chi^2(2) = 2.07, p = .36$. The majority of participants in both cities, Wellington (74%) and Palmerston North (74%), indicated that the risk had become more real for them (See Table 1)..

Attributions for risk judgments about an earthquake near Christchurch

Two researchers established inter-response reliability for the open-ended question eliciting participants' attributions for why they previously thought an



earthquake in Christchurch was unlikely. One researcher examined all responses to find emerging themes, and developed categories and subcategories that reflected those themes. All responses were then allocated to one or more subcategories. If a participant’s response matched more than one category (for example when a participant said that they gained information about a possible earthquake from television and mailers), all relevant categories were coded. All categories contained two or more items, and responses that did not fit were coded as ‘other’.

Table 1. Whether respondents expected an event such as the Canterbury Earthquake in their lifetime, and whether the risk of an earthquake had since become more real/ plausible. Data in percentages

	Yes	No	Not sure
Expect in your lifetime?			
Christchurch	22	60	17
Wellington	56	27	17
Palmerston North	59	20	27
Risk is more real/ plausible?			
Wellington	74	21	5
Palmerston North	74	16	10

Once this stage was completed, the second researcher checked the categorisation of all responses. If there was disagreement on individual items, the re-categorisation of these items was discussed with the first coder. At this point, new categories were developed between the two researchers and existing categories were also renamed or combined. The purpose of this process was that the researchers agreed on the categories as well as the allocation of all answers to these categories.

The outcome was shown to a third researcher, who suggested final changes to the categorisation. The results are shown in Table 2. The most common attributions were: they did not know that Christchurch was near a fault-line; they thought an earthquake in Canterbury was unlikely and that the next major earthquake was going to happen elsewhere; and there had been no major earthquakes near a populated area in recent New Zealand history (See Table 2).

Earthquake Information:

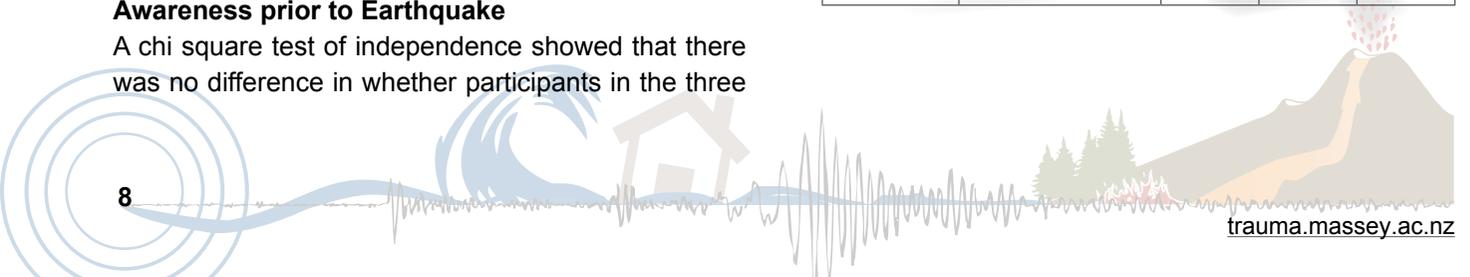
Awareness prior to Earthquake

A chi square test of independence showed that there was no difference in whether participants in the three

cities were aware of information about earthquakes, before the Darfield earthquake, $\chi^2 (4) = 6.81, p = .15$. There was, however, a significant difference in whether participants perceived this information to be relevant to them, $\chi^2 (4) = 17.72, p < .005$. Wellington (68%) and Palmerston North (66%) participants saw this information as more relevant to them than Christchurch (51%) participants. This suggests that although participants from all cities were equally conscious of information about earthquake preparedness, people in Christchurch viewed it as less relevant to them personally. ($V = .159$)

Table 2. Attributions for why participants thought an earthquake in Canterbury was unlikely (Percentages). Note: Wgtn = Wellington; ChCh = Christchurch; P North = Palmerston North

<i>If you previously thought an earthquake in or near Christchurch was unlikely, why was that?</i>				
Category	Sub-category	Chch	Wgtn	P. North
<i>Earthquake Expectancy</i>	Unlikely/Not going to Happen	11.5	1.0	2.5
	Happen elsewhere	5.5	0.0	2.5
	Wellington/North Island a bigger risk	6.5	12.0	5.0
	Flat/Stable land	4.0	0.0	1.3
	ChCh is Safe/Not earthquake prone	4.5	0.0	5.0
<i>Past Experience</i>	No personal earthquake experience	4.0	2.0	1.3
	None in recent NZ history	13.5	7.0	8.8
	Hadn't thought about it	7.5	9.0	8.8
<i>Personality Trait</i>	Complacency	1.5	0.0	0.0
<i>Lack of Knowledge/ Information</i>	No media reports/ not told about it	4.0	3.0	1.3
	Didn't know about faultline near ChCh/ thought ChCh not near/ on faultline e.g. alpine	25.5	31.0	21.3
<i>Other</i>	Because happened in Napier already	0.0	0.0	3.8
	I thought earthquake WAS likely	3.0	1.0	3.8
	Other	5.5	1.0	5.0



Did citizens who incurred damage see the risk differently?

The proportion of Christchurch citizens who incurred damage is shown in Table 3. A one way ANOVA showed that those who incurred damage saw the risk of another earthquake in Canterbury as only marginally higher than those who did not, $F(1, 185) = 3.04, p < .08, \eta^2 = .016$.

Table 3: The percentage of respondents who incurred damage from the earthquake in Christchurch, and those that knew someone close to them living in Christchurch. (Percentages)

	Yes	No
Incurred Damage		
Christchurch	34.0	65.0
Wellington	-	-
Palmerston North	-	-
Knew someone close in Christchurch?		
Christchurch	-	-
Wellington	51.5	48.5
Palmerston North	57.5	42.5

The effect of knowing persons in Christchurch

The proportion of participants who knew someone close in Christchurch was 51.5% in Wellington and 57.5% in Palmerston North. A chi square test found no difference in these proportions in Wellington and Palmerston North, $\chi^2(1) = 0.60, p = .44$. A one way ANOVA showed that those who knew people in Christchurch saw the risk of another earthquake in Canterbury as higher ($M = 3.64$) than those who did not ($M = 3.33$), $F(1, 167) = 3.80, p < .05, \eta^2 = .022$, but did not see the risk of another earthquake in their own city as higher than those who did not know anybody in Christchurch, $F(1, 167) = 0.67, ns$.

Discussion

Perceived likelihood of an earthquake

There are several interesting findings in changes in perceived earthquake likelihood after the Darfield earthquake inside and outside the affected region. As predicted, judgments of the likelihood of a further earthquake in Canterbury were low before the earthquake and rose significantly after the earthquake. This increase in the perceived likelihood of an earthquake was higher in the affected city (Christchurch) than in other cities, suggesting that direct experience of the earthquake affected local citizens' expectancy of another earthquake more than those outside the region,

suggesting that identification with an affected group may influence judgments of risk.

In judgments of the likelihood of a further earthquake in their own city, there were interesting differences across the three cities. Whereas both Palmerston North and Christchurch citizens rate the likelihood of an earthquake in their own city higher after the Darfield earthquake, Wellington citizens did not. However, the baseline level of judged earthquake likelihood for Wellingtonians was high before the earthquake. This result suggests that these risk judgments depend not only on experience of an earthquake but the effect of communications about earthquake risk. Wellingtonians have been told frequently by both civic agencies and the news media that an earthquake is likely in their city, but this has not been the case for citizens of Palmerston North and Christchurch. The findings suggest the importance of civic agencies communicating risk not only to citizens in cities thought to be at highest risk but also citizens in cities thought to have a lower (but still significant) probability of an earthquake. As in the case of this event and the Kobe earthquake, earthquakes do not always happen in the zone that is seen as the most vulnerable.

The analyses on expectancies of an earthquake in another part of New Zealand show that for Wellington and Palmerston North citizens, these expectancies changed after the earthquake. The message for citizens from this earthquake is that earthquakes happen not only in known vulnerable cities like Wellington; they may happen elsewhere in New Zealand. This recognition of the risk may not be sufficient on its own to motivate citizens to undertake preparedness activities, but it is one likely prerequisite of this preparation. Consistent with this interpretation, the data show that the Christchurch citizens were aware of the civil defence messages about preparedness but thought that these messages applied to others, not themselves. This is a vivid illustration of the optimism bias.

Other findings showed that Christchurch participants who suffered loss in the earthquake saw the probability of another earthquake in the region as only marginally higher than those who did not suffer loss, a finding that contrasts with that of Mileti and O'Brien (2002). Interestingly, citizens living outside Christchurch who had acquaintances in Christchurch judged the likelihood of another earthquake in the Canterbury region higher than those who had no acquaintances there, but did not judge an earthquake in their own region as more likely. This is a novel finding

A possible limitation in these findings is that the judgments of earthquake risk before the Darfield earthquake were recalled judgments that could be subject to memory biases. In particular, people may revise their recall judgments in line with current expectancies in a form of the hindsight bias. However, other data suggest that these judgments were consistent with risk judgments for the region collected before the Darfield earthquake (Becker, 2010). In addition revising recalled judgements in line with current judgments would diminish rather than augment the difference between the before and after judgments of earthquake likelihood shown here.

Previous research has shown that communications about damage from earthquakes and other hazards can reduce or increase people's fatalism about earthquakes and their belief in the value of preparations (e.g., Cowan, McClure, & Wilson, 2002; McClure, Sutton, & Sibley, 2007; Spittal, Siegert, McClure, & Walkey, 2002). The way messages are framed influences people's attributions about the cause of events (McClure & Hilton, 1998; McClure, White, & Sibley, 2009), and these attributions in turn affect people's perception that the causes can be prevented. Unrealistic optimism can be countered by messages that communicate that people in similar circumstances have taken steps to prepare for a hazard (Weinstein 1980). A key implication of the present findings about risk judgments is the need to get people to understand that even if they are objectively at a lower risk than others in terms of probabilities, they should *not* use this comparison as a basis for their risk judgments. Instead, they should base their actions on the actual level of risk in their own region, even if that risk is judged lower in probabilistic terms than other regions. Even when the probabilities are low, the consequences when an earthquake does occur can be devastating.

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