# The impact of the Kaikōura earthquake on risk-related behaviour, perceptions, and social norm messages

*Lauren J. Vinnell*[1,2]
*Taciano L. Milfont*[1]
*John McClure*[1]

[1] School of Psychology, Victoria University of Wellington, New Zealand.

[2] Joint Centre for Disaster Research, Massey University, New Zealand.



**Author correspondence:**
Lauren Vinnell
Joint Centre for Disaster Research,
Private Bag 756,
Wellington 6140
New Zealand.
Email: l.vinnell@massey.ac.nz

URL: http://trauma.massey.ac.nz/issues/2019-2/AJDTS_23_2_Vinnell.pdf

## Abstract

*The unpredictability of earthquakes poses a significant challenge to examining and understanding the effects of these events on risk-related perceptions and behaviour. Natural experiments, a type of quasi-experimental method, allow for close approximations of treatment-control designs when data collection and earthquake events coincide. This study reports one such natural experiment, testing the effect of the November 2016 Kaikōura earthquake on risk perception, perceived norms, and preparation among residents of Wellington, Aotearoa New Zealand. Additionally, this research tested whether previously demonstrated effects of social norm messaging on support for recent legislation for strengthening earthquake-prone buildings was weaker following the event. As expected, earthquake preparation and concern were higher after the earthquake. Social norm effects were weaker after the earthquake but did not disappear entirely; these effects therefore appear to be relatively robust even to significant events, supporting the use of social norms in earthquake-related messaging.*

**Keywords:** *Earthquake, New Zealand, natural experiment, earthquake preparation, social norms*

Social norms have been used to change behaviour in a wide range of domains, namely pro-environmentalism (Farrow, Grolleau, & Ibanez, 2017) and health (Dempsey, McAlaney, & Bewick, 2018). Recent research has demonstrated that social norms are an important concept to disaster preparation (Becker, Paton, Johnston, & Ronan, 2014; Vinnell, Milfont, & McClure, 2018). However, the role of social norms in disaster-related behaviours has not yet been explored thoroughly (Solberg, Rossetto, & Joffe, 2010). Specifically, research is needed to establish the impact of disaster experience on the effectiveness of risk-related social norm messaging (e.g., Vinnell et al., 2018), as well as on perceptions of social norms. In addition to addressing this issue, a secondary purpose of the current research is to test previously-demonstrated effects of disaster experience on risk-related concern and behaviour (e.g., Becker et al., 2014; McClure, Johnston, Henrich, Milfont, & Becker, 2015; McClure, Willis, Johnston, & Recker, 2011) using a more rigorous methodology. These previous effects as well as issues with common methodologies and benefits of the design of the current study are explained later in the introduction.

### *Context*

On the 14th of November 2016, a magnitude 7.8 earthquake struck in the North Canterbury area of Aotearoa New Zealand (NZ), leading to two fatalities, nearly 600 reported injuries, and an estimated economic loss of between NZ$4 to $5 billion (Winter, 2017). In Wellington, approximately 300 kilometres from the epicentre, the quake triggered a tsunami warning (Blake, Johnston, Leonard, McLaren, & Becker, 2018) and severely damaged several high-profile buildings (Devlin, 2017). This earthquake allowed for a study on the effects of direct experience on risk-related judgments, perceptions, and behaviours of residents in Wellington. Of interest are the impacts of the earthquake on both perceptions of social norms for earthquake preparation and the effectiveness of social norm messaging. The current study examined social norm messages used to increase support for national legislation that requires the strengthening of earthquake-prone buildings. Briefly, this legislation targets public and private non-residential

buildings and multi-level apartment buildings which were built before 1976 when earthquake codes were upgraded. Approximately 5,300 buildings in Wellington fit into this category. In 2016, 700 of those 5,300 did not meet at least 34% of the new building standard (NBS), meaning they were not likely to withstand shaking one third of the intensity of shaking which new buildings are constructed to withstand, and hence were deemed earthquake-prone.

### *Social Norms*

Social norms act as decisional shortcuts, operating on both the motivation to behave consistently with others (because a common behaviour is seen as likely to be beneficial) and to be approved of by others (because acting contrary to what others approve risks social punishment; Cialdini, 2007). These shortcuts tend to operate more strongly in new or ambiguous situations (Goldstein, Griskevicius, & Cialdini, 2007) where there is a lack of past knowledge or other guides in the environment and when the individual does not already have strong beliefs about the behaviour (Morris, Hong, Chiu, & Liu, 2015). This study examines the two main types of norms: descriptive, which refers to the prevalence of the behaviour, and injunctive, which refers to the level of approval or disapproval of the behaviour (Cialdini, Reno, & Kallgren, 1990). Vinnell and colleagues found that an injunctive norm stating that 76% of other Wellington residents approved of the earthquake strengthening legislation described above increased participants' support for the legislation. Further, a descriptive norm conveying the rate at which buildings were being strengthened (72 per year on average) increased judgments that the strengthening work was achievable within the time frame allowed by the NZ Government.

Vinnell et al. (2018) presented *actual* social norms about earthquake preparation, which convey objective information about the prevalence and approval of particular behaviours. It is therefore pertinent to test whether the social norm effects found by Vinnell et al. (2018) are robust to earthquake events, such as the 2016 Kaikōura earthquake, which should make the legislation more relevant to participants. This increase in relevance should decrease the situational ambiguity and lead to stronger opinions about the strengthening legislation, thereby weakening the effect of social norm messaging. As well as testing the impact of a disaster event on the effectiveness of actual social norm information, the present study examined the effect of the Kaikōura earthquake on perceived interpersonal norms: the extent to which participants think those close to them (friends and family) have prepared for an earthquake and approve of them preparing (Lapinksi & Rimal, 2005).

### *Risk-related Perceptions and Behaviours*

Past research demonstrates a brief increase in preparedness (e.g., McRae, McClure, Henrich, Leah, & Charleson, 2017; Russell, Goltz, & Bourque, 1995) and concern (McClure et al., 2015) following earthquakes, with some evidence showing that this increase decays completely in less than three months (McRae et al., 2017; Oishi, Kohlbacher, & Choi, 2018). However, a review of evidence suggests that experience needs to pass a threshold of impact on an individual to motivate concern and preparedness, but that too extreme an experience can lead to decreases in these outcomes (Solberg et al., 2010). The other main purpose of this study, therefore, is to test the effect of the Kaikōura earthquake on risk-related perceptions and behaviours. This includes preparation at the household level, concern about earthquakes, and concern about earthquake-prone buildings.

## Methodology

One main challenge in this research domain is that it is neither possible nor ethical to simulate a disaster caused by a natural hazard event such as an earthquake (Oishi et al., 2018). Past research has typically used retrospective self-reports (e.g., McClure et al., 2011) requiring participants to recall their risk judgments and disaster preparation from before an event. While these cross-sectional studies provide useful data, people's reports of previous knowledge and behaviour can be affected by interposing events (e.g., Smith, Leffingwell, & Ptacek, 1999). Given the unpredictability of disasters and the implausibility of true experimental manipulation, quasi-experimental research provides a useful methodology to explore causal relationships.

### *Quasi-Experimental Research Designs*

A quasi-experimental research design is one which approximates an experiment in that participants are assigned to conditions, but not truly at random (Cozby & Bates, 2012). Instead, some aspect of the environment in which participants are studied acts as the assigner. For example, field observation studies often use a number of different locations so that researchers can infer an effect of location on the observed behaviour. Quasi-experimental designs therefore allow testing

causal factors which cannot, for logistical or ethical reasons, be manipulated by researchers.

A natural experiment design, by extension, is typically one where the aspect of the environment approximating the manipulation randomly occurs, such as a natural hazard event (Leatherdale, 2019; Oishi et al., 2018), as opposed to being deliberately selected by the researcher. The natural occurrence either splits participants quasi-randomly into between-subjects "treatment" and "control" groups (Oishi et al., 2018) where data has been collected prior to the event (Leatherdale, 2019) or allows for a pretest-posttest design where the same participants are observed before and after the event. These designs have strengths over more controlled studies, such as randomized control trials, in that they test real-world effects and can examine influences which would be impractical or unethical to manipulate. Because of these strengths, calls for such methods are increasing both in the research community and within governments (Leatherdale, 2019). The current study reports survey data collected approximately three months before (Vinnell et al., 2018) and one month after the November 2016 Kaikōura earthquake, in line with one of the recommended methods for natural experiments (White & Sabarwal, 2008). As this study compares two discrete groups surveyed at different time points rather than pre-tests and post-tests using the same sample, we will use the terms control group for those surveyed before the earthquake and treatment group for those surveyed after the earthquake (Cozby & Bates, 2012).

### *The Present Study*

The present study made five main predictions. Based on the suggestions of previous researchers (e.g., Goldstein et al., 2007; Morris et al., 2015) we expected effects of social norm messaging on judgments of earthquake strengthening legislation to be weaker in the treatment group than in the control group, as these participants will have more first-hand earthquake experience to inform their judgments. We did not expect the norm effects to disappear entirely, given that high knowledge of the earthquake legislation not only failed to suppress the norm effects entirely in previous research, but even strengthened one of these effects (Vinnell, 2016). Further, we expected that the perceived norms of general preparedness, both descriptive and injunctive, would be stronger in the treatment group compared to the control group.

We expected that preparation for earthquakes would be higher in the treatment group compared to the control (e.g., McRae et al., 2017). Based on past findings (e.g., McClure et al., 2015), we also expected that concern about earthquakes and earthquake-prone buildings would be higher, and risk tolerance lower, in the treatment group (i.e., following the Kaikōura event) than the control group (i.e., before the Kaikōura event). Finally, we expected overall support for the building legislation to be higher in the treatment group than the control group, given the visible impacts of earthquake damage to buildings in Wellington.

## Method

### *Design*

As described above, this study used a natural experiment design. Participants who took part in the survey before the earthquake formed the control group and participants who took part after the earthquake formed the treatment group. This study also used a between-subjects experimental design as within both the treatment and control groups participants were randomly assigned to a social norm condition in the online survey. All conditions presented a message briefly explaining the legislation, but each had a different, additional piece of information as detailed in Table 1: descriptive norm, injunctive norm, combined norm, risk information, or control with no extra information. The treatment group included all five conditions; the control group did not include the control condition.

### *Participants*

Participants were recruited through public Facebook groups targeting Wellington audiences. Details of the control group and the treatment group are presented separately. Because the sample in the study conducted before the earthquake was larger than the sample in the treatment group, a random subsample from the first survey sample was selected to represent the control group. This random subsample was used for between-group comparisons to ensure the two groups were matched for sample size, as samples equal in size are preferred for mean comparison tests (Grace-Martin, n.d.). Because this was a subset of an existing dataset, exclusions based on age, location, and the manipulation checks had already been made and are therefore not reported here.

**Treatment group.** Six-hundred and twenty-two participants commenced the survey which ran after the

Kaikōura earthquake. The data from 126 participants were excluded as they did not complete a majority of the survey questions. A further eight participants were excluded for being under the required age of 18. Of the remaining 488 participants, 144 failed one or both of the manipulation check questions and were also removed from the dataset. This left a sample of 344 participants. The majority (272) identified as female, 66 as male, and four as transgender; the remaining two participants did not answer the gender question. Ages ranged from 18 to 65 with a mean of 26.83 (*SD* = 8.55). Time lived in Wellington ranged from less than a week to 56 years, with a mean of 13.02 years (*SD* = 12.19). Participants numbered 65 in the descriptive condition, 69 in the injunctive condition, 75 in the combined condition, 67 in the risk condition, and 68 in the control condition.

**Control group.** As the first survey did not include a control condition, a sample equal to the totals from the four other conditions in the second survey was randomly selected. Of this sample of 276 participants, the majority (219) identified as female, 46 as male, and one as non-binary. The remaining ten participants chose not to report their gender. Participants were slightly younger in the control group than in the treatment group, with ages ranging from 18 to 60 and a mean of 24.96 (*SD* = 7.97). Participants had lived in Wellington for between less than a week and 50 years, with a mean length of residence of 11.96 years (*SD* = 11.55). These apparent differences in mean age and time lived in Wellington are tested for statistical significance, reported below. Participants numbered 63 in the descriptive condition, 65 in the injunctive condition, 73 in the combined condition, and 75 in the risk condition.

Table 1.
*Information included in the pre-survey message for the different experimental conditions.*

| Condition | Information |
|---|---|
| Descriptive norm | Currently, Wellingtonians are strengthening an average of 72 earthquake-prone buildings a year to at least this standard, which means that at least 80% of these buildings will be strengthened within the 15 year time frame if this rate continues |
| Injunctive norm | In a recent survey, 76% of Wellingtonians said they support this legislation requiring the strengthening of earthquake-prone buildings |
| Combined norm | Both the descriptive and injunctive norm sentences |
| Risk-prone | The chance of these buildings collapsing or sustaining serious damage in an earthquake is about 10 to 20 times that of a new building at the same location |
| Control | No additional information |

### *Materials*

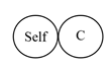
This study adapted the material used in Vinnell et al. (2018). The background information presented to all participants introduced the earthquake legislation, identified the type of buildings to which it applied, and the number of earthquake-prone buildings in Wellington (at the time, 641). Each condition also included one of the messages presented in Table 1, which represents the experimental manipulation. Consistent with the preference in past literature for factual rather than fabricated norm information, the injunctive norm conveys the actual rate of approval of the legislation found in Vinnell, McClure, and Milfont (2017) and the descriptive norm conveys the actual rate of building strengthening calculated by comparing the number of buildings on the Wellington City Council (WCC; 2015) list of earthquake-prone buildings at one time to the updated list four months later. The information about the risk of prone buildings is from a WCC (n.d.) brochure about earthquake-prone buildings.

All participants answered two manipulation questions tailored to the particular social norm condition. All manipulation questions had two response options and were not designed to be challenging to anyone who had properly read the message. An example question is: “How many buildings a year on average are being strengthened in Wellington?” which was presented to participants in both the descriptive and combined norm conditions. The two answer options were “0 – 100” and “100+”. As mentioned above, 29.5% of eligible participants gave incorrect answers to one or both of these questions. The number of participants excluded did not significantly differ between conditions ($p$ = .49).

The manipulation checks were followed by six questions about the legislation, all using seven-point Likert-type scales. Table 2 presents a full list of the questions.

These questions assessed prior knowledge of the legislation, support for the legislation, feasibility of the strengthening work, appropriateness of the standard required, justification of the expense, and appropriateness of the standard required for “modern buildings” (i.e., those built after 1976). This final question was added for the treatment group as several of the high-profile cases of damaged buildings in the Kaikōura earthquake were modern buildings (Stevenson et al., 2017).

Table 2.
*Questions included in the survey conducted after the earthquake.*

| Number | Question | '1' Anchor | '4' Anchor | '7' Anchor |
|---|---|---|---|---|
| 4 | Before reading the above information, how much did you already know about this legislation? | Nothing | Some | A lot |
| 5 | Overall, how much do you support this legislation? | Not at all | Partly | Completely |
| 6 | How possible do you think it is to strengthen all 641 of these earthquake-prone buildings in Wellington? | Impossible | Unsure | Very possible |
| 7 | Do you think 34% of the current building code is an appropriate standard compared to legislation on other risks (e.g. Vehicle Warrant of Fitness)? | Not firm enough | About right | Too firm |
| 8 | Do you think the expense of this strengthening work is justified, given the risk of earthquakes compared to other risks (e.g. traffic accidents)? | Fully justified | About right | Excessive |
| 9 | Do you think the standard for 'modern buildings' (that is, those built after 1976 and not covered in this new legislation) are appropriate? | Not firm enough | About right | Too firm |
| 10 | How concerned are you about the danger of earthquakes where you live? | Not at all | Moderately | Extremely |
| 11 | How concerned are you about the issue of earthquake-prone buildings in Wellington? | Not at all | Moderately | Extremely |
| 12 | How effective do you think strengthening buildings will be in reducing damage and injury in a large earthquake? | Not at all | Moderately | Extremely |
| 13 | How much experience do you have of earthquakes? | None | Some | A lot |
| 14 | How much preparation had you made for the event of a large earthquake (e.g. secured fixtures such as TVs and bookshelves) before the recent Kaikōura earthquake? | None | Some | A lot |
| 15 | How much earthquake preparation have you already made since the recent Kaikōura quake? | None | Some | A lot |
| 16 | How much preparation do you intend to make in the next few weeks or months? | None | Some | A lot |
| 17 | To what extent do you think personal preparation is important for surviving earthquakes?t | Not at all | Moderately | Extremely |
| 18 | How much preparation have your family/friends made for a large earthquake? | None | Some | A lot |
| 19 | How often do your family/friends tell you that you should prepare for a large earthquake? | Never | Sometimes | A lot |
| 20 | Circle the pair which best describes your connection with the community where you live (S = Self, C = community) |   |   |   |

*Note*. Question 1 asked where participants lived. Questions 2 and 3 were manipulation checks.

Participants then answered 10 general questions regarding concern about earthquakes, concern about earthquake-prone buildings, efficacy of strengthening, experience of earthquakes, preparation before and (in the treatment group) after the Kaikōura earthquake, intentions to prepare, importancte of preparation, perceived interpersonal descriptive norm, and perceived interpersonal injunctive norm (see Table 2). Participants also completed the Inclusion of Community in Self scale (ICS; Mashek, Cannaday, & Tangney, 2007) to measure the strength of their identification with their community and demographic questions assessing age, gender, and time lived in Wellington to ensure that the post-quake sample closely matched the pre-quake sample.

### *Procedure*

The survey for the treatment group ran in December 2016. Participants could complete the Qualtrics-hosted survey on any Internet-enabled device. The first page of the survey briefly introduced the study and provided a link to a more detailed information page. After the demographic questions, participants received a debrief about the purpose and experimental nature of the study. Finally, participants could follow a link to a separate web page to provide their contact details to go into the draw for an $80 supermarket gift card. This study received ethical approval from the School of Psychology Human Ethics Committee under delegated authority of the Victoria University of Wellington Human Ethics Committee (approved: 23rd March, 2016; Reference number: 0000020938).

# Results

### *Descriptive Statistics*

Participants in the different social norm conditions did not statistically differ on any of the variables unrelated to the legislation ($p > .09$ for all): knowledge of the legislation, experience of earthquakes, earthquake preparation before or after the Kaikōura quake, age, time lived in Wellington, or gender distribution, in both the treatment and control groups. The two samples did not differ on gender distribution or time lived in Wellington ($p > .27$ for both), but the control group had a significantly higher mean age, $t(535) = 2.85$, $p < .01$, $d = 0.25$. This is a small effect (Cohen, 1992) and controlling for age did not change the pattern of results; therefore, the simpler analyses without this control are presented.

Table 3.
*Mean scores for participant and dependent variables for both groups, with standard deviations presented below in parentheses.*

| | Control group | Treatment group |
|---|---|---|
| Knowledge of legislation | 2.29 (1.49) | 2.90 (1.61) |
| Concern about earthquakes | 4.57 (1.45) | 4.98 (1.44) |
| Concern about earthquake prone buildings | 4.71 (1.30) | 5.21 (1.40) |
| Efficacy of strengthening | 5.41 (1.18) | 5.13 (1.37) |
| Earthquake experience | 4.64 (1.53) | 4.81 (1.43) |
| Earthquake preparation | 3.14 (1.55) | 3.83 (1.79) |
| Interpersonal descriptive norm | 3.45 (1.53) | 4.31 (1.57) |
| Interpersonal injunctive norm | 2.55 (1.45) | 3.65 (1.83) |
| Community identification | 3.26 (1.36) | 3.03 (1.27) |
| Support for legislation | 5.84 (1.22) | 5.50 (1.54) |
| Feasibility of strengthening | 4.74 (1.32) | 4.72 (1.62) |
| Comparative risk tolerance | 2.86 (1.12) | 2.50 (1.19) |

*Note.* The two questions regarding the appropriateness of the standard and the expense of the legislation (questions 7 and 8 in Table 1, respectively) were combined to create the variable 'Comparative risk tolerance', as both required participants to compare the risk of earthquakes to other risks. Lower scores on this scale represent lower tolerance for earthquake risk

### *Between-Group Comparisons*

Table 3 presents the means and standard deviations of the participant variables, comparing scores between the control group (i.e., those surveyed before the earthquake) and the treatment group (i.e., those surveyed after the earthquake).

**Mean differences between control and treatment groups.** This section reports the results of independent samples *t*-tests comparing the means of dependent variables where the responses could be affected by experience of the Kaikōura earthquake but not by the norm manipulation. Interestingly, reports of earthquake experience did not significantly differ between participants who answered this question before and after the Kaikōura quake ($p = .21$). Other evidence shows that this earthquake, which caused shaking for nearly two minutes, was widely felt in the sampled region; in a study of two Wellington suburbs, only 3% of participants reported the earthquake shaking as mild or not felt, with the remaining 97% describing the shaking as moderate (27%), strong (51%), or severe (19%; Blake et al., 2018). Although the quake struck around midnight, 78% of participants in the study by Blake et al. (2018) reported being woken by the shaking. Further, 69% of this study sample subsequently evacuated at some point in the hours after the earthquake during which an official tsunami warning was issued. It seems unlikely therefore that this earthquake was not objectively experienced, but that other factors meant that it did not increase subjective ratings of total earthquake experience. It is possible that this lack of change is due to a shift in comparative baseline; participants were aware that this study surveyed only people from Wellington so although estimates of the average amount of experience might have shifted, each participant's personal level of experience comparative to that estimated average would have remained fairly stable. Most participants would also likely have experienced the 2013 Cook Strait earthquake, which might have raised their perceived levels of experience to a point where a single event has negligible impact.

However, consistent with predictions, knowledge of the earthquake legislation was higher for participants surveyed after the Kaikōura earthquake, $t(550) = 4.89$, $p < .01$, $d = 0.42$, as was concern about both earthquakes in general, $t(544) = 3.02$, $p < .01$, $d = 0.26$, and earthquake-prone buildings, $t(544) = 4.25$, $p < .01$, $d = 0.36$, compared to the control group. As expected,

reports of both perceived descriptive norms, $t(540) = 6.36$, $p < .01$, $d = 0.55$, and injunctive norms, $t(523.24) = 7.32$, $p < .01$, $d = 0.64$, were higher following the earthquake, suggesting that those surveyed after the earthquake believed more that their friends and family were preparing and told them more frequently that they ought to prepare themselves than those surveyed before.

Judgments of the efficacy of strengthening earthquake-prone buildings were *lower* following the earthquake, $t(544) = 2.57$, $p = .01$, $d = 0.22$. In regards to general preparation actions, the treatment group reported greater levels of personal preparation both in comparison to the control group, $t(267) = 4.54$, $p < .01$, $d = 0.56$, and to their own recollection of their prior preparation, $t(342) = 7.96$, $p < .01$, $d = 0.86$. However, participants in the treatment group only reported moderate intentions to prepare in the subsequent weeks or months ($M = 4.09$, $SD = 1.82$). The relatively neutral intentions to prepare in the immediate future likely reflects the quick decay in the motivational effect of the earthquake on behaviour.

Although we found that concern about earthquakes in general, and earthquake-prone buildings specifically, was higher for participants surveyed after the Kaikōura earthquake, these perceptions appear to differ from judgments about the strengthening legislation. The lower judgments of efficacy following the earthquake suggests that participants do not think the current legislation will be effective at reducing the risk posed by earthquake-prone buildings. In support of this suggestion, participants in the treatment group judged the appropriateness of the standard for modern buildings as not firm enough, as demonstrated by a one-sample *t*-test comparing the mean score ($M = 2.81$, $SD = 1.26$) with the neutral midpoint of the scale (4), $t(342) = 17.39$, $p < .01$, $d = 0.94$. Although this mean is still higher than the standard for the older buildings covered by the legislation ($M = 2.13$, $SD = 1.22$; $t(342) = 8.58$, $p < .01$, $d = 0.93$), this result shows that participants did not think buildings currently are being built to a high enough standard which may reflect the fact that most of the buildings severely damaged in this earthquake were relatively modern. However, as this question was not asked in Vinnell et al. (2018), it is not possible to determine with the available data if the earthquake did indeed affect the judgment of new building standards. The potential mechanism for this effect, relating to the distinctive damage to modern buildings, is discussed later.

Overall, these results are largely in line with predictions. The findings suggest that the earthquake did have an impact on risk-related knowledge, judgments, and behaviour, even though mean scores on the experience item did not change. Implications for these findings are presented in the discussion section.

### *Social Norm Effects Within and Between Groups*

Table 4 presents the mean scores of the key dependent variables across norm conditions, as well as between the treatment and control groups. The two questions regarding the appropriateness of the standard and the expense of the legislation (questions 7 and 8 in Table 1, respectively) were combined to create the variable "Comparative risk tolerance" as both required participants to compare the risk of earthquakes to other risks. Spearman-Brown's coefficient, which is more appropriate than Cronbach's alpha for a two-item scale (Eisinga, Grotenhuis, & Pelzer, 2013), was at .52. However, the inter-item correlation of .37 meets the recommended level of either above .3 (Robinson, Shaver, & Wrightsman, 1991) or between .15 and .50 (Clark & Watson, 1995). The following tests were also run for the two items individually, which produced similar patterns of findings. Therefore, in the interest of parsimony and cohesion with previous research (Vinnell et al., 2017; Vinnell et al., 2018), the results for the two-item scale are presented. Lower scores on this scale represent lower tolerance for earthquake risk.

Table 4.
*Mean scores for the key dependent variables across conditions and between the two groups, with standard deviations presented below in parentheses.*

| | Control group | | | | | Treatment group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Descriptive | Injunctive | Combined | Risk | Average | Descriptive | Injunctive | Combined | Risk | Control | Average |
| Support | 5.65 (1.32) | 6.00 (1.15) | 5.99 (1.14) | 5.72 (1.26) | 5.84 (1.22) | 5.36 (1.26) | 5.87 (1.53) | 5.69 (1.50) | 5.17 (1.68) | 5.35 (1.61) | 5.50 (1.54) |
| Feasibility | 4.68 (1.19) | 4.68 (1.36) | 5.03 (1.38) | 4.56 (1.31) | 4.74 (1.32) | 4.78 (1.47) | 4.57 (1.70) | 5.11 (1.85) | 4.71 (1.52) | 4.41 (1.77) | 4.72 (1.62) |
| Comparative risk | 2.78 (1.11) | 2.83 (1.14) | 2.95 (1.11) | 2.87 (1.14) | 2.86 (1.12) | 2.44 (1.19) | 2.49 (1.09) | 2.62 (1.39) | 2.42 (1.22) | 2.54 (1.03) | 2.50 (1.19) |

We used a series of 4 (norm condition: descriptive norm, injunctive norm, combined norm, and risk information) by 2 (group: treatment or control) two-way Analyses of Variance (ANOVAs) to test whether the norm manipulation affected key judgments differently for participants surveyed before and after the earthquake. These tests compare the means of a single dependent variable between groups split on two independent variables (in this case, norm condition and group). These tests show whether there is a difference between means in the dependent variable based on each of the individual independent variables (termed main effects), and whether those effects interact; that is, whether social norms have a differential impact on judgments for those surveyed before compared to those surveyed after the earthquake. Main effects are interpreted with follow-up tests to identify between which particular groups there is a difference. We report post-hoc Tukey HSD tests for the individual between-condition comparisons as these control for pairwise error rate (i.e., increased chance of finding significant effects due to the large number of comparisons). Because the control group survey did not include the same norm control condition used in the treatment survey, this condition was not included in the two-way ANOVAs. Therefore, we also report one-way ANOVAs comparing the mean scores for the different norm conditions within the treatment group. Finally, we report independent samples *t*-tests for main effects of group, as post-hoc Tukey tests are not computed when the variable only has two levels (treatment and control).

**Support.** Comparing the norm effects on support for the earthquake-strengthening legislation between the two treatment groups using a two-way ANOVA revealed no significant interaction between norm condition and group, $F(3, 543) = .61$, $p = .60$; experience of the earthquake therefore did not affect the influence of norms on support for the legislation. This finding suggests that, contrary to predictions, the norm effect on support was relatively stable even with increased knowledge and concern about the issue. We did however find a main effect of group, $F(1, 543) = 7.59$, $p < .01$, $\eta p^2 = .014$. Contrary to predictions, support for the legislation was *lower* after the earthquake, $t(523.67) = 2.67$, $p = .01$, $d = .23$, than before. We predicted that support would be higher following the earthquake as past research has repeatedly demonstrated that earthquake experience increases risk perceptions (Solberg et al., 2010), which could logically lead to more support for legislation to mitigate that risk. Implications for this finding, in the context of other results presented above, are discussed later. Further, we found a main effect of norm condition, $F(3, 543) = 4.43$, $p < .01$, $\eta p^2 = .024$. Overall, support for the legislation across both groups was significantly higher among those presented with the injunctive norm than risk information, $p = .018$, and marginally significantly higher than the descriptive norm, $p = .056$.

A follow-up one-way ANOVA of the treatment group to include the control information condition showed that support for the legislation varied significantly between norm conditions, $F(4, 338) = 2.50$, $p = .043$, $\eta p^2 = .029$. The injunctive norm led to significantly higher support than the risk information, $p = .006$, as did the combined norm, $p = .034$. These findings replicate those of Vinnell et al. (2018) and show that injunctive norms can be used to increase support for earthquake-related legislation. However, support in the injunctive norm condition did not differ from support in either the combined norm or the control condition. This suggests that past findings might be due to a negative effect of the risk information, therefore increasing the apparent effect of the injunctive norm.

**Feasibility.** As with the analysis for support, there was no significant interaction of norm condition and treatment group on judgments of the feasibility of carrying out the strengthening work, $F(3, 544) = 0.19$, $p = .91$. There was no main effect of treatment group, $F(1, 544) = 0.16$, $p = .69$, suggesting that these judgments of feasibility did not change after the earthquake. There was however a main effect of norm condition, $F(3, 544) = 3.08$, $p = .027$, $\eta p^2 = .017$. Post-hoc tests demonstrated significantly higher judgments of feasibility by those in the combined norm condition compared to both the risk information condition, $p = .039$, and in the injunctive norm condition, $p = .049$. These findings are in line with those found by Vinnell et al., (2018), except for the absence of the marginal effect found in Vinnell et al. where feasibility was judged higher in the descriptive norm condition than the risk information condition.

However, when norm effects were explored in the treatment group alone to include the fifth condition (control; no information), there was no overall difference in mean scores of feasibility, $F(3, 339) = 1.90$, $p = .11$, suggesting that the above main effect was driven by differences between norm conditions in the control group. Therefore, although the main effect of group was not significant, this lack of norm effects in the treatment group suggests that the influence of norm information did decrease following the earthquake.

**Comparative risk.** As with the above analyses, there was no interaction of norm condition and group for comparative risk judgments, $F(3, 543) = 0.097$, $p = .96$. There was also no main effect of norm condition, $F(3, 543) = 0.57$, $p = .63$. However, comparative risk did significantly differ between the treatment and control groups, $F(1, 543) = 13.16$, $p < .001$, $\eta p^2 = .024$. A follow-up *t*-test shows that those in the treatment group were significantly less tolerant of risk, $t(549) = 3.64$, $p < .01$, $d = 0.31$, than those in the control group. This finding suggests that participants saw more value in addressing the risk of earthquake-prone buildings after the earthquake, in contrast to the finding of lower support. It is possible that participants support strengthening but not necessarily in the manner mandated by the legislation.

**Community identification.** Finally, there was no interaction of norm condition and group for community identification, $F(3, 531) = 1.78$, $p = .15$. There was a significant main effect of group, $F(1, 531) = 4.92$, $p = .027$, $\eta p^2 = .009$, whereby community identification was weaker in the treatment group than in the control group, $t(537) = 2.16$, $p = .03$, $d = 0.19$, suggesting that the event did not lead to an increase in perceived connection with the community as was seen following the Canterbury earthquakes (Britt et al., 2011). Further, there was no main effect of norm condition, $F(4, 531) = 0.37$, $p = .77$. A follow-up ANOVA further demonstrated no norm effects in the treatment group, $F(4, 335) = 0.34$, $p = .85$. Similar to the findings for feasibility, this lack of an effect where one was found in Vinnell et al. (2018) suggests a weakening of the influence of norm information following the earthquake, although this decrease was not large enough to create a significant interaction.

## Discussion

Exploring the impact of earthquake experience on related judgments and behaviour is challenging given the unpredictability of such events. Past researchers have used a variety of methods to address this challenge such as retrospective self-reports (McClure et al., 2011), use of existing longitudinal data (e.g., Milojev, Osborne, & Sibley, 2014), and comparing affected and unaffected areas (McClure et al., 2015). This study used a natural experiment design by running a replication of the same survey before and shortly after the 2016 Kaikōura earthquake. While the same sample could not be used because the first survey was anonymous, the same sampling methods were used with the same population to allow for more confidence in statistical comparisons. Only age differed between the two samples, and controlling for this had no effect on the pattern of results.

Reports of earthquake experience did not change after the Kaikōura earthquake, perhaps due to the question being interpreted as comparative to other Wellingtonians. It is also possible that the 2013 Cook Strait earthquakes had raised self-perceptions of experience to a level too high to be raised by a single subsequent event. The overall pattern of results consistent with predictions supports the assumption that the Kaikōura earthquake did affect behaviours and opinions of Wellingtonians, even though reported experience was not higher after the earthquake. Given that the shaking lasted two minutes, that GeoNet, NZ's earthquake monitoring and reporting website, received 15,840 reports of felt shaking, and that one study found a vast minority (<3%) did not feel shaking (Blake et al., 2018), it is unlikely that many people in Wellington did not experience the actual event. However, even if it was assumed that participants in the treatment group *did not* experience the actual shaking, experience of an earthquake extends beyond feeling the shaking. Following the earthquake, cordons were put up in the central business district, workers were encouraged to stay home, and several buildings were closed or demolished. Further, the experience of the event included a large number of news reports across all media and an increase in conversation around earthquakes, as evidenced by the increase in perceptions of norms seen in this study. It is therefore highly unlikely that the participants in the treatment group did not, in some way, experience the earthquake. Future research could consider including a wider range of questions regarding earthquake experience, including differentiating between experience of shaking and of impacts of shaking, as well as questions targeted to citizens' experience of the particular event under study. These items were not included in this study to keep the surveys as consistent as possible across the two time points; we acknowledge that this is a limitation in our methodology.

As expected, we found higher knowledge of the legislation and concern about earthquakes and earthquake-prone buildings after the earthquake. Further, and again as expected, reports of personal preparation were higher after the earthquake, although the neutral rather than strong intentions to prepare in the immediate future found here suggest that this increase might not be maintained, consistent with previous

research (McRae et al., 2017). The stronger effect for the retrospective self-report measure of preparation suggests that participants in the treatment group, who completed the survey after the Kaikōura earthquake, did exhibit a hindsight bias; that is, they believed that they were less prepared before the earthquake, perhaps due to gaps in their preparedness highlighted by the event. For example, many people in areas of Wellington were not prepared to evacuate for a tsunami following the earthquake (Blake et al., 2018). This difference reveals one of the strengths of a natural experiment in that it tests more objective changes in preparation behaviour as the method typically does not rely on retrospective self-report measures which are prone to bias.

Reports of perceived descriptive and injunctive norms for preparation were also higher in the treatment group, suggesting that participants saw more people around them preparing for earthquakes and engaged in more conversations about the importance of doing so. This finding is encouraging as it implies that earthquake preparation is seen and discussed, at least at an interpersonal level; this is one of the key prerequisites for social norms to develop (Cialdini et al., 1990). The time following a hazard event could therefore be effectively used to increase preparation by taking advantage of the already-strengthened norms.

However, community identification was weaker after the earthquake. This could be due to the low levels of disruption from the Kaikōura earthquake (at least for our participants who live in Wellington) so that people were able to look after themselves without the help of their community. Given the important role that community and social networks play in the wake of a disaster (Britt et al., 2011), future research could explore the potential for a vital community response in Wellington and ways to increase both the probability of this occurring and the extent if it does occur.

Concern about earthquake-prone buildings was higher and tolerance of the risk of earthquake-prone buildings was lower after the Kaikōura event. However, both judgments of the efficacy of strengthening prone buildings and support for the legislation *decreased*. This unexpected finding could be due to the nature of the damage which occurred during the Kaikōura earthquake. In Wellington especially, several newer high-profile buildings were damaged to the extent of being unusable, such as Statistics House, completed in 2005 (Devlin, 2017). This building is not covered under the earthquake strengthening legislation as the changes made to the building code in 1976 meant that buildings constructed since then should already be at the standard required by the legislation. It is possible that the participants did not see important benefits of older buildings being brought closer to the standard of new buildings given that new buildings were the ones that failed. While there are explanations for this specific damage from engineering and seismological perspectives, it is likely that these explanations are not commonly known or understood.

Stevenson et al. (2017) suggest that this relative lack of damage to earthquake-prone buildings may lead to an increase in complacency. Although this study found greater concern following the earthquake, we did not find a commensurate increase in support for the legislation. This finding has important implications for how the legislation is communicated should public support be required, including recruiting experts to explain that the new buildings standards are in fact an improvement from those set before 1976 and thoroughly communicating explanations for the failure of modern buildings so that confidence in the current standards is not lessened.

A further purpose of this study was to test the robustness of norm effects following a large natural hazard event, as previous research suggests that norm effects are stronger when the situation is more ambiguous (Goldstein et al., 2007) and individuals are less biased (Morris et al., 2015). Knowledge of the legislation (i.e., situational ambiguity) and concern about earthquake-prone buildings (i.e., beliefs about the topic) were higher after the earthquake. While none of the two-way ANOVAs demonstrated a significant interaction of norm condition and treatment group, the pattern of norm effects differed before and after the earthquake as predicted. The descriptive norm had no effect on judgments of feasibility and the injunctive norm effect on support for the legislation was only found in comparison to the risk information condition. Further, where norm effects were found for feasibility and community identification in Vinnell et al. (2018), no such effects were found in the treatment group here. However, the finding of one significant norm effect in this study indicates that even a recent earthquake is not sufficient to nullify a norm message. This type of information is therefore useful to further explore in this context as it is at least partially robust to the impact of natural hazard events.

A major strength of this study is its natural experiment design. The two surveys were conducted within months of each other and the use of nearly-identical

measures and recruitment increases confidence in suggesting that the Kaikōura earthquake contributed to differences between the control and treatment groups. This method reduces the impact of biases from using retrospective self-report among a single sample and the potential of mere measurement effects, where people answer questions differently in part because they have answered the same or related ones before (e.g., Morwitz & Fitzsimons, 2004). Demand for these types of methods is increasing due to the real-world relevance of the data they provide (Leatherdale, 2019).

The lack of a control group in Vinnell et al. (2018) was a significant limitation of that study, although the use of a proxy control in a similar previous study suggests that the impact of this limitation was minor (Vinnell, 2016). However, in the present study which does use a control group, the injunctive norm only increased support for the legislation compared to the risk condition and not compared to the control. This suggests that the positive effect of the injunctive norm might only be significant when paired with a negative effect of risk information. While the use of controls is relatively standard in experimental practice, further rigour in this regard is required.

This study used a natural hazard event to examine the impact of recent, direct earthquake experience on norm effects. While these effects of norm messages on judgments were lessened after the earthquake as expected, they did not disappear entirely, supporting the further exploration of social norms as a robust strategy to alter disaster-related judgments and behaviours. The study also showed that perceptions of norms of earthquake preparation can *increase* after a disaster, suggesting that the time post-event presents a valuable opportunity to use existing normative beliefs to encourage preparation conversations and actions. This can facilitate efforts to create a cultural shift in how people act and think in regards to disaster preparation.

## Acknowledgments

This research was supported by a Victoria University of Wellington MSc grant and part-funded by the National Science Challenge: Resilience to Nature's Challenges. We would like to thank our participants for undertaking these surveys and our peer reviewers for their valuable suggestions. This publication was partially supported by QuakeCoRE, a New Zealand Tertiary Education Commission-funded Centre. This is QuakeCoRE publication number 0499.

## References

Becker, J., Paton, D., Johnston, D., & Ronan, K. (2014). Societal influences on earthquake information meaning-making and household preparedness. *International Journal of Mass Emergencies and Disasters, 32*(2), 317-352.

Blake, D., Johnston, D. M., Leonard, G. S., McLaren, L., & Becker, J. S. (2018). A citizen science initiative to understand community response to the Kaikoura earthquake and tsunami warning in Petone and Eastbourne, Wellington, Aotearoa/New Zealand. *Bulletin of the Seismological Society of America, 108*(3), 1807-1817. doi: 10.1785/0120170292_

Britt, E., Dorahy, M., Carter, J., Hoggath, P., Coates, A., Meyer, M., & Naswall, K. (2011). Promoting recovery and building resilience for individuals and communities. *New Zealand Journal of Psychology, 40*(4), 76-78.

Cialdini, R. B. (2007). Descriptive social norms as underappreciated sources of social control. *Psychometrika, 72*(2), 263-268. doi: 10.1007/s11336-006-1560-6

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58*(6), 1015-1026. doi: 10.1016/S0065-2601(08)60330-5

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in scale development. *Psychological Assessment, 7,* 309-319. doi: 10.1037/1040-3590.7.3.309

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155-159. doi: 10.1037/0033-2909.112.1.155

Cozby, P. C., & Bates, S. C. (2012). *Methods in behavioral research* (11th ed.). New York, NY: McGraw-Hill.

Dempsey, R. C., McAlaney, J., & Bewick, B. M. (2018). A critical appraisal of the social norms approach as an interventional strategy for health-related behavior and attitude change. *Frontiers in Psychology, 9,* 1-16. doi: 10.3389/ypsyg.2018.0218

Devlin, C. (2017, December 28). Demolition begins on earthquake-damaged Statistics House in Wellington. *Dominion Post.* Retrieved from www.stuff.co.nz

Eisinga, R., Grotenhuis, M., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health, 58,* 637-642. doi: 10.1007/s00038-012-0416-3

Farrow, K., Grolleau, G., & Ibanez, L. (2017). Social norms and pro-environmental behavior: A review of the evidence. *Ecological Economics, 140,* 1-13. doi:10.1016/j.ecolecon.2017.04.017

Goldstein, N. J., Griskevicius, V., & Cialdini, R. B. (2007). Invoking social norms: A social psychology perspective on improving hotels' linen-re-use programs. *Cornell Hotel and Restaurant Administration Quarterly, 48*(2), 145-150.

Grace-Martin, K. (n.d.). When unequal sample sizes are and are not a problem in ANOVA. Retrieved from www.theanalysisfactor.com/when-unequal-sample-sizes-are-and-are-not-a-problem-in-anova/

Lapinski, M. K., & Rimal, R. N. (2005). An explication of social norms. *Communication Theory, 15*(2), 127-147. doi: 10.1111/j.1468-2885.2005.tb00329.x

Leatherdale, S. T. (2019). Natural experiment methodology for research: A review of how different methods can support real-world research. *International Journal*

*of Social Research Methodology, 22,* 19-35. doi: 10.1080/13645579.2018.1488449

Mashek, D., Cannaday, L. W., & Tangney, J. P. (2007). Inclusion of Community in Self Scale: A single-item pictorial measure of community connectedness. *Journal of Community Psychology, 35*(2)*,* 257-275. doi: 10.1002/jcop.20146

McClure, J., Johnston, D., Henrich, L., Milfont, T., & Becker, J. (2015). When a hazard occurs where it is not expected: Risk judgments about different regions after the Christchurch earthquakes. *Natural Hazards, 75,* 635-652. doi: 10.1007/s11069-014-1338-6.

McClure, J., Willis, C., Johnston, D., & Recker, C. (2011). New Zealanders' judgments of earthquake risk before and after the Canterbury earthquake: Do they relate to preparedness? *New Zealand Journal of Psychology, 40*(4), 7-11.

McRae, C., McClure, J., Henrich, L., Leah, C., & Charleson, A. (2017). Reactions to earthquake hazard: Strengthening commercial buildings and voluntary earthquake safety checks on houses in Wellington, New Zealand. *International Journal of Disaster Risk Reduction, 28,* 465-474. doi: 10.1016/j.idrr.2017.12.007

Milojev, P., Osborne, D., & Sibley, C. G. (2014). Personality resilience following a natural disaster. *Social Psychological and Personality Science, 5,* 760-768. doi: 10.1177/1948553614528545

Morris, M. W., Hony, Y., Chiu, C., & Liu, Z. (2015). Normology: Integrating insights about social norms to understand cultural dynamics. *Organizational Behavior and Human Decision Processes, 129*, 1-13. doi: 10.1016/j.obhdp.2015.03.001

Morwitz, V. G., & Fitzsimons, G. J. (2004). The mere-measurement effect: Why does measuring intentions change actual behavior? *Journal of Consumer Psychology, 14,* 64-73. doi: 10.1207/s15327663jcp1401&2_8

Oishi, S., Kohlbacher, F., & Choi, H. (2018). Does a major earthquake change attitudes and well-being judgments? A natural experiment. *Social Psychology and Personality Science, 9*, 364-371. doi: 10.1177/1948550617707016

Robinson, J. P., Shaver, P. R., & Wrightsman, L. S. (1991). Criteria for scale selection and valuation. In J. P. Robinson, P. R. Shaver, & L. S. Wrighstman (Eds.), *Measures of personality and social psychological attitudes* (pp. 1-5). San Diego, CA: Academic.

Russell, L. A., Goltz, J. D., & Bourque, L. B. (1995). Preparedness and hazard mitigation before and after two earthquakes. *Environment and Behavior, 27,* 744-770. doi: 10.1177/0013916595276002

Smith, R. E., Leffingwell, T. R., & Ptacek, J. T. (1999). Can people remember how they coped? Factors associated with discordance between same-day and retrospective reports. *Journal of Personality and Social Psychology, 76*(6), 1050-1061. doi.org/10.1037/0022-3514.76.6.1050

Solberg, C., Rossetto, T., & Joffe, H. (2010). The social psychology of seismic hazard adjustment: Re-evaluating the international literature. *Natural Hazards and Earth System Sciences, 10,* 1663-1677. doi: 10.5194/nhess-10-1663-2010, 2010

Stevenson, J. R., Becker, J., Cradock-Henry, N., Johal, S., Johnston, D., Orchiston, C., & Seville, E. (2017). Economic and social reconnaissance: Kaikōura earthquake 2016. *Bulletin of the New Zealand Society for Earthquake Engineering, 50,* 343-351.

Vinnell, L. J. (2016). *Examining the effects of message framing and social norms on judgments of earthquake legislation* (Master's thesis). Retrieved from ResearchArchive. (5471)

Vinnell, L. J., McClure, J., & Milfont, T. L. (2017). Do framing messages increase support for earthquake legislation? *Disaster Prevention and Management, 26,* 28-40. doi: 10.1108/DPM-06-2016-0127

Vinnell, L. J., Milfont, T. L., & McClure, J. (2018). Do social norms affect support for earthquake strengthening legislation? Comparing the effects of descriptive and injunctive norms. *Environment and Behavior, 51,* 376-400. doi: 10.1177/0013916517752435

Wellington City Council. (n.d.). Earthquake-prone buildings [PDF file]. Retrieved from https://wellington.govt.nz/~/media/services/%20rates-and-property/earthquake-prone-buildings/files/%20earthquake-prone-brochure.pdf

Wellington City Council. (2015). List of earthquake-prone buildings as at 20/11/2015 [PDF file]. Retrieved from http://wellington.govt.nz/~/media/services/rates-and_property/earthquake-prone-buildings/files/eqp-building-list.pdf

White, H., & Sabarwal, S. (2008). *Quasi-experimental design and methods, methodological briefs: Impact evaluation 8.* Italy: UNICEF Office of Research.

Winter, C. (2017, June 21). Insurance claims total $1.84 billion for Kaikoura earthquake. *Stuff.* Retrieved from www.stuff.co.nz.