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Social influences on behavioural response to earthquake shaking

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ABSTRACT

Many earthquake injuries in Aotearoa New Zealand occur because people either do not act quickly to protect themselves or act in a way which can lead to harm. Earthquakes are an uncertain context in which to make behavioural decisions. Previous research has demonstrated that people's initial response to earthquake shaking is to wait and see if the shaking continues or increases in intensity. Evidence also suggests that people frequently look to those around them for behavioural cues. We discuss this evidence, in the context of underlying psychological phenomena which might explain these behavioural tendencies in response to the uncertainty of earthquake shaking, in particular social norm theory. As part of our discussion, we present evidence from Closed-Circuit Television (CCTV) footage of the 2016 Kaikōura earthquake at Wellington International Airport, Aotearoa New Zealand. We make suggestions for future work exploring the role of social influences on behavioural responses to earthquake shaking including varied study methods and data types.

1 INTRODUCTION

1.1 Earthquake impacts and safety

In the last two decades, thousands of people in Aotearoa New Zealand have been injured during earthquakes (Abeling et al., 2020; Basharati et al., 2020; Horspool et al., 2020). Many of these injuries occur when people either fall during shaking or are struck by moving objects (Horspool et al, 2020). These injuries can be reduced by taking appropriate protective actions; in New Zealand, the recommended behaviour is to "Drop, cover, and hold". Despite ongoing public education to teach these actions (Vinnell et al., 2020), few people tend to act appropriately to protect themselves during shaking (Johnston et al., 2014; Lambie et al., 2017; Vinnell et al., 2021). To increase the proportion of people undertaking appropriate protective actions during earthquakes, it is important to understand motivations for current common behaviours during shaking. One reason for people not responding appropriately to earthquakes is a concern about being perceived as overacting; embarrassment is a common reason for people not practising "Drop, cover, and hold" in the annual New Zealand ShakeOut

earthquake drill (McBride et al., 2019). Many people in New Zealand report that they do not take self-protective actions because they wait for the earthquake to continue or increase in strength, while others act to protect people around them or undertake actions which they believe are protective (e.g., running outside, which is recommended in some countries; Vinnell et al., 2021).

1.2 Social influences on behaviour

Many of the potential motivations for earthquake response behaviour align with the suggestion that how people decide to act is at least partially influenced by those around them (McBride et al., 2022). While some hazard-specific theories incorporate a component of social cues (e.g., the Protective Action Decision Model; Lindell & Perry, 2012), decades of research in the domain of social psychology offers mechanisms by which individuals' behaviour is influenced by their knowledge or perceptions of other people's behaviour. These include: the bystander effect, particularly the component of social influence whereby people look to those around them to determine whether and how to act, particularly in a potential emergency (Latané & Darley, 1968); social norms theory, which identifies how behaviour is influenced by what other people do and approve (Cialdini et al., 1990); and the related Emergent Norm Theory (Wood et al., 2018), which explores how patterns of behaviour emerge within groups. Across these theories is the idea that social behavioural influences are stronger when people are in new, uncertain, ambiguous, or emergency situations where they have less prior information about how to act (Goldstein et al., 2007). For example, in a classic study of the bystander effect, men were more likely to react to smoke filling a room when they were alone than when there were other men who did not respond to the smoke (Latané & Darley, 1968). People take cues from those around them about the risk posed by a potential hazard and consider their behaviour in relation to the behaviour of others.

Social norms theory identifies two main types of norms: descriptive and injunctive. Descriptive norms refer to how common a behaviour is within a particular group. If more people around someone are undertaking a particular behaviour, that individual is more likely to also engage in that behaviour. This motivation is adaptive; if many people like yourself are acting in a certain way, it is likely to be a beneficial behaviour (Goldstein et al., 2007). Injunctive norms refer to whether a behaviour is approved of within a particular group; people are more likely to engage in a behaviour of which they think others around them approve. This motivation is also adaptive, but in a different way. Acting in line with an injunctive norm offers the potential of social approval as a reward while acting against an injunctive norm risks social disapproval as a punishment (Cialdini, 2007). While descriptive norms can convey an implicit injunctive norm (i.e., the assumption that if most people in a group are engaging in a particular behaviour, then that group likely approves of that behaviour), these two types of norms have been shown to have discrete influences on behaviour, including in the domain of earthquake research (Vinnell et al., 2018). For example, earthquake preparation is relatively low in New Zealand despite a positive injunctive norm in part because people are hesitant to contravene the negative descriptive norm of "unpreparedness" (Becker et al., 2014). It is possible, therefore, that people in New Zealand know they should "Drop, cover, and hold" but do not do so if people around them are not.

Previous research to understand social influences on behaviour therefore suggests that during the relatively uncommon experience of earthquake shaking, and where there is a potential for injury, people are likely to look to those around them for behavioural cues. However, the extent to which people are influenced by others during earthquakes, and how those effects differ depending on who those others are, has not been thoroughly explored. To demonstrate ways in which social influences could work, we describe examples from coded Closed-Circuit Television (CCTV) footage from Wellington International Airport during the 14 November 2016 M7.8 Kaikōura earthquake (see Figure 1 for an example). These examples cover three main considerations: how do people act when they are around dependents for whom they are responsible, are people differently influenced by the behaviour of strangers compared to people they know, and are people influenced by the behaviour of actual or perceived authority figures (such as uniformed employees when they are in a place of work).

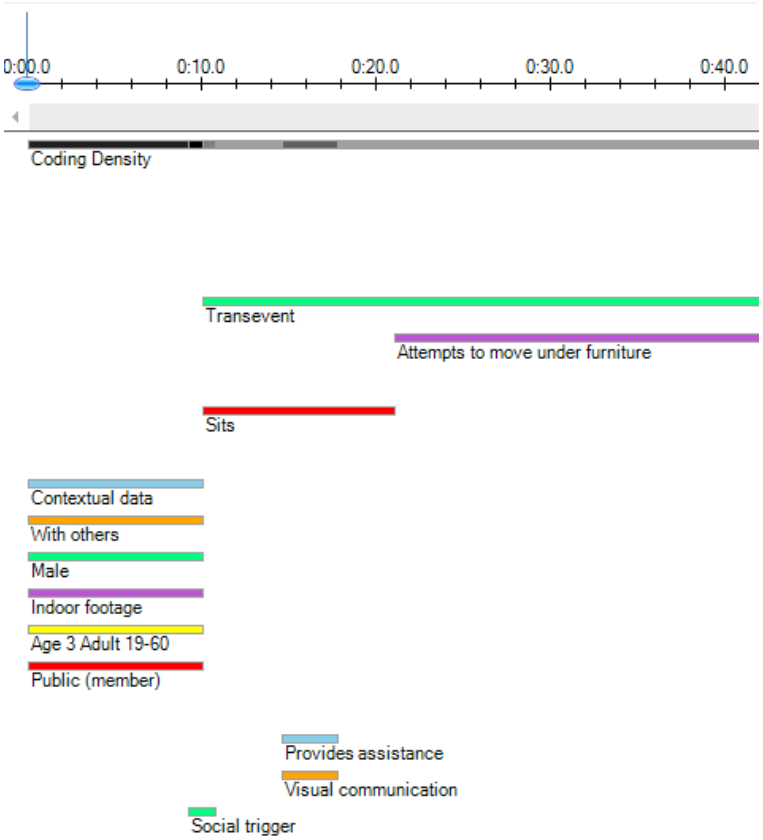

Figure 1: Example of coded transevent (during shaking) behaviour

2 EXAMPLES FROM CCTV FOOTAGE

2.1 Dependents

Previous research analysing CCTV footage from the 22 February 2011 Christchurch earthquake demonstrated that adults who were around a child tended to act to protect that child (Lambie et al., 2017), consistent with survey-based research which has shown that protecting dependents is a common reason for not undertaking self-protective actions (Vinnell et al., 2017). There are few children in the footage for our study, potentially due to the time of the earthquake (12.02 a.m.). One video contains a family appearing to consist of parents, their young son, and their young daughter. When the shaking starts, the son looked around to other people but then moved to the father and sister and crouched down with them. The mother was initially separated; during the shaking she moved across the room to the family group and joined them crouching on the ground. This behaviour is an understandable reaction to a stressful situation but likely increased the mother's chance of injury given the heightened risk from moving around during earthquake shaking.

2.2 Strangers versus companions

There were other instances where people appeared motivated to protect others they were with, who were not dependents. In one video, approximately half of the observed individuals dropped and/or took cover by a structure such as a column, while the other half left the area. This split of behaviour led to interesting observations of potential social influences. For example, in one pair of individuals who appear to know each other, one of them was sitting and looked around as shaking started. He stayed when people around him began to move away, but after the person he was with began attempting to get under her seat he moved to help her

and then also covered under his seat. Another pair followed a similar pattern, a woman dropping to the floor and a man doing the same after she gestured for him to join her. However, some other examples involving similar pairs did not follow the same pattern. In another video, as with the previous examples, a woman drops when the shaking starts and eventually covers her head. The man with her continues standing, only dropping once the shaking increases and makes it difficult to remain standing. He then shields the woman in an outwardly protective action, but does not cover, hold, or take other self-protective actions. In this case, no one else around them follows the woman's lead either, despite her exhibiting the recommended actions of "Drop, cover, and hold".

Individuals who were alone did tend to follow the behaviour of some surrounding people but usually with a delay. For example, a man sitting alone looked around as shaking started. People around him stood up and then dropped to the floor; after a delay, he copied them. This example suggests that people are undertaking a decision-making process using the behaviour of those around them as a factor informing that decision. If the response to shaking was solely driven by the behaviour of others, there would be likely be less delay in mimicking. A clear example of this, from a different video, shows a woman who reacted to the initial shaking by walking. She then looked around and observed that others around her had remained standing in their original positions. She then ambulated (walked without a clear direction) and looked around, before eventually moving back to her bag cart where she had been when the shaking started. When the shaking increased in strength, she began to run in one direction. She then changed direction, after looking around and seeing other people crouching on the floor by a structure, to run towards those people and followed their cue of dropping and bracing. This behaviour suggests a conflict of an instinctual reaction (to move) and a social cue (to stay still), with the latter eventually exhibiting a stronger influence. This example also demonstrates a strength of CCTV analysis over other methods such as surveys, as they allow for a more nuanced exploration of how people's behaviour changes throughout the shaking and the possibility of identifying social influences on those changes.

2.3 Authority figures

In one room, an opaque wall separated two groups; one group was comprised entirely of airport staff, while the other group had a mix of staff and members of the public. Members of both groups appeared to be influenced by those around them. In the latter case, members of the public appear to be guided to drop by the staff. In the group of only staff, one individual drops and covers, but then stands and follows his colleagues when they leave the room. These two groups, therefore, displayed different behaviour even though they were in the same room feeling the same shaking with similar hazards in terms of structural and non-structural building elements. However, in both groups there was clear influence from people with perceived authority. In a different video containing two airport workers and 15 to 20 members of the public, neither of the workers take any protective actions but remain standing during the shaking. Similarly, most of the public also remain standing, although it is unclear to what extent the airport staff not acting influenced the decision of others in the area. This example demonstrates a limitation of CCTV footage analysis; motivations for behaviour can only be assumed based on visual evidence. People tend to defer to authority figures (Cialdini & Goldstein, 2004), although New Zealand is low on power distance (a measure of rigidity of hierarchies and accessibility to "superiors"; Hofstede Insights, 2021).

3 OTHER CONSIDERATIONS

There is a range of considerations that need to be made when interpreting responses to earthquake shaking, particularly across contexts. In New Zealand, for example, there are more reported earthquake injuries among women than men (Basharati et al., 2020). There are several potential explanations for this difference, including a known tendency for women to seek medical treatment more often than men in New Zealand (Jatrana & Crampton, 2009) and persisting societally based gender roles influencing motivation to protect dependents such as children. Injuries also tend to be higher among middle-aged and elderly than younger age groups

(Basharati et al., 2020). It is possible that this difference reflects the more recent promotion in schools of "Drop, cover, and hold" as the recommended protective actions in New Zealand, which has not ubiquitously replaced the older belief that doorways are the safest place during earthquakes. It is also possible that patterns of social influence would differ in parts of the country where earthquakes are less common. According to social norms theory, people would be more inclined to follow the behaviour of people around them in areas where earthquakes are less common because they would have less experience and prior knowledge to use in deciding how to respond. However, it would also be less likely that there would be someone nearby modelling appropriate behaviour for the same reasons. Consequently, it could be expected that there would be a stronger social influence but a wider variety of behaviours, particularly inappropriate actions, exhibited. Finally, it is probable that strength and patterns of social influence would differ between countries; norm effects tend to be stronger in countries that are less economically developed and more collectivistic (i.e., people's behaviour is more determined by the needs and opinions of others; Fischer, Karl, & Fischer, 2019). New Zealand on average is relatively individualistic (Brougham & Haar, 2013), suggesting that social influences may be weaker than in some other countries. An important caveat here is that some of the footage in this study is from international arrival areas, so it is possible that some people are not typically resident in New Zealand.

3.1 Future research

CCTV footage is a useful data source as it provides visual evidence of contextual influences and objective data about people's behaviour, in contrast to other common methods such as retrospective surveys when can be influenced by issues such as memory errors. In order to fully understand what people do during earthquakes and, crucially, *why*, we need to use a combination of data types. While motivations can be inferred from visual evidence in the footage, retrospective data collection such as surveys and interviews can provide more nuanced information about people's decision-making process during earthquake shaking. Several countries have established permanent surveys for people to provide their experiences of specific earthquake events, such as NZ's Felt Reports run by GeoNet (Goded et al., 2021) and the USGS's Did You Feel It? survey (Wald et al., 1999). Other work could explore people's behavioural decisions during earthquake shaking using experimental methods and earthquake simulators. Possibilities include confederate studies, where one person is "planted" in a group of participants and instructed to act in a certain way to test whether those participants follow their behaviour. These sorts of experimental designs can help to determine the extent of social influences. In the broader context, we can supplement this knowledge of human behaviour with information about how different behaviours interact with building design, such as non-structural elements, in the occurrence of injuries and fatalities. This could include, for example, testing the effectiveness of different protective actions to reduce potential injury from building components (e.g., ceiling tiles) and furniture or other common household/workplace objects.

3.2 Implications and applications

There are several ways in which this work, and the work proposed in the previous section (some of which is being planned or ongoing), can be implemented to reduce injuries during earthquake shaking. Three key areas are education, early warning, and engineering.

3.2.1 Education

People are more likely to undertake a behaviour if they understand the benefit of it (Vinnell et al., 2021). Campaigns to teach people what to do during earthquakes, such as the ShakeOut drill, could therefore be more effective if, as well as teaching why correct actions are effective, they also address why what people are currently doing (e.g., not acting, running to doorways) is unhelpful and potentially increasing their chances of being injured. Understanding what people do "wrong", and why, can help to make these education efforts more effective.

3.2.2 Early warning

Several countries now have earthquake early warning systems, including Japan, Mexico, and the US (Allen & Melgar, 2019). Work is underway in NZ to determine the feasibility and benefit of a potential national early warning system (e.g., Becker et al., 2020) and in 2021 Google launched their Android-based early warning system which has produced several alerts. These warnings are intended to give people time to prepare for strong earthquake shaking. While the most common perceived benefit among New Zealanders was the ability to mentally prepare, such warnings can also give people time to protect themselves. How these actions are communicated, in the short time available between receipt of the warning and arrival of shaking, should be informed by an understanding of people's current behavioural tendencies and motivations. For example, it may be more beneficial to give an instruction to *not* run for a doorway rather than an instruction to "Drop, cover, and hold" given the tendency for people to move in response to earthquake shaking.

3.2.3 Engineering

While many people are injured when they fall during earthquakes, a considerable number are injured by components of buildings. These can include external (e.g., balconies and facades) and internal (e.g., light fixtures and furniture) as well as structural and non-structural elements. Knowledge of what people tend to do during earthquakes can be used to inform design choices to both limit the number of elements which might pose a risk to people inside (and outside) buildings, as well as to provide more ways for people to protect themselves. For example, several individuals in the CCTV footage presented here attempted to get under seating, with only some succeeding after time and with effort. Decisions at the design stage could therefore include furniture which can be used to as cover during earthquakes.

4 CONCLUSIONS

Decades of research in other behavioural domains has shown that behaviour is typically influenced, albeit to varying extents, by the behaviour other people demonstrate. Some evidence suggests similar influences on how people respond to earthquake shaking; further work, using a combination of methods including CCTV footage analysis and both quantitative and qualitative retrospective studies, is necessary to fully understand these influences. This understanding will help to improve public education strategies. In particular, the examples presented here reiterate the importance of continuing to teach "Drop, cover, and hold" in initiatives such as the ShakeOut earthquake drill. Practising what to do during an earthquake will help to reduce the ambiguity of the situation so that people are more likely to act to protect themselves during shaking regardless of what people around them are doing. This will have the added benefit of sending a behavioural cue to those people and encouraging them to also protect themselves, further reducing the likelihood of injuries.

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